Marulan South Limestone Mine | SSD 7009

Water Management Plan

Prepared for Boral Cement Limited | 15 August 2022

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SSD 7009 | WATER MANAGEMENT PLAN

Prepared for Boral Cement Limited
15 August 2022

PR163

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Contents

Figures

Tables

Appendices

1 INTRODUCTION

1.1 Background

Boral Cement Limited (Boral) owns and operates the Marulan South Limestone Mine (the mine), an open cut mine located in Marulan South, New South Wales (NSW). Limestone mining north of Bungonia Gorge began around 1830 with major developments emerging in the 1920s to supply limestone for cement manufacturing and steel making.

The limestone mine was opened in 1929 to supply limestone for cement, manufacturing, and steel making. By 1953 two main pits (northern mine pit and southern mine pit) were well established and by the early 1970s the facets of the business included limestone for cement, steel making, agriculture, glass making, lime manufacturing, quicklime and hydrated lime.

The mine produces up to 3.38 million tonnes (Mt) of limestone-based products per year for the cement, steel, agricultural, construction and commercial markets.

Due to changes in the *NSW Mining Act 1992* (Mining Act) and the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act), a State significant development (SSD) consent under the EP&A Act was required to move mining operations beyond the area covered by the mining operations plan (MOP).

Two approvals are required for the mine:

- a consent for the Project (SSD 7009) under Part 4, Division 4.7 of the EP&A Act; and
- controlled action approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for impacts on listed threatened species and communities (sections 18 and 18A of the Act).

An environmental impact statement (EIS) was prepared to accompany the application for SSD 7009 and addresses the requirements of State agencies under the EP&A Act and the Commonwealth Department of Agriculture, Water, and the Environment. A response to submissions (RTS) report was subsequently prepared to consider and respond to agency and public submissions and provide clarification of project components where relevant.

Development consent (the consent) was granted by the Department of Planning, Industry and Environment (DPIE) on 19 August 2021, to continue mining limestone at a rate of up to 4 million tonnes per annum (Mtpa) for a period of up to 30 years (the Project).

To satisfy Condition of Consent (CoC) D5(i), the EIS, RTS, development consent and other publicly available information related to the assessment and determination of SSD 7009 can be accessed on DPIE's Major Projects Planning Portal (https://www.planningportal.nsw.gov.au/major-projects/project/9691).

The consent 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 Water Management Plan (WMP, the plan) is required in accordance with CoC B45.

This plan incorporates the relevant management measures presented in the EIS, RTS and conditions of consent relating to surface and groundwater**.** The WMP will be a dynamic document which will be updated as required over the life of mining operations until 31 August 2051.

This plan has been prepared by Michael Butcher of Advisian on behalf of Boral. DPIE has endorsed Michael as a suitably qualified and experienced person for the preparation of this plan (DPIE, 2021a).

1.2 Overview of operations

1.2.1 Site description

The Project site is in Marulan South, 10 km south-east of Marulan village and 35 km east of Goulburn. It is in the Goulburn Mulwaree Local Government Area (LGA).

The mine is separated from the Bungonia National Park (NP) and State Conservation Area to the south by Bungonia Creek and is separated from the Shoalhaven River and Morton NP to the east by Barbers Creek.

The Project site and surrounds are characterized by rolling hills of pasture interspersed with forest to the west, contrasting with the heavily wooded, deep gorges that begin abruptly to the east of the mine, forming part of the Great Escarpment and catchment of the Shoalhaven River.

Access is via Marulan South Road, which connects the mine and Boral's Peppertree Quarry with the Hume Highway approximately 9 km to the north-west. Boral's private rail line connects the mine and Peppertree Quarry with the Main Southern Railway approximately 6 km to the north.

The Project site covers historical and proposed future areas of disturbance and comprises two geographically separate areas:

- the existing mine including the proposed 30-year mine footprint and associated infrastructure; and
- the proposed Marulan Creek dam to be on Marulan Creek, within Boral landholdings approximately 2.5 km north of the mine entrance.

The Project site covers an area of 846.4 ha. The existing pre-SSD disturbance footprint is 341.5 ha with 256.5 ha of new disturbance associated with the proposed 30-year mine plan.

Most of the Project site is zoned RU1 - Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009. Mining and extractive industries are permissible in this zone with consent. The remaining area is zoned E3 - Environmental Management. Mining and extractive industries are prohibited in this zone. However, as agriculture is permitted in the E3 zone with consent, mining is also permitted in this zone under the Mining Sate Environmental Planning Policy with consent.

1.2.2 Overview of existing mining

The mine is sited on a high-grade limestone resource. Subject to market demand the mine has typically produced up to 3.38 Mt of limestone and up to 200,000 t of shale per annum.

The mine currently produces a range of limestone products for internal and external customers in the Southern Highlands/Tablelands, the Illawarra, and Metropolitan Sydney markets for use primarily in cement and lime manufacture, steel making, agriculture, and other commercial uses. Products produced at the mine are despatched by road and rail, with the majority despatched by rail.

Historically limestone mining was focused on the approximately 200-400 m wide Eastern Limestone and was split between a north pit and a south pit. A limestone wall (referred to by the mine as the 'centre ridge') rising almost to the original land surface, divided the two pits. The north and south pits were joined in 2016/2017 by mining the centre ridge to form a single contiguous pit, approximately 2.5 kilometres (km) in length. However, the north pit/south pit nomenclature remains important as current mining operation locations continue to be reported with respect to one or other of the old pits.

Limestone and shale are extracted using open-cut hard rock drill and blast techniques. Limestone is loaded using front end loaders and hauled either to stockpiles or the processing plant using haul trucks. Oversized material is stockpiled and reduced in size using a hydraulic hammer attached to an excavator.

Limestone processing facilities including primary and secondary crushing, screening, conveying and stockpiling plant and equipment are in the northern end of the north pit. Kiln stone grade limestone is also processed on site through the existing lime plant comprising kiln stone stockpiles, rotary lime kiln, hydration plant and associated auxiliary conveying, processing, storage, despatch plant and equipment. Overburden from stripping operations is emplaced in the Western Overburden Emplacement (WOE), west of the open cut pits.

1.2.3 Overview of approved project

Consent was granted for a 30-year mine plan accessing approximately 120 Mt of limestone down to a depth of 335 m. The mine footprint focuses on an expansion of the pit westwards to mine the Middle Limestone and to mine deeper into the Eastern Limestone. As the Middle Limestone lies approximately 70-150 m west of the Eastern Limestone, the 30-year mine plan avoids mining where practical the interburden between these two limestone units thereby creating a smaller second, north-south oriented west pit with a ridge remaining between. The north pit will also be expanded southwards, encompassing part of the south pit, leaving the remainder of the south pit for overburden emplacement and a visual barrier.

Limestone will be extracted at up to 4 Mtpa for 30 years until 31 August 2051. Clay shale will also continue to be extracted at up to 200,000 tonnes per annum (tpa). The limestone will be processed to create limestone and lime products including limestone aggregates and sand, hydrated lime and quick lime.

Existing infrastructure is being retained along with the following changes:

- relocation of a section of high voltage power line to accommodate a proposed overburden emplacement;
- realignment of a section of Marulan South Road, to accommodate a proposed overburden emplacement;
- relocation of the processing infrastructure and the stockpile and reclaim area at the northern end of the north pit to allow the northward expansion of the pit;
- development of a shared Road Sales Stockpile Area including a weighbridge and wheel wash to service both the mine and Peppertree Quarry; and
- construction of a 118 megalitre (ML) in-stream water supply dam on Marulan Creek.

Boral will transport up to 600,000 tpa of limestone and hard rock products along Marulan South Road to the Hume Highway, as well as 120,000 tpa of limestone products to the agricultural lime manufacturing facility.

The Project provides continued direct employment for 118 people on the mine site and 73 offsite. It will operate 24-hours per day, 7 days per week. Blasting will continue to be restricted to daylight hours on weekdays, excluding public holidays.

1.3 Environmental management framework

The mine operates in accordance with the Boral integrated Health Safety, Environment and Quality Management System (HSEQ MS) which establishes a strategic platform for regulatory compliance and continual improvement in environmental management. This framework is documented in GRP-HSEQ-1-01 Management System Framework and Operational Control. The Boral HSEQ MS is aligned with the international standard ISO-14001.

1.3.1 Environmental Management System

CoC D1 requires the preparation of an Environmental Management Strategy (EMS) for the mine. The EMS provides the mine's strategic framework for environmental management under which the WMP operates.

1.3.2 Alignment with other plans

The Groundwater Management Plan (GWMP) is a separate document that is a sub-plan to the WMP (Appendix A). The GWMP details the specific groundwater management aspects for the mine.

The WMP is aligned with the Biodiversity Management Plan (BMP), and Rehabilitation Strategy (RS) in regard water quality objectives at all stages of mine development. The RS and BMP details the specific aspects of managing the overburden emplacement areas, including the measures to ensure the geomorphological stability of the emplacements, proposed final land use and revegetation species. The BMP also details the baseline aquatic ecology monitoring of local creek systems and the monitoring required by the Trigger Action Response Plan (Section 7.1).

In consultation with DPIE (2021b), the WMP has been staged to include Stage 1 and 2 of the Project as described in the EIS. The Marulan Creek Dam has been deferred to Stage 3 of the Project and the Marulan Creek Dam Management Plan will be developed at a later date.

The WMP is aligned with Peppertree Quarry Water Management Plan. The Peppertree Quarry South West Overburden Emplacement Area (referred to in the EIS as the Northern Overburden Emplacement) was approved as part of Peppertree Quarry Modification 5. Construction, erosion and sediment control, management and maintenance of this area is undertaken by Peppertree Quarry (Boral, 2021).

1.4 Purpose and objectives

This WMP describes how Boral will manage and control water impacts of operating the mine for Stage 1 and 2 of the mine development as described in the EIS. The WMP will require updating prior to the commencement of Stage 3 of the development.

This WMP applies to all activities undertaken by the mine including water supply, water storage, overburden emplacement areas, erosion and sediment control measures and wastewater treatment.

Specific objectives of the WMP are to:

- comply with regulatory requirements including water licences, the consent and the Environment Protection Licence (EPL);
- meet the obligations and commitments identified in the Environmental Impact Statement (EIS) (Boral, 2019);
- ensure compliance with relevant environmental legislation;
- ensure compliance with the water management performance measures;
- minimise dirty water generation by implementation of appropriate erosion and sediment controls;
- maintain a sustainable water balance;
- protect surface and groundwater quality and availability;
- ensure appropriate water control systems are planned and established prior to commencement of any new activities with potential to impact water;
- ensures appropriate and representative monitoring is conducted for verification that the WMP is effectively implemented and meeting its objectives; and

- ensure appropriate contingencies and resources for mitigating adverse impacts to surface and groundwater from mining activities.

The WMP is prepared for a mixed audience of consent authorities, environmental regulators and site personal; the latter of which are responsible for implementing this plan as part of day-to-day operations.

1.5 Responsibility for implementation

The Site Manager carries ultimate responsibility for implementing this WMP and providing the necessary resources as required. The site Environmental Coordinator is responsible for carrying out and/or coordinating the monitoring and reporting requirements of this plan.

1.6 Document structure

In accordance with CoC B45 (e), the WMP comprises a Site Water Balance, an Erosion and Sediment Control Plan and a Surface Water Management Plan. As noted in Section 1.3.2, the Groundwater Management Plan (GWMP) is a separate document that is a sub-plan to the WMP, and the Marulan Creek Dam Management Plan has been deferred and will be developed prior to Stage 3 of the Project. The structure of the WMP is outlined in Table 1.1.

Table 1.1 Structure of the Water Management Plan

Section	Content
1	Provides an overview of the project and objectives of the plan
2	Outlines statutory requirements associated with the development consent, environmental protection licence (EPL) and consultation regarding the plan
3	Describes the existing environment of the site and baseline data
4	Outlines water management criteria and defines performance indicators
5	Describes the water management approach and actions to be implemented in the operation of the mine
6	Presents the surface water monitoring protocols
7	Describes contingency plans
8	Outlines the review and improvement requirements
9	Outlines incident response, reporting and complaint management
10	Lists references used in the plan preparation
Appendix A	Groundwater Management Plan
Appendix B	Erosion and Sediment Control Checklist
Appendix C	Trigger Action Response Plan
Appendix D	Erosion and Sediment Control Plans
Appendix E	Agency Consultation
Appendix F	Flocculant Assessment

2 STATUTORY REQUIREMENTS

2.1 Development consent

The WMP has been developed to meet the water related requirements of the CoC and detail the management measures that ensure the mine meets the necessary performance criteria (CoC B43). Table 2.1 presents the water management performance measures, Table 2.2 the specific requirements relevant to the WMP and identifies where each condition has been addressed in this plan. Aspects related to groundwater management are covered in a separate GWMP (Appendix A).

In consultation with DPIE (2021b), the WMP has been staged to include Stage 1 and 2 of the Project as described in the EIS. The Marulan Creek Dam has been deferred to Stage 3 of the Project and the Marulan Creek Dam Management Plan will be developed at a later date.

Table 2.1 Water Management Performance Measures

Feature	Performance	Section reference
Water management – General	• 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	Section 4.1, 5.1 and 5.3 Section 4.1 and 5 Section 4.1 and 5 Section 5.2 Section 4.1, 5.1 and 5.3.4 Section 5, 7.2
Barbers Creek, Bungonia Creek and Shoalhaven River alluvial aquifers	• Negligible impacts to alluvial aquifers as a result of the development, beyond those predicted in the document/s listed in condition A2(c), including: – negligible change in groundwater levels; – negligible change in groundwater quality; and – negligible impact to other groundwater users	GWMP
Groundwater springs	• Negligible impacts to groundwater springs as a result of the development, beyond those predicted in the document/s listed in condition A2(c), including: – negligible change in groundwater supply; and – negligible change in groundwater quality	GWMP
Aquatic and riparian ecosystems	• Negligible environmental consequences beyond those predicted in the document/s listed in condition A2(c) • Negligible decline in baseline channel stability • Develop site-specific in-stream water quality objectives in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000) and *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006)	Section 5 Section 4.2.4 and 6.5.2 Section 4.2.2 and 6.2
Marulan Creek Dam	• Negligible impacts on the quality and quantity of downstream flows and geomorphic processes in Marulan Creek and Barbers Creek as a result of the development, beyond those predicted in the document/s listed in condition A2(c) • Design, install and maintain dam infrastructure in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012)	Not applicable – Marulan Creek Dam construction is deferred beyond the term of this WMP
Erosion and sediment control works	• Design, install and maintain erosion and sediment controls in accordance with the guidance series *Managing Urban Stormwater: Soils and Construction* including *Volume 1: Blue Book (Landcom, 2004), Volume*	Section 5.3, Appendix C and Appendix D

Feature	Performance	Section reference
	2A: Installation of Services (DECC, 2008), Volume 2C: Unsealed Roads (DECC,2008), Volume 2D: Main Road Construction (DECC, 2008) and Volume 2E: Mines and Quarries (DECC, 2008) • Design, install and maintain any creek crossings in accordance with the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why Do Fish Need To Cross The Road*? *Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003) • Design, install and maintain any new infrastructure within 40 metres of watercourses in in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012)	Not applicable – No creek crossings proposed during the term of this WMP Not applicable – No new infrastructure proposed within 40 metres of watercourses
Clean water diversions and storage infrastructure	• Design, install and maintain the clean water system to capture and convey the 100 year ARI flood • Maximise, as far as reasonable, the diversion of clean water around disturbed areas on the site, except where clean water is captured for use on the site	Section 5.3and Appendix D
Sediment dams	• Design, install and maintain sediment dams in accordance with the guidance series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008) and the requirements under the POEO Act	Section 5.3 and Appendix D
Chemical and hydrocarbon storage	• Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standard	Section 4.1
Overburden emplacements	• Design, install and maintain emplacements to encapsulate and prevent migration of acid forming and potentially acid forming materials, and saline and sodic material • Design, install and maintain out-of-pit emplacements to prevent and/or manage long term saline seepage	RS

Table 2.2 Water Management Plan Requirements

Condition No.		Condition requirement	Reference
B45		The Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
a		be prepared by a suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary	DPIE (2021a)
b		be prepared in consultation with WaterNSW, DPIE Water, Fisheries NSW and the EPA	Section 2.2 Appendix E
c		describe the measures to be implemented to ensure that the Applicant complies with the water management performance measures (see B43)	Section 5
d		utilise existing local data and build on existing monitoring programs, where practicable;	Section 3
e		include a:	
	i	**Site Water Balance** that includes details of: • predicted annual inflows to and outflows from the site; • sources and security of water supply for the life of the development (including authorised entitlements and licences); water storage capacity; • water use and management on the site, including any water transfers or sharing with neighbouring mines; • licenced discharge points and limits; and	Section 5.2, 6.3 and 8.1

Condition No.		Condition requirement	Reference
		• reporting procedures, including the annual preparation of an updated site water balance;	
	ii	**Erosion and Sediment Control Plan** that: • is consistent with the requirements of Managing Urban Stormwater: Soils and Construction - Volume 1: Blue Book (Landcom, 2004) and Volume 2E: Mines and Quarries (DECC, 2008) • identifies activities that could cause soil erosion, generate sediment or affect flooding • includes a program to periodically review sheet, rill and gully erosion risks, particularly in relation to emplacement areas • includes a program to monitor the geomorphological stability of emplacement areas, in consultation with WaterNSW • describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk; • describes the location, function, and capacity of erosion and sediment control structures; and • describes what measures would be implemented to maintain (and if necessary decommission) the structures over time	Section 5.3, Appendix B and Appendix D
	iii	**Surface Water Management Plan** that includes: • detailed baseline data on surface water flows and quality of watercourses and/or water bodies potentially impacted by the development, including: – stream and riparian vegetation health; – channel stability (geomorphology); and – water supply for other surface water users; • a detailed description of the surface water management system, including consideration of mitigation measures to manage downstream risks associated with alkalinity, TSS and settling agents • details of the water licensing requirements for all water storages (i.e. exempt, harvestable rights or licenced); • detailed plans, design objectives and performance criteria for water management infrastructure, including: – water run-off diversions and catch drains; – water storages (excluding Marulan Creek Dam) and sediment dams; – emplacement areas; – backfilled pits and any final voids for the development;	Section 3, 4, 5 and Appendix D
		• surface water performance criteria, including trigger levels for identifying and investigating any potentially adverse impacts (or trends) associated with the development, for: – water supply for other water users; – downstream surface water flows and quality, including (but not limited to) specific trigger levels for TSS, metals, alkalinity, bicarbonate alkalinity and settling agents, which are informed by baseline data, having regard to the sensitivity of downstream waters; – downstream flooding impacts; – stream and riparian vegetation heath; and – post-mining water pollution from rehabilitated areas of the site;	Section 4.2
		• a program to monitor and evaluate: – compliance with the relevant performance measures listed in Table 4 and the performance criteria in this plan;	Section 6

Condition No.		Condition requirement	Reference
		– controlled and uncontrolled discharges and seepage/leachate from the site; – impacts on water supply for other water users; – surface water inflows, outflows and storage volumes, to inform the Site Water Balance; and – the effectiveness of the surface water management system and the measures in the Erosion and Sediment Control Plan;	
		• reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results; and	Section 8, 9 and Appendix C
		• a trigger action response plan to respond to any exceedances of the relevant performance measures or performance criteria, and repair, mitigate and/or offset any adverse surface water impacts of the development;	Section 7.1 and Appendix C
	iv	**Marulan Creek Dam Management Plan** • detailed plans, design objectives and performance criteria for the dam infrastructure; • detailed measures to ensure compliance with the relevant performance measures in Table 4; • performance criteria, including trigger levels for identifying and investigating any potentially adverse impacts (or trends) associated with the development with respect to: – downstream geomorphic processes; – sediment transmission; – ecological function; and – water quality • a program to monitor and evaluate compliance with the relevant performance measures in Table 4, including justification for proposed monitoring frequencies and parameters; • reporting procedures for the results of the monitoring program; • a remediation and rehabilitation strategy for areas of Marulan Creek both above and below the dam up to the entry to the Barber's Creek gorge, which has been prepared by a suitably qualified and experienced fluvial geomorphologist, having regard to A Rehabilitation Manual for Australian Streams (Land and Water Resources Research and Development Corporation, 2000); and • a trigger action response plan to respond to any exceedances of the relevant performance measures or performance criteria, and repair, mitigate and/or offset any adverse impacts on downstream flows and/or ecological processes;	Not applicable - Marulan Creek dam construction deferred to Stage 3 of the project, with management plan developed at a later date
	v	**Groundwater Management Plan** (requirements detailed in the Groundwater Management Plan)	GWMP
	vi	• a protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition D11.	Section 8
		Management Plan Requirements	
D5		Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:	
a		Summary of relevant background or baseline data;	Section 3
b		Details of	
	i	The relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 2 and 4.3
	ii	Any relevant limits or performance measures and criteria; and	Section 4

Condition No.		Condition requirement	Reference
	iii	The specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 4
c		Any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	Table 2.3 and Table 2.4
d		A description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Section 5
e		A program to monitor and report on the:	
	i	Impacts and environmental performance of the development; and	Section 6 and 8
	ii	Effectiveness of the management measures set out pursuant to condition D4(c);	Section 5.3.5 and 8
f		A contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 7
g		A program to investigate and implement ways to improve the environmental performance of the development over time;	Section 8.2
h		A protocol for managing and reporting any:	
	i	Complaint; or	Section 9.3
	ii	Failure to comply with other statutory requirements;	Section 9.2
i		Public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and	EMS
j		A protocol for periodic review of the plan.	Section 8.2

2.1.1 EIS Commitments

Commitments made in the EIS (Boral, 2019) related to surface water are summarized in Table 2.3. Additional water related commitments made in the Response to Submission process, are summarized in Table 2.4.

Table 2.3 EIS Commitments

EIS Section	Commitment	Reference
29.2 Construction (general)	A construction environment management plan (CEMP) will be prepared prior to, and implemented during construction of: • Marulan Creek dam • The realigned section of Marulan South Road • The relocated high voltage powerline • The intersection at the proposed Road Sales Stockpile Area	Not applicable – Marulan Creek dam and realigned section of Marulan South Road not proposed during the term of the WMP
29.2 Surface Water	The CEMP for the Marulan Creek dam, the relocated high voltage powerline and the Road Sales Stockpile Area intersection, will include and erosion and sediment control plan prepared in accordance with Landcom's (2004) *Managing Urban Stormwater: Soils and Construction*	CEMPs are yet to be developed, with works not proposed during the term of the WMP
	The CEMP for construction of the Marulan South Road realignment will include an erosion and sediment control plan prepared in accordance with DECC's (2008) *Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction*.	Not applicable – realigned section of Marulan South Road not proposed during the term of the WMP
	A water management plan (WMP) will be prepared and implemented for the mine and Marulan Creek Dam which will detail management system design, training, community consultation, complaint resolution protocols, strategies for performance improvement and responses to exceedances.	Not applicable – Marulan Creek dam not proposed during the term of the WMP

EIS Section	Commitment	Reference
	The WMP will include a trigger action response plan which will include, triggers, actions and responses based on the water quality triggers in Table 8.6 of the EIS.	Water quality triggers - Table 4.1 Trigger Action Response Plan – Section 7.1
	The WMP will include the requirement to undertake visual inspection of all temporary and permanent surface water management structures to identify any risks of failure or erosion.	Section 5.3.4
29.3 Monitoring – Weather	Weather will continue to be monitored at the mine's weather station and data recorded hourly including temperature, humidity, wind direction and speed and rainfall. Additional data that can be used by the mine including evapotranspiration and solar radiation are recorded at the Peppertree Quarry weather station.	Section 6.1
29.3 Monitoring – Water	Oil and grease, pH, total suspended solids and turbidity will be monitored during discharges from sediment basins at the locations and in the frequency described in Table 8.5 of the EIS.	Section 6.2.1
	The ongoing quarterly ambient surface water monitoring will continue for the parameters and at the locations identified in Table 2.2 and Figure 2.4 of the EIS. However, it may cease in Barbers Creek and Shoalhaven River when NOE, WOE and external sections of the SOE are complete and rehabilitated, pending results of initial monitoring after completion. Water quality monitoring results will be compared to the trigger values, and the TARP included in the WMP will be followed if there are exceedances of the trigger values.	Ambient monitoring detailed in Section 6.2.1 Overburden emplacement rehabilitation works will occur through the period of the WMP TARP details in Section 7.1
	Regular monitoring of water quality at the two Marulan Creek monitoring sites will be undertaken for the duration of construction of the Marulan Creek dam. The frequency of the monitoring would be identified in the WMP and/pr the CMP.	Not applicable – Marulan Creek dam not proposed during the term of the WMP.
	Flow meters will be installed on water transfer pipelines and water use points to record total flow rates and total flows and readings will be taken at least monthly.	Table 6.6
	Water levels in mine water dams will be recorded monthly	Table 6.5
	Water level and flow data will be used to confirm the accuracy of the water balance and predict water supply shortfalls.	Section 6.3
	Monitoring of the water level of the final void will be undertaken post mining to confirm the predicted seepage rate. Adaptive measures will be included in the WMP and will be undertaken if water levels in the final void exceed predicted levels under heavy rainfall conditions.	Not applicable – final void not proposed during the term of the WMP

Table 2.4 EIS Response to Submission Commitments

Response to submission	Commitment	Reference
19 February 2020	Include remediation and rehabilitation of channel degradation along streams in the project area (including Marulan Creek) in the rehabilitation management plan committed to in Table 29.2 of the EIS. Note that this part forms part of the Rehabilitation Management Plan.	RS
27 July 2020	Marulan Creek Dam Construction will include: • Best Practice Erosion and Sediment Control • Construction Erosion and Sediment Control Plan • Temporary diversion of creek during construction	Not applicable – dam not proposed during the term of the WMP
	Marulan Creek Dam Design will include: • Investigate options for inclusion of a low flow channel in the spillway design	Not applicable – dam not proposed during

Response to submission	Commitment	Reference
	• Multi-level offtake with control valve for riparian release flow control • Assessment of an appropriate inflow design flood to ensure spillway erosion resistance	the term of the WMP
	Marulan Creek Dam operation will include: • Riparian releases including flushing flow based on upstream flow trigger • Riparian restoration of Marulan creek upstream of the dam	Not applicable – dam not proposed during the term of the WMP

2.2 Consultation

CoC B45(b) requires this plan be prepared in consultation with WaterNSW, DPIE Water, Fisheries NSW and the EPA. A draft of this WMP has been provided to the above agencies. These agencies comments and how they have been addressed is included in Appendix E.

3 SUMMARY OF BASELINE DATA

3.1 Climate

3.1.1 Rainfall

Average rainfall is summarized in Table 3.1. Peak rainfall occurs in the summer months, with slightly lower rainfall in winter. Rainfall is highly variable ranging from a minimum of zero in a month up to a maximum of 407 mm. In wet (90th percentile) years the annual rainfall can be up to 847 mm while in a dry (10th percentile) year it can be as low as 455 mm.

Table 3.1 Monthly Rainfall (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average	69	72	73	53	52	67	44	48	45	58	59	60	698
Minimum	1	1	0	0	1	0	0	1	0	1	0	0	291
10th %ile	18	8	10	8	8	10	8	8	15	15	10	13	455
Median	57	53	53	39	27	45	32	31	37	44	53	52	671
90th %ile	104	119	120	83	83	103	66	67	68	81	92	93	847
Maximum	226	258	349	275	407	417	312	239	178	269	231	203	1499

Source: Silo, 2021

Design rainfall depths applicable to the design of site water conveyance and sediment control structures based on the IFD data are summarized in Table 3.2 and five-day rainfall total in Table 3.3.

Table 3.2 Design Rainfall Depth (mm)

Duration	Annual Exceedance Probability					
	50%	20%	10%	5%	2%	1%
5 min	6.43	8.66	10.2	11.8	14	15.7
10 min	10.1	13.9	16.6	19.3	23	25.9
15 min	12.5	17.2	20.5	23.9	28.5	32.2
30 min	16.8	22.7	27	31.2	37.1	41.8
1 hour	21.3	28.2	33.1	38.1	44.8	50.2
2 hour	26.8	35.1	40.8	46.6	54.4	60.6
3 hour	31	40.4	47	53.6	62.5	69.5

Source: ARR, 2016

Table 3.3 Design five-day rainfall (mm)

Rainfall percentile	Mittagong	Goulburn	Marulan
90th	49.0	28.6	35.7
95th	75.2	40.8	52.8

Source: Advisian, 2019

3.1.2 Evaporation

Two evaporation datasets have been used for different aspects of the water balance modelling undertaken for the mine:

- evapotranspiration data to account for surface water loss to vegetation
- pan evaporation for the purpose of accounting for evaporation from water storages and for dust suppression water requirements.

Evapotranspiration

For the purposes of modelling catchment runoff, Boughton (2010) recommends the use of areal potential evapotranspiration (Areal PET) data. Areal PET is the evapotranspiration that would take place, if there was an unlimited water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average.

Table 3.4 Average daily potential evapotranspiration (mm/day)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.7	4.1	3.3	2.4	1.6	1.3	1.3	1.9	2.7	3.7	4.4	4.7

Source: BOM, 2002

Pan Evaporation

Statistics of monthly pan evaporation for Marulan (1969 – 2021) are provided in Table 3.5. Pan Factor is applied to pan evaporation to estimate potential evaporation from water bodies, such as the mine water dams on the site.

Table 3.5 Monthly Pan Evaporation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg	143	101	92	53	43	29	33	32	68	93	105	127
Min	188	145	125	83	57	41	48	70	98	132	153	188
10th %	152	114	101	65	47	32	38	55	82	106	122	147
Median	190	145	123	83	56	40	47	70	97	128	150	179
90th%	226	178	149	101	71	52	58	89	120	163	180	236
Max	266	215	178	123	83	57	80	109	168	190	257	293
Pan Factor	0.79	0.79	0.77	0.80	0.80	0.85	0.88	0.88	0.87	0.88	0.85	0.81

Source: Pan evaporation (Silo, 2021), Pan Factor (McMahon et al, 2013)

3.2 Hydrology

The site is located within the catchment of the Shoalhaven River (NSW Drainage Basin 215), within the headwaters of Barbers Creek and Bungonia Creek tributaries.

Barbers Creek is bounded by the Morton National Park to the east for a distance of about 4 km upstream of the Shoalhaven River. Bungonia Creek runs through a section of the Bungonia State Conservation Area for a distance of about 4 km upstream of Boral owned land and is then bounded by the Bungonia National Park for the remaining 2 km to the confluence with the Shoalhaven River.

The site is drained by a number of minor ephemeral drainage lines into Barbers Creek to the east and Bungonia Creek to the south. These creeks are tributaries of the Shoalhaven River which, at its closest point, is located 1.5 km from the mine and flows eastwards into Lake Yarrunga, approximately 20 km downstream and enters the Pacific Ocean approximately 15 km east of Nowra (approximately 100 km downstream).

Prior to mining, the natural runoff generally drained in easterly and southerly directions across the site to Barbers Creek and Bungonia Creek respectively. Historical natural catchments have been identified using the earliest available archived aerial photography of the mine area from 1963 (NSW Department of Lands) and 1:250,000 topographic maps (Figure 4.4 of EIS).

The drainage pattern has been altered in places by mining activities over time. On the eastern and southern sides of the mine, steep batters have been constructed in external sections of both the North and South Pits above the steep ravines below.

The southern end of the mine area drains naturally towards Bungonia Creek. Incised gullies in the vicinity of the mine drain into Barbers and Bungonia Creeks before discharging into the Shoalhaven River immediately south-east and east of the mine respectively. A number of small farm dams currently exist on ephemeral creeks on the site and appear to retain water with little seepage. Main Gully is a drainage line that, prior to mining, had a catchment area of 230 ha, much of which has been subsumed by prior mining or overburden emplacements, but remains the main drainage line for the southern part of the Project area.

Marulan Creek and Tangarang Creek are ephemeral drainage lines located within the Barbers Creek catchment. The catchments of both creeks contain several farm dams and Tangarang Creek has been dammed to supply water for Peppertree Quarry.

3.3 Surface Water Flow

The creeks in the vicinity of the mine are all ephemeral, apart from the Shoalhaven River. Flow characteristics of the watercourses could potentially be impacted either by extraction of water (such as the proposed Marulan Creek Dam) or by discharge from the mine (such as runoff from the south-western area of the disturbance footprint which currently drains to the South Pit).

Flow characteristics retrieved from DPI Water gauge sites at Bungonia Creek at Bungonia (215014), Shoalhaven River at Fossickers Flat (WaterNSW gauge 215207), and AWBM derived model data for Marulan Creek, indicate:

- similar annual runoff expressed as depth over the catchment area for Marulan Creek and Bungonia Creek (53.3 mm/year compared to 54.9 mm/year) but a much longer flow recession for Bungonia Creek attributable to baseflow contribution
- significantly higher flow per unit area in the Shoalhaven River (117.8 mm/year – twice that of the flow in Bungonia Creek) mainly attributable to higher rainfall in the southern section of the catchment

Table 3.6 summarizes the flow characteristics.

Table 3.6 Flow statistics for Marulan Creek, Bungonia Creek and Shoalhaven River

Statistic	Marulan Creek at proposed dam site	Bungonia Creek at Bungonia (215014)	Shoalhaven River at Fossickers Flat
Catchment Area (km^2)	19.2	164	4,667
Average Annual Runoff (ML)	1,023	9,009	549,184
Average Annual Runoff (mm)	53.3	54.9	117.8

3.4 Surface Water Quality

Baseline surface water quality data was assessed in the EIS. Water quality sampling sites are shown in Figure 3.1, while water quality results, updated with additional monitoring data to June

2021, are in Table 3.7. pH, salinity and suspended solids in the Marulan, Barbers and Bungonia creeks generally exceed the ANZECC default trigger values, while the water quality in the Shoalhaven River generally do not exceed the ANZECC trigger values. However, these elevated results for the smaller creeks are consistent with the regional water quality results reported by WaterNSW.

Specific trends for each creek are summarized below:

- Marulan Creek and Tangarang Creek. The Marulan Creek water quality data indicates that water quality improves for some parameters as it moves downstream. Also, the water quality for both Marulan Creek and Tangarang Creek indicate that this water is diluted in Barbers Creek, as demonstrated by the better water quality of Barbers Creek.
- Bungonia Creek and Barbers Creek. Both creeks demonstrate a small water quality decline when comparing upstream and downstream results. The difference observed between upstream and downstream water quality for Barbers Creek and Bungonia Creek is not significant, indicating that under existing operational practices the mine has no impact on surface water quality.
- Shoalhaven River. Very slight decreases between the upstream sampling point (SR1) and further point downstream (SR3) across all analytes are recorded in the Shoalhaven River sampling points. This decreasing trend is similar to Barbers and Bungonia Creeks records, indicating water quality generally declines through this system possibly due to broader land-use and runoff quality influences.

Table 3.7 Baseline surface water quality

Analyte	Unit	Statistic	Marulan Up	Marulan Down	Tangarang Up (U1)	Tangarang Down (T1)	Barbers Up	Barbers Down	Bungonia Up	Bungonia Down	SR 1	SR 2	SR 3	ANZECC* Default
pH	pH	Count	27	26	3	24	36	35	39	39	30	38	38	6.5 - 8.0
		20th %ile	7.6	7.8	7.5	7.7	7.8	7.9	7.6	7.9	7.3	7.1	7.1	
		Median	7.8	8.0	7.6	8.1	8.0	8.0	7.8	8.1	7.4	7.4	7.4	
		80th %ile	7.9	8.2	7.8	8.3	8.1	8.1	7.9	8.2	7.5	7.5	7.5	
Electrical Conductivity @ 25°C	µS/cm	Count	27	26	3	24	36	35	39	39	30	38	38	350
		20th %ile	438	649	151	523	422	452	450	488	84	89	94	
		Median	1020	1020	245	683	638	679	599	590	103	107	113	
		80th %ile	1512	1280	270	898	922	1002	746	697	139	140	143	
Total Dissolved Solids	mg/L	Count	27	26	3	24	36	35	39	39	30	38	38	NA
		20th %ile	284.8	422.0	98.4	339.8	274.0	293.6	290.0	316.8	54.8	58.0	61.4	
		Median	663.0	663.0	159.0	444.0	414.5	441.0	389.0	384.0	66.5	69.5	73.5	
		80th %ile	984.8	832.0	175.2	583.4	599.0	651.2	485.0	452.8	90.4	90.4	92.4	
Suspended Solids	mg/L	Count	18	17	3	24	26	18	30	26	18	25	26	NA
		20th %ile	2.5	2.5	5.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
		Median	6.5	2.5	10	4.4	2.5	2.5	2.5	2.5	2.5	2.5	6	
		80th %ile	10	5.3	20.8	40.6	2.5	2.5	5	5	7.6	6.2	8	
Total Nitrogen as N	mg/L	Count	27	26	0	0	36	35	36	39	30	38	38	0.25
		20th %ile	0.52	0.40			0.30	0.20	0.50	1.62	0.28	0.20	0.30	
		Median	0.80	0.60			0.40	0.40	0.85	2.40	0.45	0.40	0.45	
		80th %ile	1.10	0.80			0.60	0.60	1.40	3.74	0.60	0.50	0.60	
Total Phosphorus as P	mg/L	Count	27	26	3	24	36	35	36	39	30	38	38	0.02
		20th %ile	0.02	0.01	0.13	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
		Median	0.03	0.01	0.26	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
		80th %ile	0.09	0.02	0.50	0.03	0.01	0.02	0.01	0.01	0.02	0.02	0.02	

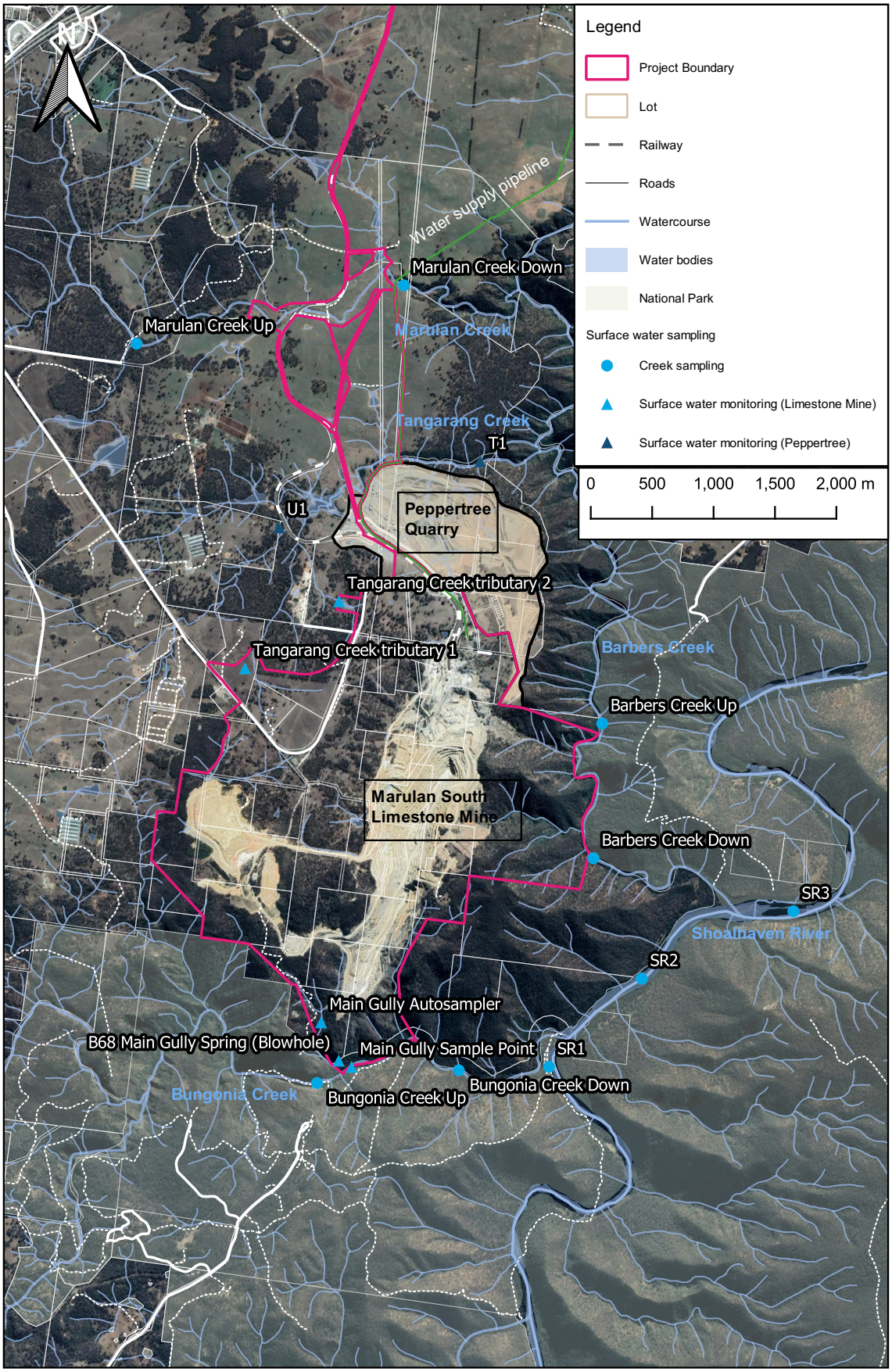


Figure 3.1 Water quality monitoring sites

3.5 Stream and riparian vegetation health

Marulan Creek and Tangarang Creek are fourth order streams and drain to the Shoalhaven River via Barbers Creek. The proposed dam on Marulan Creek and the existing dam on Tangarang Creek are located on an escarpment where grass forms the majority of the vegetation cover in the bed of the creek (Figure 3.2). Further downstream, the creeks drain down into steep rocky gorges (Figure 3.3).

Figure 3.2 Marulan Creek upstream of the proposed dam site

Figure 3.3 Marulan Creek downstream of the proposed dam site

Barbers Creek is a fifth order stream at the junction with the Shoalhaven River, based on the Strahler Stream Order system. About 1.5 km upstream of the confluence with Marulan Creek, Barbers Creek enters a steep sided gorge which extends for a distance of about 8 km down to the Shoalhaven River, which is characterised by a rocky boulder-strewn channel with rock pools (Figure 3.4).

Figure 3.4 Barbers Creek at water quality monitoring point 'Barbers Creek Up'

Bungonia Creek is also a fifth order stream at the junction of the Shoalhaven River and comprises a rocky boulder-strewn channel with pools (see Figure 3.5). Like Barbers Creek, it runs through a steep sided narrow gorge for about 8.5 km upstream of the confluence with the Shoalhaven River.

Figure 3.5 Bungonia Creek near confluence with 'Main Gully'

The Shoalhaven River, in the reach mid-way between Bungonia Creek and Barbers Creek, has a wide channel with sandy banks indicating significantly lower velocities than those experienced in Bungonia Creek and Barbers Creek (Figure 3.6).

Figure 3.6 Shoalhaven River mid-way between Bungonia and Barbers Creeks

3.6 Channel stability (geomorphology)

Watercourses in the project area are characteristics according to the River Styles Framework (Fryirs and Brierley, 2005) and geomorphic naming convention (Fryirs and Brierley, 2018). The upper reaches of Marulan Creek and on Tangarang Creek are in a Laterally Unconfined Valley setting with combination of channelised fill (LUV CC) and valley filled - fine grained (LUV DC), with creek gradients in the order of 0.5% to 1%. In the area of the proposed Marulan Creek Dam, there is a reach of Laterally Unconfined Valley, with a discontinuous channel - chain of ponds, fine grained (LUV – DC), as shown in Figure 3.2. Both Marulan and Tangarang Creek then enter a Confined Valley Setting – Gorge (CVS – Gorge), with gradient increasing to as much as 10% in the reach between the escarpment and confluence with Barbers Creek (DPIE, 2022).

On Barbers Creek, about 1.5km upstream from the confluence with Marulan Creek, Barbers Creek enters a steep sided gorge (CVS-Gorge) which extends for a distance of about 8 km down to the Shoalhaven River. This section is characterised by a rocky boulder-strewn channel with rock pools and channel gradient ranges from about 5% to 6%.

The River Style of Bungonia Creek adjacent to the Project is Confined Valley Setting - Gorge (CVS-Gorge), with gradients in the order of 4%. The Bungonia Creek catchment is about three times larger than that of Barbers Creek and therefore has sufficient flow during large floods to mobilise the larger boulders.

3.7 Water supplies for other surface water users

No water is supplied by the mine to other water users.

4 WATER MANAGEMENT OBJECTIVES AND PERFORMANCE CRITERIA

4.1 Water Management Design Objectives and Performance Criteria

The design objectives for the site water management system are to:

- minimise impacts on the receiving environment by retaining all overburden emplacement runoff on-site except where the rainfall exceeds the specified design storm
- separate runoff from undisturbed, rehabilitated and mining affected areas
- design and manage the system to operate reliably throughout the life of the mine in all seasonal conditions, including both extended wet and dry periods
- design permanent drainage infrastructure to be stable in storms up to the 1% AEP
- maximise site water supply using runoff from the overburden emplacement areas, and thereby minimise the requirement for external water supply
- minimise the number of licenced discharge points
- design post-mining drainage systems and a final landform to reflect pre-mining catchment areas and flows where practicable
- chemical and hydrocarbon products will be stored in in accordance with the relevant Australian Standard
- rehabilitated mine landforms will be designed to shed water without causing excessive erosion or increasing downstream pollution
- the final pit void will not require any water releases.

To support the design objectives, the following performance criteria have been developed:

- clean water diversions and storage infrastructure designed to capture and convey 100 year Average Recurrence Interval (ARI) flood
- temporary drainage (erosion) controls are designed to have non-erosive hydraulic capacity to convey runoff from the 20-year ARI storm event according to the criteria for ‘sensitive’ environments
- water storages do not release or overflow offsite
- sediment basins are designed for the 95th percentile 5-day storm (52.8 mm) according to the criteria for discharge to ‘sensitive’ environments
- dimensions and frequency of occurrence of erosion rills and gullies in overburden emplacement areas are generally no greater than that in reference sites that exhibit similar landform characteristics (as detailed in the RS).

Detailed plans, design objectives and performance criteria of water management infrastructure of backfilled pits and final voids are not described in this WMP, as it has been developed for Phase 1 and 2 of the Mine. An overview of the final concept landform design and control measures is detailed in the RS.

4.2 Surface water performance criteria and trigger values

4.2.1 Water supply for other users

The Greater Metropolitan Region Unregulated Area Water Sharing Plan set out the rules for the sharing of water between users to ensure sustainable water use within catchments while protecting environment. Water Access Licences (Boral’s licences are detailed in Section 4.3.1)

define maximum annual water 'take' for each licence holder. Extraction in accordance with the requirements of the Water Access Licence ensures equitable water sharing within the catchment.

As detailed in Section 3.7, no water is supplied by the mine to other water users.

Performance criteria

Sufficient Water Access Licence entitlements to meet actual and projected water demand for the mine.

Trigger values

Actual or projected annual extraction exceeds values in Table 4.2.

4.2.2 Surface water quality

Based on Southern Rivers Catchment Action Plan (Southern Rivers Catchment Management Authority, 2013), the water quality criteria for physical and chemical ecological stressors specified in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) have been adopted as water quality objectives for the mine.

Performance criteria

Water quality meets site-specific in-stream water quality objectives of the ANZECC Fresh and Marine Water Quality Guidelines (2000), considering local reference systems data.

Triggers

Sufficient baseline water quality data is available to characterize the baseline conditions (detailed in EIS Appendix G – Annexure C). and determine site-specific trigger values in accordance with Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000) and Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006). Considering the slightly disturbed ecosystem condition, the EIS recommended site-specific trigger values which have been expanded to also include metals, alkalinity and bicarbonate alkalinity. If settling agents (flocculants) are used, specific triggers will be established based on a risk assessment (detailed in Appendix F). Due to local ecosystem variability, site specific water quality trigger values appropriate to conditions recorded at the mine were derived from the 20th and 80th percentile values for Bungonia Creek and Barbers Creek. Default toxicant trigger values for 95% protection levels (ANZECC Guidelines Table 3.4.1) have been applied rather than 80th percentile, as results are less than the default trigger values. The surface water trigger values, for identifying and investigating any potentially adverse impacts (or trends) associated with the site, are summarized in Table 4.1 .

Table 4.1 Surface water quality trigger values

Indicator	Site Specific Guideline Value
pH	6.5 – 8.5
EC µS/cm	1,600
Total nitrogen (mg/L)	4.0
Total phosphorus (mg/L)	0.03
Turbidity (NTU)	25
Total suspended solids (mg/L)	50
Total alkalinity (mg/L)	200
Bicarbonate alkalinity (mg/L	200
Aluminium (mg/L)	0.055
Arsenic (mg/L)	0.013
Copper (mg/L)	0.0014
Lead (mg/L)	0.0034
Manganese (mg/L)	1.9
Nickel (mg/L)	0.011
Zine (mg/L)	0.008

4.2.3 Downstream flooding impacts

Impacts on flooding were associated with the Marulan Creek Dam, which as described in Section 1.3.2 has been deferred beyond the term of this WMP.

Performance criteria

Negligible change in downstream flooding regime as a result of mine.

Trigger values

The Flood Study from the EIS will be updated during the design of the Marulan Creek Dam to determine any potential changes in downstream flood regime.

4.2.4 Stream and riparian vegetation health

Performance criteria

Negligible decline in baseline channel stability.

Trigger values

Inspections (see Section 6.5) identify decline in baseline channel stability.

4.2.5 Post-mining water pollution from rehabilitated areas of the site

As detailed in Section 1.3.2, the WMP has been staged and only includes Stages 1 and 2. Release of water from rehabilitated areas will be described in future updates to the WMP.

4.3 Licencing

4.3.1 Water Access Licences

The mine is located within Barbers Creek Management Zone and has Water Access Licences (WALs) issued under the Water Management Act (2000). Table 4.2 summarizes the licences held by Boral.

Table 4.2 Water Access Licences

WAL No	Works Approval	Water Source	Management Zone	Entitlement (ML)
Unregulated River				
WAL25207	10WA102352	Shoalhaven River Water Source	Barbers Creek Management Zone	76
WAL25373	10WA102377	Shoalhaven River Water Source	Barbers Creek Management Zone	10
Total Unregulated River				86
Domestic and stock				
WAL25352	10WA102352	Shoalhaven River Water Source	Barbers Creek Management Zone	1
Aquifer				
WAL24697	10WA116141 and 10WA116142	Goulburn Fractured Rock Groundwater Source		12
WAL41976		Goulburn Fractured Rock Groundwater Source		838
Total Aquifer				850

4.3.2 Environmental Protection Licence

Boral is the licensee of EPL 944 for the “Marulan South Limestone Mine and Lime Plant” for 100,000-250,000 tpa of lime production and 2-5 Mtpa of minerals obtained by mining. The licence only specifies groundwater monitoring at the North Pit Bore.

Boral will apply for a variation to the EPL to specify conditions for water quality monitoring and discharge from Sediment Basins W1, N2 and S2 following rainfall when there is not capacity in onsite storages to allow for the transfer of water or when design criteria are exceeded (i.e. where rainfall exceeds 52.8 mm in a 5-day period). The location of the basins and the discharge points is shown in Appendix D (Erosion and Sediment Control Plan MSLM-WMP-ESCP-0005), with details in Table 5.6.

4.3.3 Maximum Harvestable Rights

The maximum harvestable right dam capacity (MHRDC) for a landholding is calculated by multiplying the area of the land holding by a location specific multiplier value, available from the online calculator on the WaterNSW website. The landholding owned by Boral attributable to the Project for purposes of harvestable rights is 481 ha as detailed in the Surface Water Assessment (Advisian, 2019). Accordingly, the MHRDC for The Project is approximately 36 ML. The existing clean water storage dams within the project landholding are shown in Table 4.3, with total storage 6.8 ML compared to the MHRDC of 36 ML.

Table 4.3 Identified Clean Water Storage Dams within the Project

Clean Water Dam	Location	Volume (ML)
Minor Mine Dam 1	Located upstream of mine operations north east of the WOE	4.0
Minor Mine Dam 2	Located north east of Main Gully overburden emplacement	0.5
Minor Mine Dam 3	Located in far west of site west of WOE	0.4
Minor Farm Dam 1	Located north of CML16 upstream of WOE	0.3
Minor Farm Dam 2	Located immediately upstream of the WOE	1.0
Northern clean water diversion dam	Clean water diversion around Main Plant 2 dam	0.6
TOTAL		**6.8**

Consultation with DPI Water during the EIS confirmed that the sediment basins and water storage dams proposed as part of the Project, including structures that collect runoff from haul roads, limestone stockpiles and infrastructure areas, as well as sediment basins constructed to control runoff from emplacements, would be required for purposes of pollution control and would therefore be exempt from the Project's MHRDC.

5 WATER MANAGEMENT AND CONTROL MEASURES

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. The site water balance has been developed to assess the performance of the water management system.

The overall strategy for the management of water for the Project is based on the separation of water from different sources based on anticipated water quality as follows:

- wherever possible, 'clean' surface runoff will be diverted around disturbed areas and released from site
- no further overburden will be placed on the Eastern Emplacement (eastern batters) and any remaining disturbed areas would be rehabilitated as detailed in the RS
- 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 WOE to the north
  - construct a Northern Overburden Emplacement (NOE), also referred to as Peppertree Quarry SWOE (as detailed in Section 1.3.2)
- 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 sediment basins that have been provisionally sized (see Section 5.3.5)
- 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. In the event that there is insufficient capacity in the mine water dams to retain water pumped from the sediment basins, water quality in the sediment basins would be tested and flocculant added if necessary to achieve total suspended solids of 50 mg/L for discharge
- areas that would continue to drain to the mine pit are:
  - lime production facilities
  - limestone blending and stockpiling
  - the northern face of the SOE
  - other areas immediately adjacent to the western side of the mine pit.
- any excess water in the mine water dams will overflow to the mine pit
- to the extent possible, post mining catchment areas draining from the site will be comparable to the pre-mining catchment areas draining to the following discharge locations:
  - the SOE and the southern section of the WOE will drain to Main Gully
  - the northern section of the WOE and the north-west corner of the NOE will drain to tributaries of Tangarang Creek upstream of the water supply dam for Peppertree Quarry

5.1 Surface Water Management System

5.1.1 Water supply

Current water supply for lime hydration, kiln cooling and non-potable uses in this area of the site has been provided by pipeline from Tallong Weir. Water from the Tallong Weir is supplied under

a lease agreement with the State Rail Authority until 2027, providing up to 75 ML/year. Additionally, on-site bores provide up to 187 ML/year.

The progressive development of the water management system accounts for the ongoing development of the open cut and mine areas, as well as the continuing prompt rehabilitation of sections of the overburden emplacements once the final level and landform has been achieved. The progressive development of the mine is depicted in Appendix D. Water management structures, such as sediment basins, storage dams and drains, as well as indicative drainage pathways, are detailed on each figure. A schematic of the water management system is provided in Figure 5.1.

Stage 1 – (5 years) (Appendix D – MSLM-WMP-ESCP-0005) involves:

- Construction of the new Central and Eastern Gully water storage dams, enlargement of the existing Kiln Dam, revegetation of all new dam walls
- Pipeline connecting Eastern Gully Dam to Kiln Dam via the Reservoir
- Construction of the North Pit Sump towards the end of Stage 1 following north west mine development
- Installation of pipelines to connect N1 and N2 to Kiln Dam, Eastern Gully Dam to Kiln Dam via the Reservoir, and W1 and W2 to Central Dam
- Completion of construction of Sediment Basin W1 to control runoff from the upper slopes of the WOE that progresses northwards toward Marulan South Road
- Completion of rehabilitation of the lower slopes of the WOE
- Progressive “in-pit” filling of the SOE and commencement of western “out-of-pit” section. Progressive rehabilitation of the lower south-eastern slopes of the SOE.

Aspects of the water management system completed as part of the Peppertree Quarry operations (as detailed in the Peppertree Quarry Water Management Plan (Boral, 2021)) involves:

- Construction of Sediment Basins N1 and N2 in preparation for emplacement of overburden in the Northern NOE
- Completion of the NOE including overburden emplacement to create southern stockpile/reclaim area. Commencement of rehabilitation of western section of NOE
- Construction of Sediment Basin P1 to receive runoff from the new shared road sales stockpile area.

Stage 2 – (8 years) (Appendix D MSLM-WMP-ESCP-0011) involves:

- Complete rehabilitation of the NOE (northern section) and complete construction of new stockpile/reclaim area infrastructure (southern section of NOE) to allow northern mine pit development
- Progressive filling and rehabilitation of the southern section of the WOE
- Progressive filling of the SOE above current South Pit rim. As the level of overburden rises above the level of the South Pit rim, Sediment Basin S1 would be constructed at approximately 440 m AHD. Water captured in this sediment basin would be used for revegetation purposes and dust suppression in the immediate area. Any overflow to be directed along the contour to limestone benches to drain to the base of the South Pit.
- A small area in the SOE (0.8 ha) which would be at a lower elevation than Sediment Basin S1 would drain towards Main Gully where the existing sediment control facilities would be enlarged (to 1 ML) to form Sediment Basin S2 to treat any runoff from the emplacement and natural catchment before it discharges towards Bungonia Creek.
- Progressive rehabilitation of the lower southern and south-eastern slopes of the SOE and upper slopes of the western “out-of-pit” section.

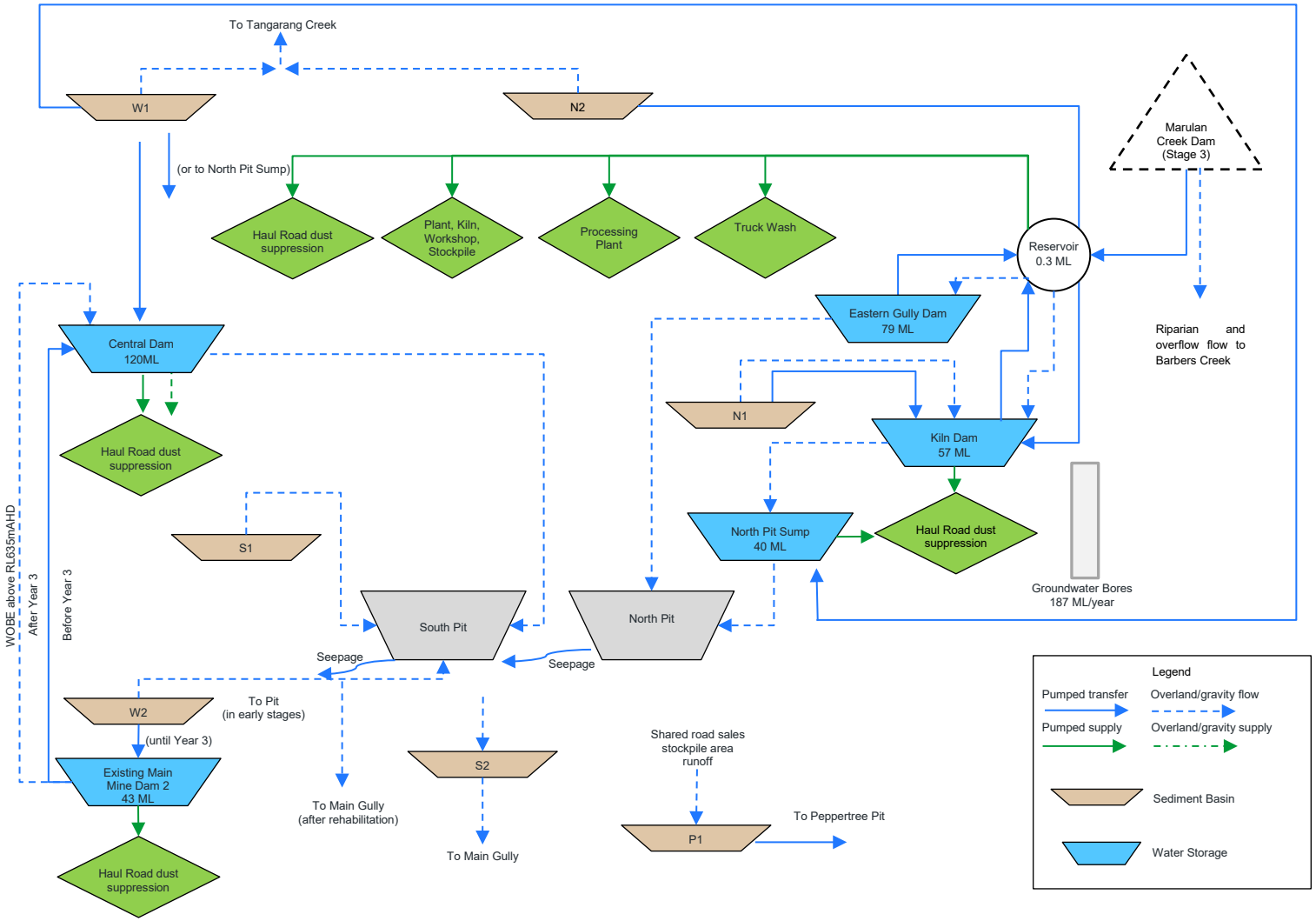


Figure 5.1 Water Management System Schematic

5.1.2 Water Storage Dams

Existing mine water supply storage dams are detailed in Table 5.1. Dams proposed to be constructed during the term of the WMP are detailed in Table 5.2.

Table 5.1 Water storage details

Storage	Catchment/ Water Source	Notes	Volume (ML)
Main Plant Dam 1 (Kiln Dam)	Water pumped from Tallong Weir	Currently overflows to the mine pit.	27
Main Plant Dam 2	Runoff from processing plant area	Dam will be replaced by the Northern Pit Sump	11
Main Mine Dam 1	Runoff from catchment of the WOE	Previously provided a source of water for dust suppression. Has now been subsumed by the expansion of the WOE	12
Main Mine Dam 2	Runoff from catchment of the NOE (21 ha)	Provides intermittent water supply for dust suppression. Will be subsumed by the expansion of mining to the west	43

Table 5.2 Proposed water storage

Storage	Catchment/ Water Source	Notes	Volume (ML)
Enlarged Kiln Dam	Tallong Weir, overflow from Sediment Basin N1, excess water from Sediment Basins N1 and N2	Overflow will be redirected to North Pit Sump once constructed.	57
Eastern Gully Dam	Water pumped from Tallong Weir, Northern Bore, transfer from Kiln Dam and runoff from the Peppertree Southern Overburden Emplacement Area (10 ha)	Water to be pumped back to the site reservoir for use in the lime processing plant and for haul road dust suppression. Dam overflows to the natural drainage line and into the mine pit.	79
Central Dam	Excess water initially from Sediment Basin W2 and then from W1, plus catchment runoff from the WOE (56 ha)	Water to be used for haul road dust suppression. Dam overflows to the natural drainage line and into the mine pit.	120
North Pit Sump	Overflow from enlarged Kiln Dam and runoff from the plant (31 ha) northern catchment of the mine pit (68 ha)	Water to be used for haul road dust suppression. Dam overflows to the main pit.	40

5.1.3 Sewage treatment

The on-site sewage management systems are described in Table 5.3 and shown in Figure 5.2.

Table 5.3 On-site sewage management systems

Facility	Type	Capacity	People serviced	Effluent disposal
Main envirocycle treating offices, laboratory, bathrooms, store and conference room	Super Treat AWT 2 tank	Septic 4,300 L, treatment 4,500 L	30	Irrigation
Two lime plant envirocycles treating kiln control room, hydration, dispatch and workshop areas	Super Treat	Septic 4,300 L, treatment 4,500 L	10	Absorption trench
	Super Treat	Septic 4,300 L, treatment 4,500 L	10	Absorption trench
Two septic tanks, one in the machine shop/primary crusher and the other near Fettler's Shed	Septic tank	3,000 L	20	Pump out – weekly
	Septic tank	4,500 L	2	Absorption trench
Two septic tanks in services department	Septic tank with absorption trench	4,500 L	10	Absorption trench
Oil and grease separator	Oil and grease separator	-	-	-

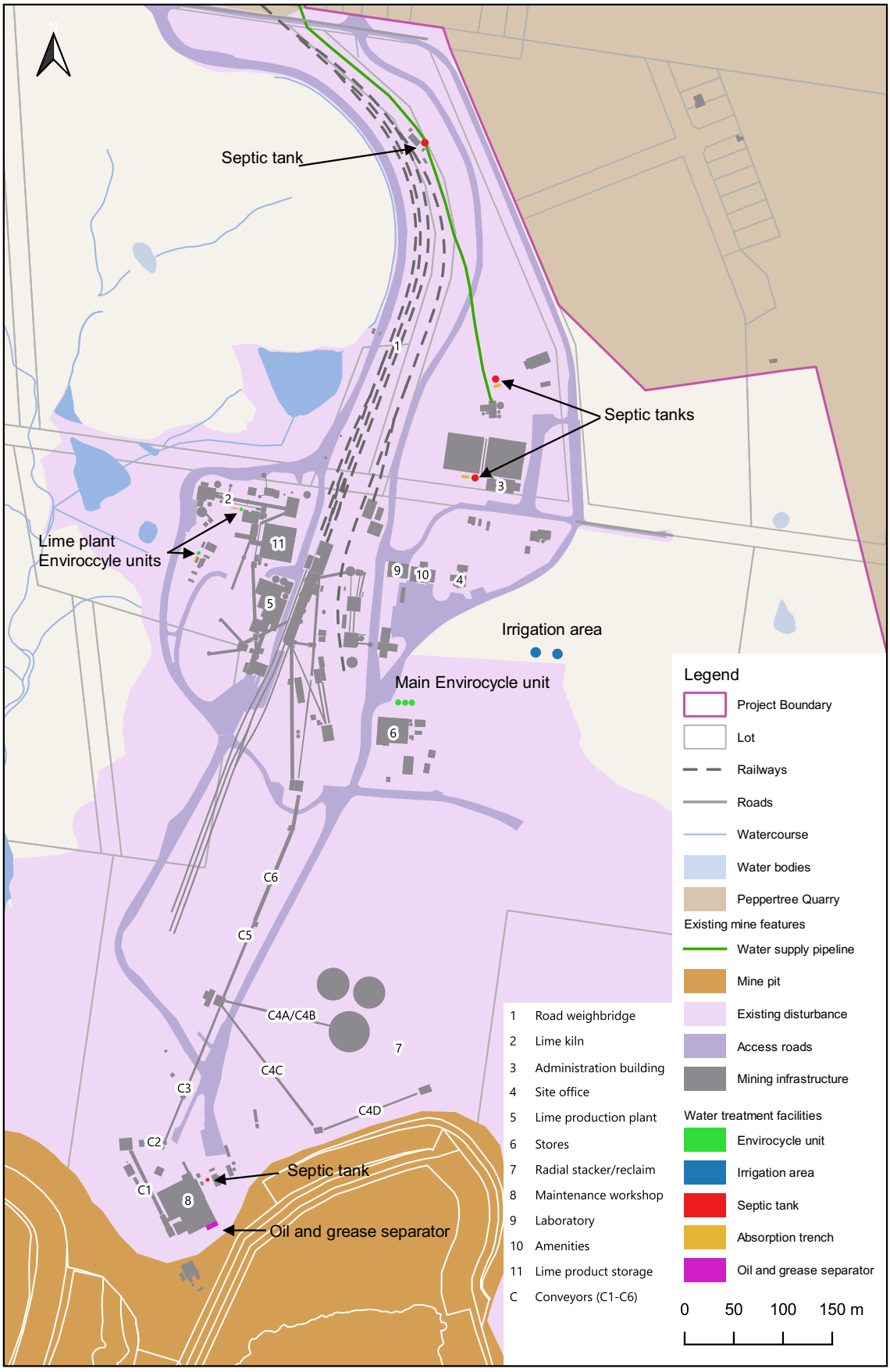


Figure 5.2 Water treatment facilities

5.2 Site Water Balance

The performance of the water management system over the life of the mine has been assessed using a daily water balance model. The water balance model accounts for runoff from the overburden areas and all inflows to and losses from storages. The model includes the progressive changes in the mine as well as taking account of climate conditions (rainfall and evaporation) which govern the runoff from the overburden emplacements and the requirement for water for haul road dust suppression. The water balance model details are included in the SWA.

The Water Balance Model has been updated for the WMP, including:

- Climate data has been extended, now covering the period of 1 July 1889 – 30 June 2021
- Period assessed is 13 years, equivalent to Stages 1 and 2 described in the SWA
- Supply from Marulan Creek Dam has been deferred to Stage 3 (after 13th year)
- The northern pit bore (12 ML/year) has been decommissioned and removed from the model. Current on-site bore supply has a maximum extraction rate of 187 ML/year
- Tallong Weir Supply has been extended from 2 years to 6 years

Water supply for processing and dust suppression requirements are prioritized to maximize water recycling and minimize the requirements for external supply. The priority of water sources for water supply is as follows:

- Excess water stored in sediment basins
- Water stored in mine water storage dams
- Extraction of groundwater from existing groundwater bores
- Supplementary supply from Tallong Weir

The predicted median annual water demand is 120 to 127 ML/year. During extreme dry conditions, annual demand could be expected to increase to 175 ML/year as a result of increased dust suppression requirements. Table 5.4 summarizes water balance modelling results of the Water Management System, with the change in storage indicating that water stored in the mine water dams is generally increasing each year through Stage 1 and 2 of the Project.

Table 5.4 Median water balance results (ML/year)

	Year 1	Year 5	Year 10
Water sources			
Rainfall	16	41	42
Runoff	688	865	848
Bore	59	28	44
Tallong Weir	24	12	0
Groundwater inflow	8	9	11
Total inflow	**795**	**955**	**945**
Demand			
Haul road dust suppression	64	60	67
Plant	80	80	80
Total demand	**124**	**120**	**127**
Losses			
Evaporation – dams	29	69	72
Evaporation – groundwater	8	9	11
Sediment basin overflow	4	18	16
Diversion from rehabilitation	0	0	0
Seepage	598	718	715

	Year 1	Year 5	Year 10
Total losses	**639**	**814**	**814**
Change in storage	32	21	4
Balance	**0**	**0**	**0**

Boral currently holds water entitlements to meet the maximum annual off-site water demand during the first 13 years of operation. Water balance modelling shows that the plant and dust suppression demands can be met without supply from the proposed Marulan Creek Dam during this period.

5.3 Erosion and Sediment Control

Design and scheduling of rehabilitation works (as detailed in the RS) is the primary erosion and sediment control measure for the Project. During the operational phase erosion control is priority for managing surface water runoff quality and alleviating pressure on the site sediment basins. The erosion and sediment controls provided in this WMP comply with the requirements of CoC B45(e)(ii).

The approach to the design and management of erosion and sediment controls have been adopted from various guidelines including:

- Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom 2004) – referred to as the "Blue Book"
- Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008)
- Minimum design criteria for sediment basins and runoff conveyance structures as set out in Table 6.1 of Volume 2E – Mines and Quarries (DECC, 2008)
- Appendix D of Managing Urban Stormwater: Soils and Construction, Volume 2D – Main Roads (DECC, 2008) to address requirements for road construction.

5.3.1 Activities that could cause soil erosion, generate sediment or affect flooding

Activities that could cause soil erosion, generate sediment or affect flooding include:

- Expansion of mining operations including pre-clearing activities and construction of overburden emplacements
- Development of sediment basins
- Rehabilitation and/or revegetation of:
  - the overburden emplacements
  - upper "inner" facing slopes of the SOE
  - upper mine benches and infrastructure areas
- Contouring banks and channels.

5.3.2 Erosion risk program

The erosion risk program has been developed to select the most suitable erosion and sediment control measure which will be implemented prior to any disturbance of land, including the development of sediment basins during ongoing mine operations.

The erosion risk program includes:

- Prior to land being disturbed, the area to be marked out and personnel will be instructed that works cannot extend outside the boundary of this area. This will ensure that the erosion and sediment control measures set up are able to capture the area of land being disturbed.
- Land disturbance will be minimised by clearing the smallest practical area possible and rehabilitating non-active operational areas as quickly as possible.
- The selection of the most suitable erosion and sediment control measure including structures that collect runoff from haul roads, limestone stockpiles and infrastructure areas, as well as sediment basins constructed to control runoff from overburden emplacements
- The implementation of erosion and sediment controls and measures in a staged process, as detailed in the staging plans contained in Appendix D.

5.3.3 Measures to reduce erosion risk

The erosion control measure selection process is based on identifying whether the issue is either erosion or sedimentation, whether erosion is caused by rainfall impact or concentrated flow, whether sedimentation is conveyed by sheet or concentrated flow, effectiveness and practicality. Standard erosion and sediment control measures are detailed in Appendix D (MSLM-WMP-ESCP-0017 to MSLM-WMP-ESCP-0020). Measures to manage erosion risk include:

- The drainage network is designed to pre-treat runoff, where possible, prior to discharging to sediment basins. This is accomplished by installing rock check dams along the drainage pathways to reduce flow energy and promote capture and settling of fines. The permanent areas of the drainage network are designed to minimise in drain erosion and include:
  - installation of appropriate liners, including prefabricated liners consisting of concrete, polyethylene, other forms of erosion control blankets or rock lined channels;
  - rock check dams at regular intervals along drainage lines to reduce flow energy; and
  - design of drains with grades of less than 1% where possible. Where grades are greater than 1%, suitable systems are developed to prevent erosion of the drainage channels in accordance with the Blue Book, including the use of liner blankets.
- Surface run-off reporting to the mine pit is directed to rock lined drains and natural rock outcrop to minimise erosion.
- In areas of the mine footprint which are not yet disturbed, surface runoff is diverted around the pit and site operations by clean water diversion drains.
- Topsoil stripping will be undertaken when the soil is moist to prevent disaggregation of soil structure where possible with a philosophy of handling soil only once by appropriately scheduling mining activities and having designate permanent areas for topsoil stockpiling.
- Stockpiles and bunds will be managed in accordance with the Blue Book SD 4-1 stockpile guideline. Drainage will be provided around stockpiles to prevent ponding on or around the base of the stockpiles. Erosion control systems for stockpiles and bunding will include surface roughening, soil surface mulching and mid slope diversions.
- Roads are constructed to ensure that erosion is reduced and sedimentation along roadside drains is minimised. Roads are graded such that runoff flows by the shortest routes to roadside drainage systems that redirect runoff to catchment drainage networks and sediment basins.
- An overburden emplacement drainage management system will control runoff using a combination of contour banks and channels, rock lined chutes, and progressive rehabilitation. Specific reduction measures include a tailored drainage network for the WOE (two large, slightly domed plateau areas) and a closed catchment to the west of the western emplacement (refer Section 6.2.7.3 and 6.2.7.4 in EIS). Overburden emplacements would

be progressively enlarged over time and shaped and rehabilitated on those sections that have been completed.

- Sediment basins will be operated so that the required 'air space' (settlement zone) is restored within five days of the end of a rainfall event.
- Erosion and sediment controls would be retained and maintained during the rehabilitation and revegetation establishment phase. Following the establishment of self-sustaining, stable final landforms, key elements of the sediment controls would either be left as passive water control storages (if practicable) or would be reshaped or removed if they could not be left without an ongoing maintenance requirement. Rehabilitation of disturbed areas will be carried out in accordance with the RS.
- no further overburden would be placed on the eastern batters and any remaining disturbed areas would be rehabilitated in line with the recommendations in the RS.
- settling agents will be applied to sediment basins where additional settlement of suspended sediments is required prior to release of excess runoff captured in the basins. Only low risk settling agents will be used, where an assessment has been undertaken including discharge characterisation and ecotoxicological testing as detailed in Appendix F.

5.3.4 Maintenance program

The following describes the measures implemented to maintain erosion and sediment control structures over time.

- The Environmental Coordinator is responsible for undertaking regular inspections to assess the integrity of the sediment and erosion control systems on site in accordance with the checklist provided in Appendix B.
- Inspections of permanent structures is undertaken of newly constructed drains or recently cleared areas after rainfall events that generated runoff, until surface stabilizes.
- Inspections of permanent structures are also undertaken after rainfall events greater than 50 mm in 24 hours, measured at the site rainfall gauge, to assess how the system has performed. The 50 mm rainfall event used for initiating checks is a trigger criterion only, and actual frequency of inspections is revised if the system is performing effectively under this amount of rainfall.
- Inspection of temporary structures around construction areas, overburden stripping areas and unconsolidated stockpiles is undertaken prior to the commencement of works and following a rainfall event and on a regular basis thereafter.
- Inspections include visual observations to check for erosion of surfaces on site and sedimentation within the water management network (Appendix B). Inspections will be recorded on this checklist or a modified version thereof.
- If any component of the system is identified as not functioning in accordance with the requirements of the WMP, maintenance will be undertaken to reinstate it to the required condition. Additional erosion and sediment control measures will be established if required.

The areas that require regular inspection under this WMP include:

- Access road and associated drainage systems;
- drainage networks;
- sediment basins;
- overburden emplacement areas;
- temporary stockpiles; and
- overburden stripping areas.

Specific inspection requirements for these areas are presented below, with details shown in standard drawings MSLM-WMP-ESCP-0017 to MSLM-WMP-ESCP-0021.

Access Roads

Access roads are visually inspected for the presence of erosion of the road systems and sedimentation within roadside drainage networks. Where erosion and sedimentation impacts are observed, they are rectified by regrading the road and by clearing sediment accumulation within the drainage network. An assessment is then conducted to identify the potential cause of the erosion and sediment control issues and additional measures are put in place to reduce erosion including:

- installation of mitre drains;
- scour protection of road drainage; and
- regrading of the road surface to reduce gradient.

Drainage Network

Drainage networks are visually inspected for the presence of erosion of drainage channels and accumulation of sediment in drainage channels. Where erosion and sedimentation has occurred, immediate action is taken to repair the damage. Rock check dams are also inspected for sedimentation and cleaned out as required.

Where regular erosion and sedimentation is occurring, an assessment is made of the likely cause of the issue and further protection measures implemented including:

- installation of additional up gradient sediment fences;
- installation of more robust drain liners in accordance with the “Blue Book”;
- installation of additional energy dissipation structures in accordance with the “Blue Book”; and
- reduction of the grade of the drainage network.

Sediment Basins

The following management activities will apply to sediment basins

- Sediment basins will be maintained in between rainfall events to ensure sufficient capacity is available to manage the required rainfall intensity.
- Sediment basins batters will be appropriately stabilised to assist with minimising the potential for erosion.
- Sediment basins and associated water conveyance structures will be inspected twice yearly and immediately after rainfall events for capacity, structural integrity and effectiveness.
- Visual inspections are conducted of the integrity of the basin structures and on the clarity of water within the basins prior to discharge. This includes checking for cracking of and leakage from the basin walls. Where the integrity of the basin walls appears to be compromised, immediate works will be undertaken to stabilise the structure.

Overburden Emplacements Areas

The overburden emplacements and bunding are regularly inspected visually to check the condition of existing erosion control structures and for the development of erosion features such as scouring. Where identified, additional measures are put in place to reduce erosion including the installation of up-gradient surface water flow diversion systems, development of mid-slope terraces or the re-grading of the slopes to reduce gradients.

Temporary Stockpiles

Regular visual inspections of the temporary stockpiles are undertaken to ensure appropriate and effective erosion and sediment controls, such as sediment control fencing and hay bailing, have been implemented and are operating effectively. Details are shown in MSLM-WMP-ESCP-0017.

Overburden Stripping Areas

The overburden stripping areas are regularly inspected visually to check the condition of existing erosion control structures, particularly diversion features to divert upslope runoff around stripping areas and for the development of erosion features such as scouring. Where identified, additional measures are put in place to reduce erosion including the installation of up-gradient surface water flow diversion systems, development of mid-slope terraces or the re-grading of the slopes to reduce gradients.

Remaining Areas

A general inspection of all other areas onsite is regularly undertaken for signs of erosion and sedimentation. Where identified, an assessment is made of the likely cause of the erosion/ sedimentation and appropriate control measures are installed.

5.3.5 Erosion and sediment control structures

This section describes the location, function, and capacity of existing and proposed erosion and sediment control structures, such as sediment basins.

Existing sediment basins are described in Table 5.5. Proposed sediment basins are described in Table 5.6. Detailed erosion and sediment control plans are shown in Appendix D.

Table 5.5 Existing Sediment Basins

Name	Description	Approximate Catchment Area (ha)	Required Volume (ML)	Actual Volume (ML)	Minimum Airspace (m)
Southern Haul Road Check Dam	Pre-treatment sediment check dam in roadside drainage of Southern Haul Road. Not sized to a design event, overflows to south pit.	6.5		0.08	N/A
Main Gully Sediment Basin 1	First dam in Main Gully series of 3 sediment basins. Land cover 85% native vegetation, with 2 ha not rehabilitated.	12.9	3.1	5.8	3.4
Main Gully Sediment Basin 2	2nd in-line sediment basin in Main Gully prior to discharge via the auto-sampler point into Bungonia Creek gorge. Land cover 89% native vegetation, with 2 ha not rehabilitated. Provides additional settlement capacity but not sized to design event.	18.1		0.2	N/A
Main Gully Sediment Basin 3	Final sediment basin in Main Gully series prior to discharge. Landcover 100% native vegetation. Provides additional settlement capacity, but not sized to design event.	2	0.8	0.8	N/A
Plant Sediment Basin	Completed late 2007 when Main Plant 1 Dam	N/A		0.3	N/A

Name	Description	Approximate Catchment Area (ha)	Required Volume (ML)	Actual Volume (ML)	Minimum Airspace (m)
	diversion works undertaken. Operates in conjunction with Main Plant Dam 2 that recycles processing plant water. Provides additional settlement capacity, but not sized to design event.				

As part of ongoing mining, a series of sediment basins are proposed at key locations and have been sized and operated in accordance with the requirements set out in the Blue Book (Landcom, 2004). The basins have been sized to capture the runoff from a 95th percentile 5-day storm (52.8 mm) according to the criteria for discharge to a 'sensitive' environment. Proposed sediment basin sizes are shown in Table 5.6.

Table 5.6 Proposed Sediment Basins

Name	Description	Catchment Area (ha)	Volume (ML)	Minimum Airspace (m)
N1	NOE (east)	Detailed in the Peppertree Quarry Water Management Plan (Boral, 2021).		
N2	NOE (west)			
P1	Shared road sales stockpile area			
W1	WOE (north)	25.5	10.8	1.9
W2	WOE (south)	13	7.5	1.9
S1	SOE	25	5.7	1.9
S2	SOE	13	4.1	1.9

5.3.6 Emplacement geomorphological stability monitoring

Geomorphological stability of rehabilitated emplacement areas will be monitored through inspections (5.3.4) and survey of transects used for Ecosystem Function Analysis as part of the rehabilitation monitoring program (see RS for further details). Survey of transects will detect movement and/or slippage in the rehabilitated emplacements, and surveys of analog sites will provide quantified baseline erosion characteristics. Transect surveys will be conducted annually.

Data collected as part of this program will support the independent audit of the long-term geomorphological stability of the Western Overburden and Southern Overburden Emplacement areas, which is anticipated to be completed following rehabilitation works during Stage 4 of the mine development. This audit will meet the requirements of CoC B48.

6 SURFACE WATER MONITORING

6.1 Climate

Continuous climate data monitoring is conducted at the Limestone Mine and Peppertree Quarry Weather Stations. Parameters collected are detailed in Table 6.1.

Table 6.1 Climate monitoring

Limestone Mine Weather Station	Peppertree Quarry Weather Station
Rainfall [mm]	Rainfall [mm]
Temperature (Max, Min, Average) [°C]	Temperature (Max and Min) [°C]
Humidity (Max and Min) [%]	Humidity (Max and Min) [%]
Wind Speed (Max gust, Average) [m/s]	Wind Speed [m/s]
Time of Max Wind Gust	Time of Max Wind Gust
Average Wind Direction [degrees]	Evapotranspiration [mm]
	Solar radiation [MJm^2]

6.2 Water quality

6.2.1 Ambient

Surface water quality monitoring at the sites in Marulan Creek, Barbers Creek, Bungonia Creek and the Shoalhaven River will continue on a quarterly basis during operation of the mine (refer details in Table 6.2 and Table 6.3). Figure 3.1 shows the location of the monitoring sites.

Monitoring may cease in Barbers Creek and the Shoalhaven River once the NOE and WOE and all externally draining sections of the SOE are completed, rehabilitation has been established and monitoring shows that water quality has stabilized. However, ongoing quarterly monitoring will continue in Main Gully and Bungonia Creek for the duration of the Project.

Table 6.2 Ambient Water Quality Monitoring Sites

Site	Description	Easting	Northing	Frequency
U1	Tangarang Creek upstream of Dam 1	226950	6149970	Quarterly
T1	Tangarang Creek downstream of Dam 1	228730	6150550	Quarterly
Marulan Up	Marulan Creek upstream of track crossing	225825	6151504	Quarterly
Marulan Down	Marulan Creek downstream of track crossing	228002	6151977	Quarterly
Barbers Up	Barbers Creek upstream	229518	6148416	Quarterly
Barbers Dn	Barbers Creek downstream	229542	6147306	Quarterly
Bungonia Up	Bungonia Creek upstream of mine	227294	6145485	Quarterly
Bungonia Dn	Bungonia Creek downstream of mine	228445	6145589	Quarterly
SR1	Shoalhaven River site 1	229183	6145620	Quarterly
SR2	Shoalhaven River site 2	229940	6146335	Quarterly
SR3	Shoalhaven River site 3	231172	6146891	Quarterly

Water quality parameters used in the EIS baseline assessment will continue to be analyzed. Some parameters including Beryllium, Cadmium, Chromium, Cobalt, Selenium, Vanadium, Boron

and Mercury have consistently reported values below detection limits across all monitoring sites. These parameters will not continue to be analyzed, with the resultant parameter list detailed in Table 6.3.

Table 6.3 Ambient Water Quality Monitoring Parameters

Parameter		
pH	Sodium Adsorption Ratio	Electrical Conductivity @ 25°C
Total Dissolved Solids	Suspended Solids	Total hardness as $CaCO_3$
Bromide	Hydroxide Alkalinity as $CaCO_3$	Carbonate Alkalinity as $CaCO_3$
Bicarbonate Alkalinity as $CaCO_3$	Total Alkalinity as $CaCO_3$	Sulphate as SO_4
Chloride	Calcium	Magnesium
Sodium	Potassium	Fluoride
Arsenic (dissolved & total)	Aluminium (dissolved & total)	Barium (dissolved & total)
Copper (dissolved & total)	Iron (dissolved & total)	Lead (dissolved & total)
Manganese (dissolved & total)	Molybdenum (dissolved & total)	Nickel (dissolved & total)
Strontium (dissolved & total)	Zinc (dissolved & total)	Silicon as SiO_2
Nitrate + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N
Total Phosphorus as P		
Total Anions	Total Cations	Ionic Balance
Total Organic Carbon	Dissolved Oxygen	Biochemical Oxygen Demand

6.2.2 Discharge

Excess runoff collected in sediment basins may be discharged from the locations detailed in Table 6.4 (locations shown in Appendix D – MSLM-WMP-ESCP-0005). Monitoring will be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004). Water quality monitoring during discharge would be by means of a grab/automated sample which would be analyzed for the following parameters:

- Oil and grease
- pH
- Total Suspended Solids
- Turbidity

Table 6.4 Discharge monitoring

Receiving Water	Discharge Structure	Proposed Monitoring	Easting	Northing
Main Gully	Sediment Basin S2	Daily samples collected at the automated water sampler downstream of S2 during any discharge offsite	227325	6146075
North-eastern tributary of Tangarang Creek	Sediment Basin N2	Daily samples collected during any discharge offsite	227420	6149425
Eastern tributary of Tangarang Creek	Sediment Basin W1	Daily samples collected during any discharge offsite	226700	6148850

6.3 Water Balance

Key aspects of the site water balance will be monitored to ensure that the water management system is meeting the performance measures of the Project.

Following the construction of the mine water dams, elevation-storage curve will be determined by "As Constructed" survey and staff gauge will be installed within the reservoir to allow for the monitoring of water levels. The estimated location of the staff gauges is detailed in Table 6.5 and will be updated following installation. Locations of dams is shown in MSLM-WMP-0005.

Table 6.5 Water storage monitoring

Dam	Description	Easting	Northing
Kiln Dam	Expansion of the Kiln Dam as part of the NOE	228255	6149110
Eastern Gully Dam	New dam to be constructed to the east of the processing facility	228830	6148950
Central Dam	New dam constructed as part of the expansion of the WOE	227185	6147610
Main Mine Dam 2	Existing water supply dam	227360	6147600

Key water transfer and use (processing and dust suppression) will be monitored by flowmeters. Flowmeters will meet the requirements of Australian Standard 4747.5-2013 and in accordance with NSW non-urban water metering - A best-practice guide to installing, validating and maintaining non-urban water meters in NSW (DPIE, 2019). Locations of the flowmeters are shown in Table 6.6. Monthly and total flow will be recorded at least monthly.

Table 6.6 Flowmeter locations

Flowmeter ID	Description	Easting	Northing
TBA	Tallong Weir to Marulan pipeline	228515	6149125
TBA	Eastern Gully Dam supply pipeline	228745	6148945
TBA	Kiln Dam supply pipeline	228500	6149100
TBA	Central Dam dust suppression supply	227080	6147500
TBA	North Pit Sump dust suppression supply	228150	6148250
TBA	Processing Plant Supply	228515	6149125
TBA	Sediment Basin N1 to Kiln Dam	228225	6149250
TBA	Sediment Basin N2 to Kiln Dam	227500	6149430
TBA	Sediment Basin W1 to Central Dam	226715	6148685
TBA	Sediment Basin W2 to Central Dam	226575	6147280

Periodic review and revision of the Site Water Balance (SWB) will be undertaken over the life of the Project to record and document the status of inflows, storage and consumption and to optimise water management performance. The reviews would also evaluate actual external make-up water requirements, climatic conditions and long-term predictions.

The SWB will be reviewed every year and will incorporate potential measures to improve the environmental performance of the Project.

6.4 Flooding

The EIS has not identified flooding as a significant issue of concern as any water that floods the pit floor is expected to drain away quickly due to the high seepage capacity of the pit floor.

Construction of the Marulan Creek Dam has been deferred beyond the term of the water management plan. Monitoring of the flood impacts of the proposed dam will be described in subsequent revisions of the WMP, once detailed designs are completed. No monitoring of flooding is proposed in the WMP at this time.

6.5 Inspections

6.5.1 Stream and Riparian Vegetation Health

Inspections will be conducted quarterly of Marulan, Barbers and Bungonia Creek to assess any potential changes in the stream or vegetation health. The inspections will be carried out by the Environmental Coordinator and include site notes and photographs. Inspections will be conducted at the surface water quality monitoring sites:

- Marulan Up
- Marulan Dn
- Barbers Up
- Barbers Dn
- Bungonia Up
- Bungonia Dn

The inspections will involve photographing the channel and creek banks, description of the condition and note any changes observed since the last inspection. Aquatic biodiversity monitoring is detailed in the BMP, additional monitoring may be undertaken as part of the assessment where monitoring indicates that surface water quality exceeds trigger levels (as detailed in Section 7.1) and/or groundwater quality exceeds trigger levels (as detailed in GWMP Section 9.1).

Inspections will note details of riparian vegetation condition and channel form and condition in accordance with the River Styles framework (www.riverstyles.com). Relevant indicators that provide a direct insight into how the river adjusts are detailed in Table 6.7.

Table 6.7 Geomorphic indicators

Site	River Style	Aspect	Attributes	Items to consider
Marulan Up	CVS - Floodplain pockets, sand	Channel platform	Lateral stability	Identification of channel expansion, bank erosion migration and avulsion processes
			Riparian vegetation	Qualitative rating of the composition (native vs. exotic), continuity and vegetation assemblages in the riparian zone
		Bed character	Grain size and sorting	Visual estimate of the percent of the bed that comprises different grain size fractions
			Bed stability Hydraulic diversity Sediment regime	Interpretation of vertical bed activity via incision Visual estimate of surface water flow Identify sediment process zones (i.e. source transfer, accumulation)
Marulan Down	CVS - Gorge	Bed character	Grain size and sorting	Visual estimate of the percent of the bed that comprises different grain size fractions
			Bed stability Hydraulic diversity Sediment regime	Interpretation of vertical bed activity via incision Visual estimate of surface water flow Identify sediment process zones (i.e. source transfer, accumulation)

Site	River Style	Aspect	Attributes	Items to consider
Barber Up	CVS - Gorge	Bed character	Grain size and sorting	Visual estimate of the percent of the bed that comprises different grain size fractions
			Bed stability Hydraulic diversity Sediment regime	Interpretation of vertical bed activity via incision Visual estimate of surface water flow Identify sediment process zones (i.e. source transfer, accumulation)
Barbers Down	CVS - Gorge	Bed character	Grain size and sorting	Visual estimate of the percent of the bed that comprises different grain size fractions
			Bed stability Hydraulic diversity Sediment regime	Interpretation of vertical bed activity via incision Visual estimate of surface water flow Identify sediment process zones (i.e. source transfer, accumulation)
Bungonia Up	CVS - Gorge	Bed character	Grain size and sorting	Visual estimate of the percent of the bed that comprises different grain size fractions
			Bed stability Hydraulic diversity Sediment regime	Interpretation of vertical bed activity via incision Visual estimate of surface water flow Identify sediment process zones (i.e. source transfer, accumulation)
Bungonia Down	CVS - Gorge	Bed character	Grain size and sorting	Visual estimate of the percent of the bed that comprises different grain size fractions
			Bed stability Hydraulic diversity Sediment regime	Interpretation of vertical bed activity via incision Visual estimate of surface water flow Identify sediment process zones (i.e. source transfer, accumulation)

6.5.2 Channel Stability

The Project mining area contains a number of fourth and fifth order (Strahler classification) drainage lines. No impacts on the fluvial geomorphic characteristics of the creek lines are expected. Baseline channel conditions have been presented in Section 3.6. Channel stability will be monitored via regular photographic records, as collected as part of stream and riparian vegetation monitoring inspections (Section 6.5.1).

7 CONTINGENCY PLAN

In the event a water management performance measure has not been met or a performance indicator is considered to have been exceeded, Boral will implement the following Contingency Plan in accordance with CoC D5 (f):

- The Environmental Coordinator will report the event in accordance with Section 9.
- Boral will apply adaptive management (Section 7.2).
- Boral will identify the appropriate course of action with respect to the identified impact(s), in consultation with technical specialists where required. For example, contingency measures, such as, but not limited to, those described in Section 7.3.
- Boral will implement the appropriate course of action to the satisfaction of the Secretary.

7.1 Trigger Action Response Plan

The water quality performance indicators described in Section 4.3 form the basis for the Trigger Action Response Plan (TARP). The TARP outlines actions and responses in the event trigger thresholds are exceeded. The process is outlined as follows, with a flowchart in Appendix C.

- If, during quarterly ambient surface water quality monitoring the upper bounds for pH, EC, TSP or turbidity are exceeded downstream of the mine but not exceeded upstream of the mine, it will trigger further monitoring on a monthly basis for two more months at the sampling point where the exceedance was measured.
- If one or more of the same parameters are exceeded in the three consecutive months of monitoring downstream of the mine but not exceeded during this period upstream of the mine, it will trigger assessment of potential sources in the mine.
- If the assessment finds the change in water quality may be caused by the mine, the source will be identified and operations will be reviewed and revised to address the impact.
- Following the revision of operations, monthly monitoring will continue to be undertaken at the sampling point where the exceedance was measured, until none of the parameters trigger values are exceeded. Thereafter monitoring at that sampling point will revert to quarterly monitoring.

The results of the trigger investigations will be reported in each annual review. Each year if it is clear the baseline dataset is changing in response to factors not related to mining such as climate or other land uses then the trigger thresholds will be recalculated, and the control thresholds adjusted to improve the baseline statistics. When this occurs the WMP will be updated.

Aquatic and riparian ecosystem aspects will be managed in a similar manner. The process is outlined as follows.

- If, during quarterly stream health and riparian vegetation inspections, a decline in channel stability is identified (e.g. bed gravel sediment clogging), it will trigger assessment of potential sources of the decline. The assessment will include an investigation of the upstream catchment to identify extent of the issue and potential sources.
- If the assessment finds the change in channel stability may be caused by the mine, the source will be identified, and operations will be reviewed and revised to address the impact.
- Following the revision of operations, monthly monitoring will continue to be undertaken at the location where the exceedance was measured, until the condition is comparable to the baseline conditions. Thereafter monitoring at that sampling point will revert to quarterly monitoring.

The results of the trigger investigations will be reported in each annual review. Each year if it is clear the baseline dataset is changing in response to factors not related to mining such as climate or other land uses, then the trigger thresholds will be recalculated, and the control thresholds adjusted to improve the baseline statistics. When this occurs the WMP will be updated.

7.2 Adaptive Management

In accordance with CoC D4, Boral will assess and manage risks to comply with the criteria and/or performance measures outlined in B43.

As soon as practical after any exceedance of the criteria and/or performance measures occurs, Boral will:

- take all reasonable and feasible steps to ensure that the exceedance ceases and does not reoccur;
- consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Secretary describing those options and any preferred remediation measures or other courses of action; and
- implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary.

7.3 Potential Contingency Measures

Key potential contingency measures to be implemented may include the following:

- Conduct additional monitoring (e.g. increase in monitoring frequency or additional sampling), which would inform further specific contingency measures.
- Implement adaptive management strategies (e.g. on-site reconfiguration) to better separate clean and mine waters, divert clean runoff and avoid discharge of mine waters.
- Provide a compensatory water supply to a landowner of privately-owned land whose rightful water supply is adversely and directly impacted by the Project.
- Obtain additional entitlements under the *Water Management Act 2000* if additional water supply is required.
- Adjust the scale of operations to match the available water supply if additional water supply is required and additional entitlements under the *Water Management Act, 2000* are not available.
- Chemical dust suppression additives to improve the efficiency of haul road dust suppression.
- Application of settling agents to sediment basis to ensure that any water released from the basins complies with the conditions of EPL 994.

8 ENVIRONMENTAL PERFORMANCE REVIEW AND IMPROVEMENT PROGRAM

In accordance with CoC D5 (g), Boral has developed a program to investigate and implement ways to improve the environmental performance of the development over time.

8.1 Annual review and compliance reporting

In accordance with CoC D11, by the end of July each year after the commencement of development, or other timeframe agreed by the Planning Secretary, a report will be submitted to DPIE reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary.

The activities and performance outcomes of the WMP will be presented in the Annual Environmental Management Report (AEMR). The report includes a detailed assessment of monitoring results, an evaluation of any trends occurring across the site, any community/stakeholder complaints or non-conformances with licences/criteria and recommendations for management actions.

As detailed in the EMS, the AEMR will be available on Boral's website.

8.2 Continuous improvement

The plan is to be reviewed in terms of CoC D5(j). The plan will be reviewed and updated if necessary in the following circumstances:

- where the Project is modified and may change the water demand and/or surface water management system; and/or
- where complaints, incidents and/or non-conformances require changes to ensure suitable management of surface water quality.

Each year following the annual review outlined in Section 8.1 and every three years after the independent environmental audit detailed in CoC D13, Boral will review this plan and update it if necessary, with findings of the annual review and independent environmental audit, to promote continuous improvement.

In accordance with CoC D8, if changes are required to this plan, it will be resubmitted to the Planning Secretary for approval within six weeks of the review. The most recent version of this plan as approved by the Planning Secretary is to be implemented.

9 INCIDENT, NON-COMPLIANCE, AND COMPLAINT MANAGEMENT AND REPORTING PROTOCOLS

9.1 Incident reporting

In accordance with CoC D9 Boral will immediately notify DPIE and any other relevant agencies after it becomes aware of an incident resulting in unauthorised surface water impacts. The notification will be in writing through DPIE's Major Projects Website and identify the development (including the development application number and name) and set out the location and nature of the incident.

The development consent defines an 'incident' as:

"An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance".

Material harm is defined as:

"*harm to the environment that:*

1. *involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or*
2. *results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000 (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)*

This definition excludes "harm" that is authorised under either this consent or any other statutory approval"

Per EPL 944, notifications of environmental harm must be made by telephoning the Environment Line service on 131 555. Boral must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred. Boral 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 Protection of the Environment Operations Act 1997.

9.2 Non-compliance reporting

The development consent defines a 'non-compliance' as:

"An occurrence, set of circumstances or development that is a breach of this consent".

In accordance with CoC D10 Boral will, within seven days of becoming aware of a surface water non-compliance, notify DPIE of the non-compliance. The notification will be in writing through DPIE's Major Projects Website and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.

The Site Manager is responsible for reporting exceedances or incidents causing (or threatening to cause) material harm to surface water to DPIE.

9.3 Complaints protocol

After receiving a surface water complaint, the Environmental Coordinator will undertake further investigations to verify the complaint and obtain additional details required to ascertain the cause of the complaint.

Where further investigations into the complaint are undertaken, the findings and any corrective action will be discussed with the complainant.

Surface water related complaints received by Boral will be recorded in a complaints register which will include the following details where available:

- The date and time of the complaint.
- The method by which the complaint was made.
- Any personal details of the complainant which were provided by the complainants or, if no such details were provided, a note to that effect.
- The nature of the complaint.
- The action taken by Boral in relation to the complaint, including any follow-up contact with the complainant.
- If no action was taken by Boral, the reasons why no action was taken.

The overarching complaints protocol for the mine, which provides further details on how all complaints will be received, recorded, handled and responded to is described in the EMS.

10 REFERENCES

Advisian (2019) Marulan South Limestone Mine Continued Operations Environmental Impact Assessment – Appendix G: Surface Water Assessment (Revision 2)

ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Boral (2019) Marulan South Limestone Mine Continued Operations State Significant Development Application, Environmental Impact Statement.

Boral Quarries (2021) Peppertree Quarry Water Management Plan

DPIE (2019) NSW non-urban water metering - A best-practice guide to installing, validating and maintaining non-urban water meters in NSW. NSW Department of Planning, Industry and Environment (DPIE)

DPIE (2021a) Letter to Rachel Snape 17 September 2021 RE: Marulan South Limestone Mine Continued Operations Project (SSD-7009) Endorsement of Experts. NSW Department of Planning, Industry and Environment (DPIE)

DPIE (2021b) Letter to Les Longhurst 8 November 2021 RE: Marulan South Limestone Mine (SSD-7009) Staging of Management Plans. NSW Department of Planning, Industry and Environment (DPIE).

DPIE (2022) NSW River Styles Database, https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=425c7364e9dc4a71a90c4ba353b8949f, accessed 30 June 2022.

Fryirs K and Brierley G (2005) Geomorphology and river management: Applications of the river styles framework. Blackwell Publishing.

Fryirs K and Brierley G (2018) What's a name? A naming convention for geomorphic river types using the River Styles Framework. PLoS One 13(9).

Landcom (2004) Managing Urban Stormwater: Soils and Construction, Volume 1

Landcom (2008) Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries

Landcom (2008) Managing Urban Stormwater: Soils and Construction, Volume 2D – Main Roads

McMahon T, Peel M, Lowe L, Srikanthan R, and McVicar T (2013). Estimating actual, potential, reference crop and pan evaporation using standard meteorological data: a pragmatic synthesis, Hydrology and Earth System Sciences, 17, 1331-1363.

Silo (2021) Summarized data from the Scientific Information for Landowners (SILO) climate database for Latitude -34.75, Longitude 150.05, 1 July 1889 – 30 June 2021.

APPENDIX A

Groundwater Management Plan

Marulan South Limestone Mine | SSD 7009

Groundwater Management Plan

Prepared for Boral Cement Limited | 8 December 2021

Marulan South Limestone Mine

SSD 7009 | GROUNDWATER MANAGEMENT PLAN

Prepared for Boral Cement Limited
8 December 2021

PR163

	Prepared by	Reviewed by
Name	Pieter Labuschagne	James Tomlin
Company	Australasian Groundwater & Environmental Consultants Pty Ltd	Australasian Groundwater & Environmental Consultants Pty Ltd
Position	Principal Hydrogeologist	Technical Director and Principal Hydrogeologist
Project Role	Hydrogeologist	Project Director
Signature		
Date	8 December 2021	11 October 2021

DOCUMENT CONTROL

Revision	Date	Description	Prepared by	Reviewed by
0	12 October 2021	For Boral Cement Limited review	Australasian Groundwater & Environmental Consultants Pty Ltd	Boral Cement Limited
1	8 December 2021	For submission to DPIE	Australasian Groundwater & Environmental Consultants Pty Ltd	Boral Cement Limited

Contents

Tables

Figures

Appendices

1 INTRODUCTION

1.1 Background

Boral Cement Limited (Boral) owns and operates the Marulan South Limestone Mine (the mine), an open cut mine located in Marulan South, New South Wales (NSW). Limestone mining north of Bungonia Gorge began around 1830 with major developments emerging in the 1920s to supply limestone for cement manufacturing and steel making.

The limestone mine was opened in 1929 to supply limestone for cement, manufacturing and steel making. By 1953 two main pits (northern mine pit and southern mine pit) were well established and by the early 1970s the facets of the business included limestone for cement, steel making, agriculture, glass making, lime manufacturing, quicklime, and hydrated lime.

The mine produces up to 3.38 million tonnes (Mt) of limestone based products per year for the cement, steel, agricultural, construction and commercial markets.

Due to changes in the *NSW Mining Act 1992* (Mining Act) and the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act), a State significant development (SSD) consent under the EP&A Act was required to move mining operations beyond the area covered by the mining operations plan (MOP).

Two approvals are required for the mine:

- a consent for the Project (SSD 7009) under Part 4, Division 4.7 of the EP&A Act; and
- controlled action approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for impacts on listed threatened species and communities (sections 18 and 18A of the Act).

An environmental impact statement (EIS) was prepared to accompany the application for SSD 7009 and addresses the requirements of State agencies under the EP&A Act and the Commonwealth Department of Agriculture, Water and the Environment. A response to submissions (RTS) report was subsequently prepared to consider and respond to agency and public submissions and provide clarification of project components where relevant.

Development consent (the consent) was granted by the Department of Planning, Industry and Environment (DPIE) on 19 August 2021, to continue mining limestone at a rate of up to 4 million tonnes per annum (Mtpa) for a period of up to 30 years (the Project).

To satisfy Condition of Consent (CoC) D5(i), the EIS, RTS, development consent and other publicly available information related to the assessment and determination of SSD 7009 can be accessed on DPIE's Major Projects Planning Portal (https://www.planningportal.nsw.gov.au/major-projects/project/9691).

The consent 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 Groundwater Management Plan (GWMP) is required in accordance with CoC B42, B43 and B45 (e, v, vi).

This plan incorporates the relevant management measures presented in the EIS, RTS and conditions of consent relating to groundwater. The GWMP will continue to remain a dynamic document which will be updated as required over the life of mining operations until 31 August 2051.

This GWMP has been prepared by Australasian Groundwater & Environmental Consultants on behalf of Boral. The authors of this GWMP, P Labuschagne and J Tomlin are both principal hydrogeologists with more than 20 years industry experience and completed various groundwater monitoring and management plans in New South Whales (NSW). The Planning Secretary endorsed both Peter Labuschagne and James Tomlin of Australasian Groundwater & Environmental Consultants to prepare the GWMP on 17 September 2021[1].

1.2 Overview of operations

1.2.1 Site description

The Project site is in Marulan South, 10 km south-east of Marulan village and 35 km east of Goulburn (Figure 1.1). It is in the Goulburn Mulwaree Local Government Area (LGA).

The mine is separated from the Bungonia National Park (NP) and State Conservation Area to the south by Bungonia Creek and from the Shoalhaven River and Morton NP to the east by Barbers Creek.

The Project site and surrounds are characterised by rolling hills of pasture interspersed with forest to the west, contrasting with the heavily wooded, deep gorges that begin abruptly to the east of the mine, forming part of the Great Escarpment and catchment of the Shoalhaven River.

Access is via Marulan South Road, which connects the mine and Boral's Peppertree Quarry with the Hume Highway approximately 9 km to the north-west. Boral's private rail line connects the mine and Peppertree Quarry with the Main Southern Railway approximately 6 km to the north.

The Project site covers historical and proposed future areas of disturbance and comprises two geographically separate areas:

- the existing mine including the proposed 30-year mine footprint and associated infrastructure; and
- the proposed Marulan Creek dam to be on Marulan Creek, within Boral landholdings approximately 2.5 km north of the mine entrance.

The Project site covers an area of 846.4 ha. The existing pre SSD disturbance footprint is 341.5 ha with 256.5 ha of new disturbance associated with the proposed 30-year mine plan.

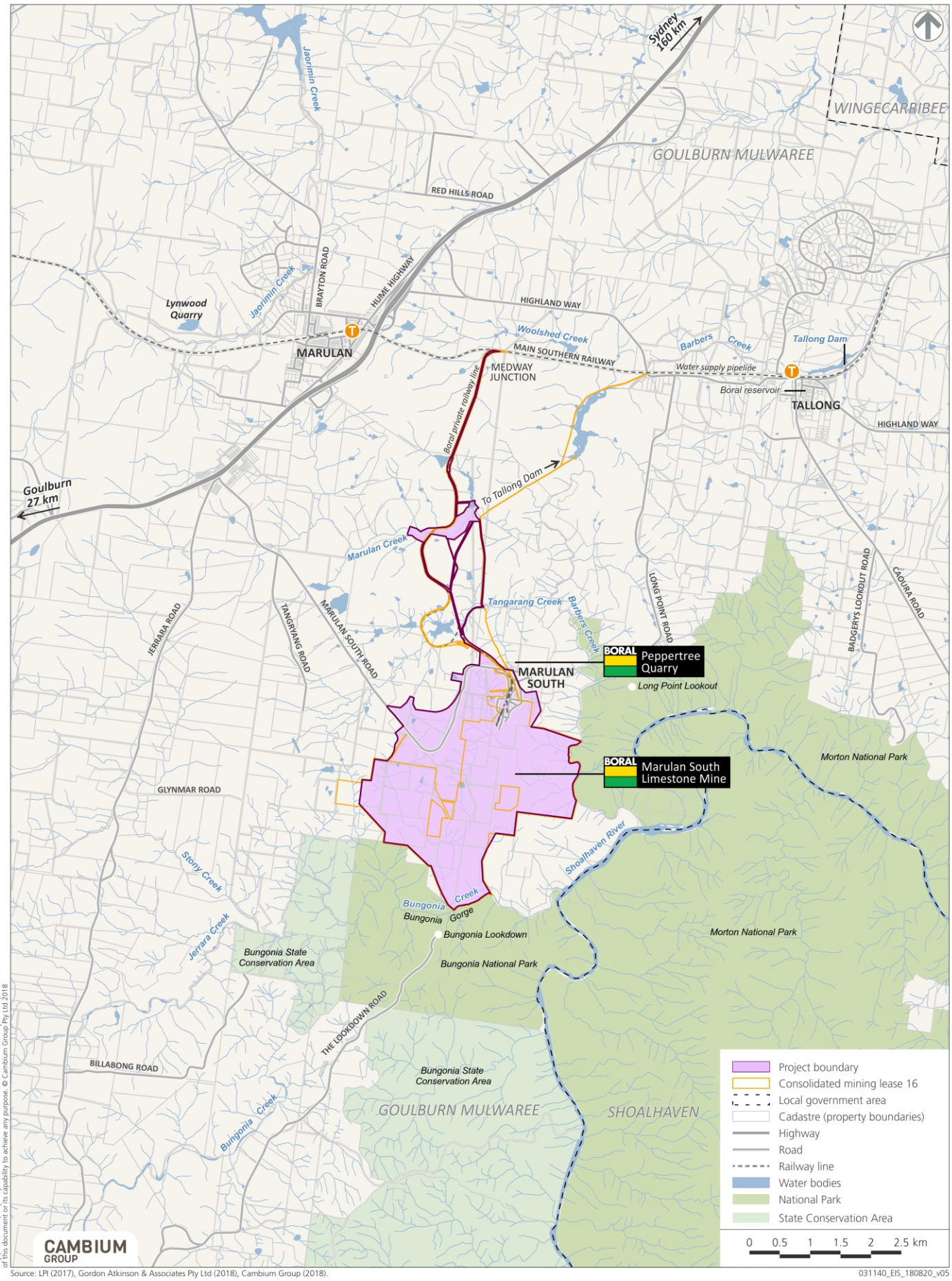
Most of the Project site is zoned RU1 - Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009. Mining and extractive industries are permissible in this zone with consent. The remaining area is zoned E3 - Environmental Management. Mining and extractive industries are prohibited in this zone. However, as agriculture is permitted in the E3 zone with consent, mining is also permitted in this zone under the Mining State Environmental Planning Policy with consent.

[1] Letter from the Planning Secretary "Marulan South Limestone Mine Continued Operations Project (SSD-7009) Endorsement of Experts". Contact person: Nagindar Singh 82896873, email Nagindar.singh@planning.nsw.gov.au., 17 Sept 2021.

Figure 1.1

Regional context

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2018).

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1.2.2 Overview of existing mining

The mine is sited on a high grade limestone resource. Subject to market demand the mine has typically produced up to 3.38 Mt of limestone and up to 200,000 t of shale per annum.

The mine currently produces a range of limestone products for internal and external customers in the Southern Highlands/Tablelands, the Illawarra and Metropolitan Sydney markets for use primarily in cement and lime manufacture, steel making, agriculture and other commercial uses. Products produced at the mine are despatched by road and rail, with the majority despatched by rail.

Historically limestone mining was focused on the approximately 200-300 m wide Eastern Limestone and was split between a north pit and a south pit. A limestone wall (referred to by the mine as the 'centre ridge') rising almost to the original land surface, divided the two pits. The north and south pits were joined in 2016/2017 by mining the centre ridge to form a single contiguous pit, approximately 2 kilometres (km) in length. However, the north pit/south pit nomenclature remains important as current mining operation locations continue to be reported with respect to one or other of the old pits.

Limestone and shale are extracted using open-cut hard rock drill and blast techniques. Limestone is loaded using front end loaders and hauled either to stockpiles or the processing plant using haul trucks. Oversized material is stockpiled and reduced in size using a hydraulic hammer attached to an excavator.

Limestone processing facilities including primary and secondary crushing, screening, conveying and stockpiling plant and equipment are in the northern end of the north pit. Kiln stone grade limestone is also processed on site through the existing lime plant comprising kiln stone stockpiles, rotary lime kiln, hydration plant and associated auxiliary conveying, processing, storage, despatch plant and equipment. Overburden from stripping operations is emplaced in the Western Overburden Emplacement (WOE), west of the open cut pits.

1.2.3 Overview of approved project

Consent was granted for a 30-year mine plan accessing approximately 120 Mt of limestone down to a depth of 335 m. The mine footprint focuses on an expansion of the pit westwards to mine the Middle Limestone and to mine deeper into the Eastern Limestone (Figure 1.2). As the Middle Limestone lies approximately 70-150 m west of the Eastern Limestone, the 30-year mine plan avoids mining where practical the interburden between these two limestone units thereby creating a smaller second, north-south oriented west pit with a ridge remaining between. The north pit will also be expanded southwards, encompassing part of the south pit, leaving the remainder of the south pit for overburden emplacement and a visual barrier.

Limestone will be extracted at up to 4 Mtpa for 30 years until 31 August 2051. Clay shale will also continue to be extracted at up to 200,000 tonnes per annum (tpa). The limestone will be processed to create limestone and lime products including limestone aggregates and sand, hydrated lime and quick lime.

Existing infrastructure is being retained along with the following changes:

- relocation of a section of high voltage power line to accommodate a proposed overburden emplacement;
- realignment of a section of Marulan South Road, to accommodate a proposed overburden emplacement;
- relocation of the processing infrastructure and the stockpile and reclaim area at the northern end of the north pit to allow the northward expansion of the pit;
- development of a shared Road Sales Stockpile Area including a weighbridge and wheel wash to service both the mine and Peppertree Quarry; and
- construction of a 118 megalitre (ML) in-stream water supply dam on Marulan Creek.

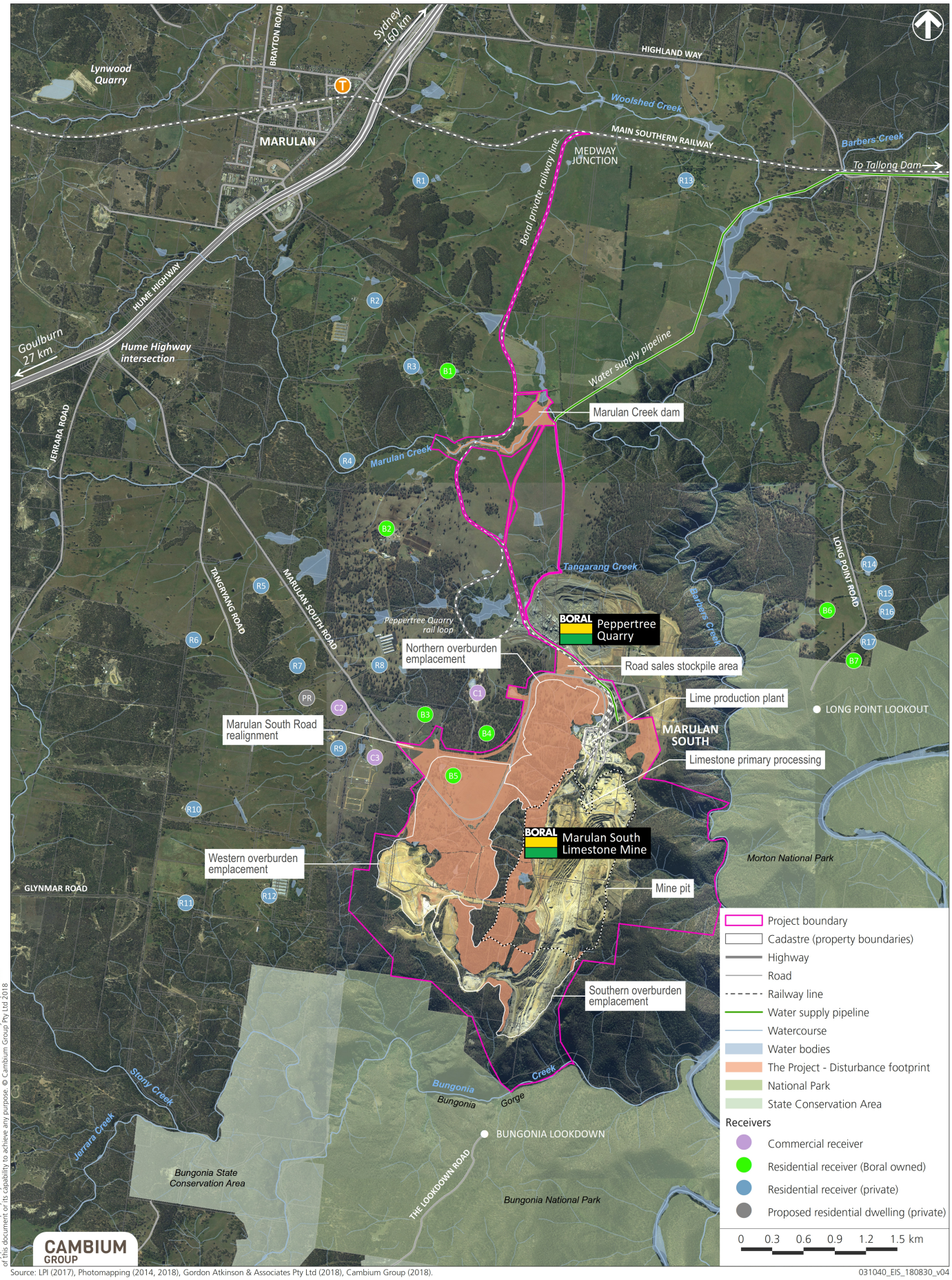
Boral will transport up to 600,000 tpa of limestone and hard rock products along Marulan South Road to the Hume Highway, as well as 120,000 tpa of limestone products to the agricultural lime manufacturing facility.

The Project provides continued direct employment for 118 people on the mine site and 73 offsite. It will operate 24-hours per day, 7 days per week. Blasting will continue to be restricted to daylight hours on weekdays, excluding public holidays.

Figure 1.2

The Project - Disturbance footprint

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2018).

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1.3 Environmental management framework

The mine operates in accordance with the Boral integrated Health Safety, Environment and Quality Management System (HSEQ MS) which establishes a strategic platform for regulatory compliance and continual improvement in environmental management. This framework is documented in GRP-HSEQ-1-01 Management System Framework and Operational Control. The Boral HSEQ MS is aligned with the international standard ISO-14001.

1.3.1 Environmental Management System

CoC D1 requires the preparation of an Environmental Management Strategy (EMS) for the mine. The EMS provides the mine's strategic framework for environmental management under which the GWMP operates.

1.3.2 Alignment with other plans

This GWMP has been prepared as an integral part of the Project's Water Management Plan (WMP) and should be read in conjunction with the WMP.

1.4 Purpose and objectives

This GWMP describes how Boral will monitor, manage and protect groundwater when operating the mine.

This GWMP applies to all activities undertaken by the mine, including extraction (drilling and blasting), loading and haulage of materials, stockpiling, processing (crushing, screening and conveying) and operation of the lime plant.

Specific objectives of the GWMP are to:

- comply with regulatory requirements including water licences, the consent and the Environment Protection Licence (EPL);
- describe the baseline groundwater data generated for the mine and how the data is applied;
- outline the groundwater data collection and analysis methods;
- establish performance measures;
- establish groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts (or trends) associated with the mine, on:
    - regional and local aquifers (alluvial and hard rock);
    - groundwater springs; and
    - groundwater supply for other water users such as licensed privately-owned groundwater bores; and
- prescribe the Trigger Action Response Plans (TARPs).

The GWMP is prepared for a mixed audience of consent authorities, environmental regulators and site personal; the latter is responsible for implementing this plan as part of the day-to-day operations.

1.5 Responsibility for implementation

The Site Manager carries ultimate responsibility for implementing this GWMP and providing the necessary resources as required. The site Environmental Coordinator is responsible for ensuring that the management and control measures outlined in this plan are implemented on site, responding to performance measures and TARPs, and for carrying out and/or coordinating this plan's monitoring and reporting requirements. The Environmental Coordinator is responsible for reporting anomalies identified from interpretations of the routine groundwater level and groundwater quality monitoring data and reporting them to the Technical Manager.

Operations personnel (Technical Manager and Mine Production Manager) are responsible for adjusting mine operations as appropriate to minimise groundwater impacts on site and neighbouring properties.

1.6 Document structure

The structure of the GWMP is outlined in Table 1.1.

Table 1.1 Structure of the GWMP

Section	Content
1	Provides an overview of the mine and objectives of the plan.
2	Outlines statutory requirements associated with the development consent, environmental protection license (EPL) and consultation undertaken by the specialist to develop the plan.
3	Supplies an overview of the groundwater regime.
4	Outlines the current groundwater monitoring network and proposed additional groundwater monitoring bores.
5	Discusses the Project baseline groundwater data used for the GWMP.
6	Specifies the data collection methodology and outlines the methodology to monitor groundwater.
7	Outlines the data analysis methods.
8	Outlines the groundwater level and quality criteria (triggers) and performance measures.
9	Outlines the groundwater management and control measures and the trigger action response plans (TARPs)
10	Supplies a brief overview of cumulative impacts.
11	Outlines the contingency measures, incident response actions and the unforeseen impacts protocol.
12	Outlines the environmental performance review and improvement program.
13	Outlines the incident, non-compliance, and complaint management and reporting protocol.
14	Reference list.

2 STATUTORY REQUIREMENTS

2.1 Development consent

This GWMP has been prepared in accordance with the development consent. Table 2.1 presents the consent conditions relevant to the GWMP and identifies where each condition has been addressed in this plan.

Table 2.1 Management plan requirements

Condition No.		Condition requirement	Section reference
B42		Groundwater Management Within 12 months of the commencement of development under this consent, or other timeframe as agreed by the Planning Secretary, the Applicant must install a groundwater level and quality monitoring network within and adjacent to the Mt Frome Middle Limestone, or a suitable alternative location, in consultation with DPIE Water and to the satisfaction of the Planning Secretary.	Sections 3, 4 and 6
B43	Table 4	Water Management Performance Measures The Applicant must ensure that the development complies with the performance measures in Table 4 *(Table 4 Water management performance measures, Conditions of Consent, page 16)*.	Sections 6 to 8
B45	(e)(v)	Groundwater Management Plan that includes: detailed baseline data of groundwater levels, yield and quality for groundwater resources and groundwater dependent ecosystems potentially impacted by the development, including groundwater supply for other water users.	Sections 3 and 5
		a detailed description of the groundwater management system.	Section 9
		groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts (or trends) associated with the development, on: • regional and local aquifers (alluvial and hardrock) • groundwater springs; and • groundwater supply for other water users such as licensed privately-owned groundwater bores;	Sections 6 to 8
		a program to monitor and evaluate: • compliance with the relevant performance measures listed in Table 4 and the performance criteria in this plan; • water loss/seepage from water storages into the groundwater system, including from any final voids; • groundwater inflows, outflows and storage volumes, to inform the Site Water Balance; • the hydrogeological setting of any nearby alluvial aquifers and the likelihood of any indirect impacts from the development; • impacts on groundwater dependent ecosystems; • impacts on groundwater supply for other water users; • the effectiveness of the groundwater management system;	Sections 4, 6 and 7
		reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results;	Sections 7 and 13
		a trigger action response plan to respond to any exceedances of the relevant performance measures and groundwater performance criteria, and repair, mitigate and/or offset any adverse groundwater impacts of the development;	Section 9
		a program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years (unless otherwise agreed by the Planning Secretary), and comparison of monitoring results with modelled predictions; and	Section 12

Condition No.		Condition requirement	Section reference
	(e)(vi)	a protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition D11.	Sections 7 and 12
D5		Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:	
	(a)	Summary of relevant background or baseline data;	Sections 3 and 5
	(b)	Details of	
	(b)(i)	The relevant statutory requirements (including any relevant approval, license or lease conditions);	Section 2
	(b)(ii)	Any relevant limits or performance measures and criteria; and	Section 8
	(b)(iii)	The specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 8
	(c)	Any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	Sections 4.2, 5 and 6
	(d)	A description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Sections 6 and 8
	(e)	A program to monitor and report on the:	
	(e)(i)	Impacts and environmental performance of the development; and	Sections 6, 12 and 13
	(e)(ii)	Effectiveness of the management measures set out pursuant to condition D4(c);	Section 8
	(f)	A contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 11
	(g)	A program to investigate and implement ways to improve the environmental performance of the development over time;	Section 12
	(h)	A protocol for managing and reporting any:	
	h (i)	incident, non-compliance or exceedance of any impact assessment criterion or performance criterion);	Sections 9 and 13
	(h)(ii)	complaint; or	Sections 11 and 13
	(h)(iii)	failure to comply with other statutory requirements;	Sections 11 and 13
	(i)	Public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and	Section 12.3
	(j)	A protocol for periodic review of the plan.	Section 12

2.2 Environment Protection License

Boral is the licensee of EPL 944 for the “Marulan South Limestone Mine and Lime Plant” for 100,000-250,000 tpa of lime production and 2-5 Mtpa of minerals obtained by mining. EPL 944 will be amended to align with the development consent, after which this plan will be updated in accordance with any relevant requirements of the EPL.

2.3 Consultation

CoC B45 (b) requires this plan be prepared in consultation with WaterNSW, DPIE Water, Fisheries NSW and the EPA.

Table 2.2 Consultation undertaken with regulators

Regulator	Representative	Date	Discussion	Outcomes	Section of report

3 OVERVIEW OF THE GROUNDWATER REGIME

3.1 Groundwater regime

The Project site has a unique groundwater regime controlled by various factors, including the steeply dipping geology and the water pressures imposed by the steep terrain. The main groundwater system within the Project site is the limestone ore body targeted for mining (AGE, 2019[2]). Fracture networks and vertical bedding convey water vertically and connect with karst seepage zones that form springs surfacing within the Bungonia Gorge (e.g. on the gorge slopes). Less permeable rock units 'sandwich' the limestone and retard lateral groundwater flow with fine-grained siltstones and sandstones present to the east towards the gorge and a sequence of volcanic units to the west.

GeoRes (2017, 2018) describes the limestone currently and historically mined at Marulan South as two sub-parallel and steeply west dipping members of the Bungonia Limestone Group. These include the upper 'Mt. Frome Limestone' (formally the 'Folly Point Limestone' member) and the lower 'Eastern Limestone' (formally the 'Lookdown Limestone' member). The Mt. Frome Limestone comprises three separate limestone units: the Upper, Middle, and Lower Limestone. Each limestone unit is separated by fine-grained sediments such as mudstones, siltstones and sandstones.

To the west, the limestone is overlain by series of volcanoclastic and intrusive units composed of dacites, tuffs and volcanic breccias. All geological units dip towards the west-north-west with variable degree of steepness (GeoRes, 2018). To the south, the limestone units extend south beyond Bungonia Creek, whereas to the north, the Glenrock Granodiorite intrusion truncates the limestone. The granodiorite has also metamorphosed the limestone to varying degrees across the site.

Generally speaking, there are two groundwater zones within and adjacent to the mine's rock units, including shallow, unconsolidated zones and deep, consolidated zones. The shallow unconsolidated aquifer is mainly within the weathered zone where the groundwater exists in the pore spaces within the sediment or regolith. Groundwater within the deep, bedrock aquifer exists mainly in rock fractures caused by geologic and structural movement. The groundwater sources are described in Section 3.3 below.

Figure 3.1 shows the mine area looking from the southern edge of Bungonia Gorge in a northerly direction and approximates the outcrop of key stratigraphic units. Figure 3.2 presents a simplified cross-section of the conceptual model showing stratigraphy and groundwater regime including groundwater flow, recharge and discharge zones. A geology map is included in Section 4, Figure 4.2.

The limestone is intruded with a number of dykes, both parallel and perpendicular to the strike of the limestone body. Based on site observation data, the dykes oriented perpendicular to the limestone strike appear to act as hydraulic barriers, as evidenced by groundwater levels varying considerably on either side of the dykes (AGE, 2019). Regionally, groundwater level measurements indicate flow is generally toward the east-south-east towards the deeply incised gullies of Bungonia and Barber's Creeks. The groundwater gradient across the Project area is influenced by geology changes, which often mark changes in hydraulic properties on a local and regional scale.

[2] The groundwater impact assessment (GIA) completed for the Environmental Impact Statement (EIS). AGE (2019). Marulan South Limestone Mine Continued Operations - Groundwater Technical Study for EIS, Project No. G1714C, March 2019.

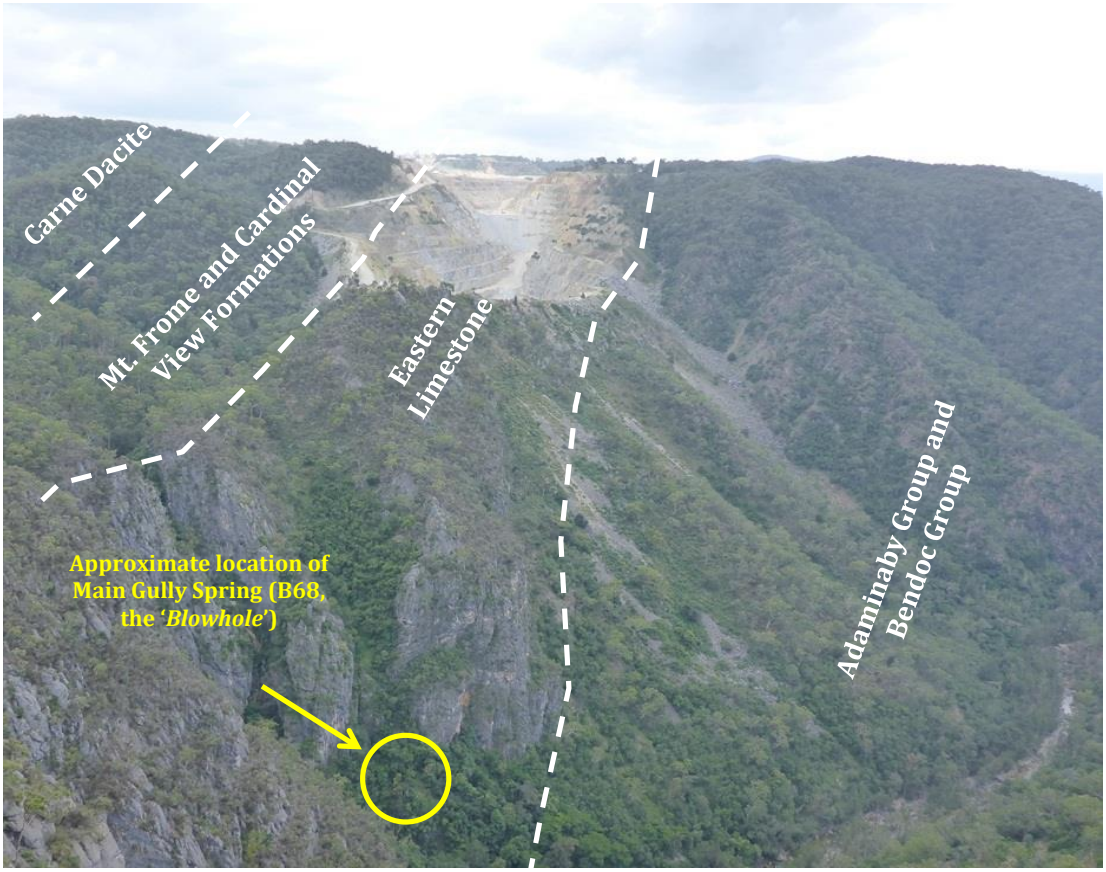
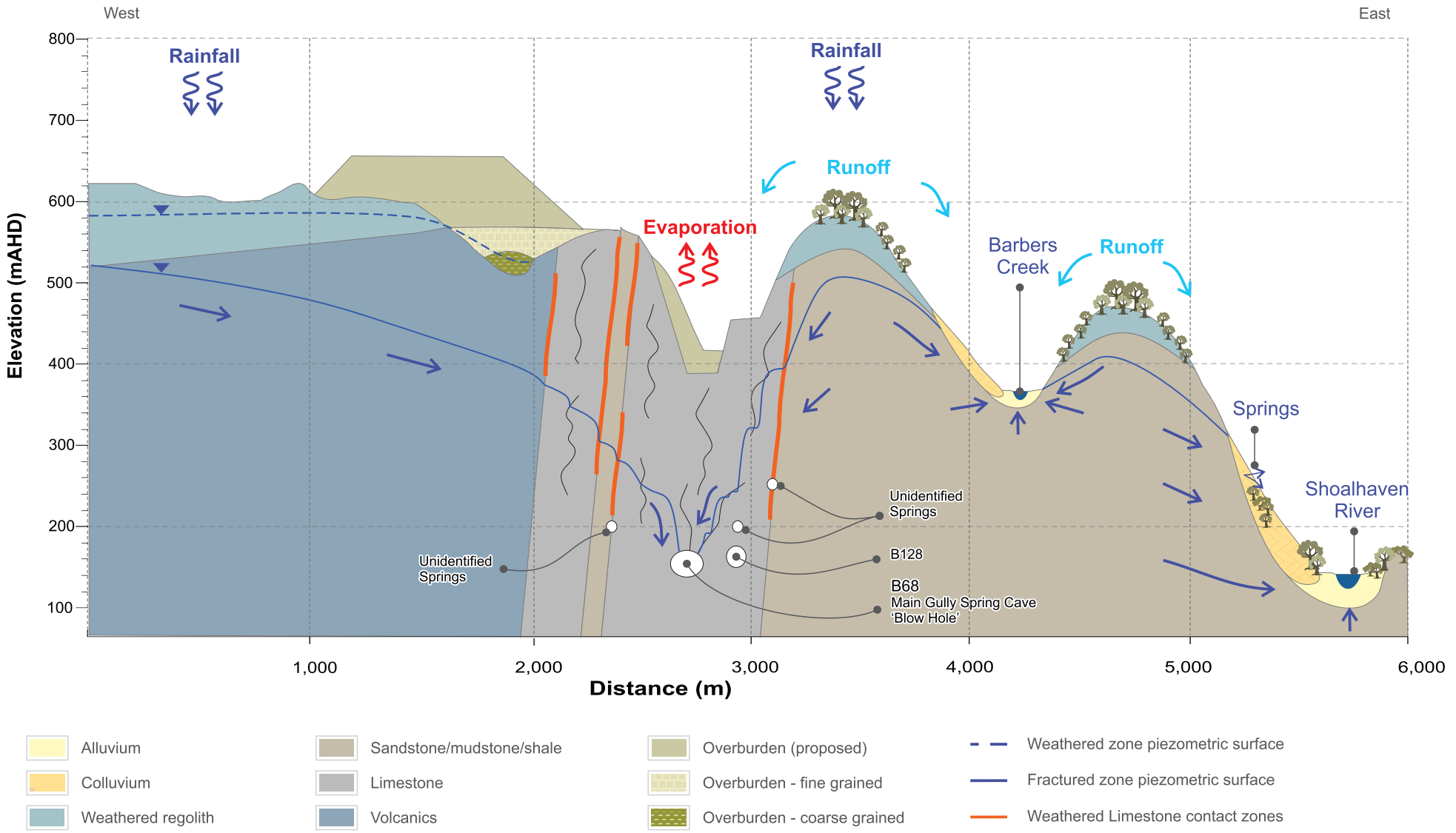


Figure 3.1 View North from Bungonia Gorge lookout - generalised geology and approximate geological boundaries



Simplified hydrogeological conceptual W-E cross-section

Figure 3.2

Marulan GWMP (MSL5000.001)

AGE

3.2 Recharge, discharge and receptors

The level of connectivity between surface water and groundwater systems in the Project area is controlled by the steep gradients from the plateau towards Bungonia Gorge and the hydraulic properties of the fractured limestone with karst features. The main groundwater recharge zones are in topographically elevated areas on the plateau and occur through diffuse rainfall recharge. Recharge on the plateau also occurs as seepage through creek and riverbeds when flowing. The mine pit also presents a groundwater recharge zone where runoff collects during rainfall events on exposed fractured limestone.

Bungonia Creek is also fed by springs and seepages originating from the limestone aquifer and flow in the creek is therefore indirectly connected to the limestone aquifer. An example of this process can be observed in two small caves known as Main Gully Spring (B68 - locally referred to as the 'Blowhole') and Main Gully Spring Too (B128), located within the northern escarpment of the Bungonia Gorge, south of the mine (Figure 3.1). These springs are regarded as groundwater dependent ecosystems (GDEs).

Limited alluvial sediments are associated with the Barbers and Bungonia creek lines due to their steep and rocky nature (Figure 4.2). Conversely, alluvial deposits occur closer to and along the Shoalhaven River, situated further to the east. No alluvial aquifers occur within the current and proposed mining area on the plateau.

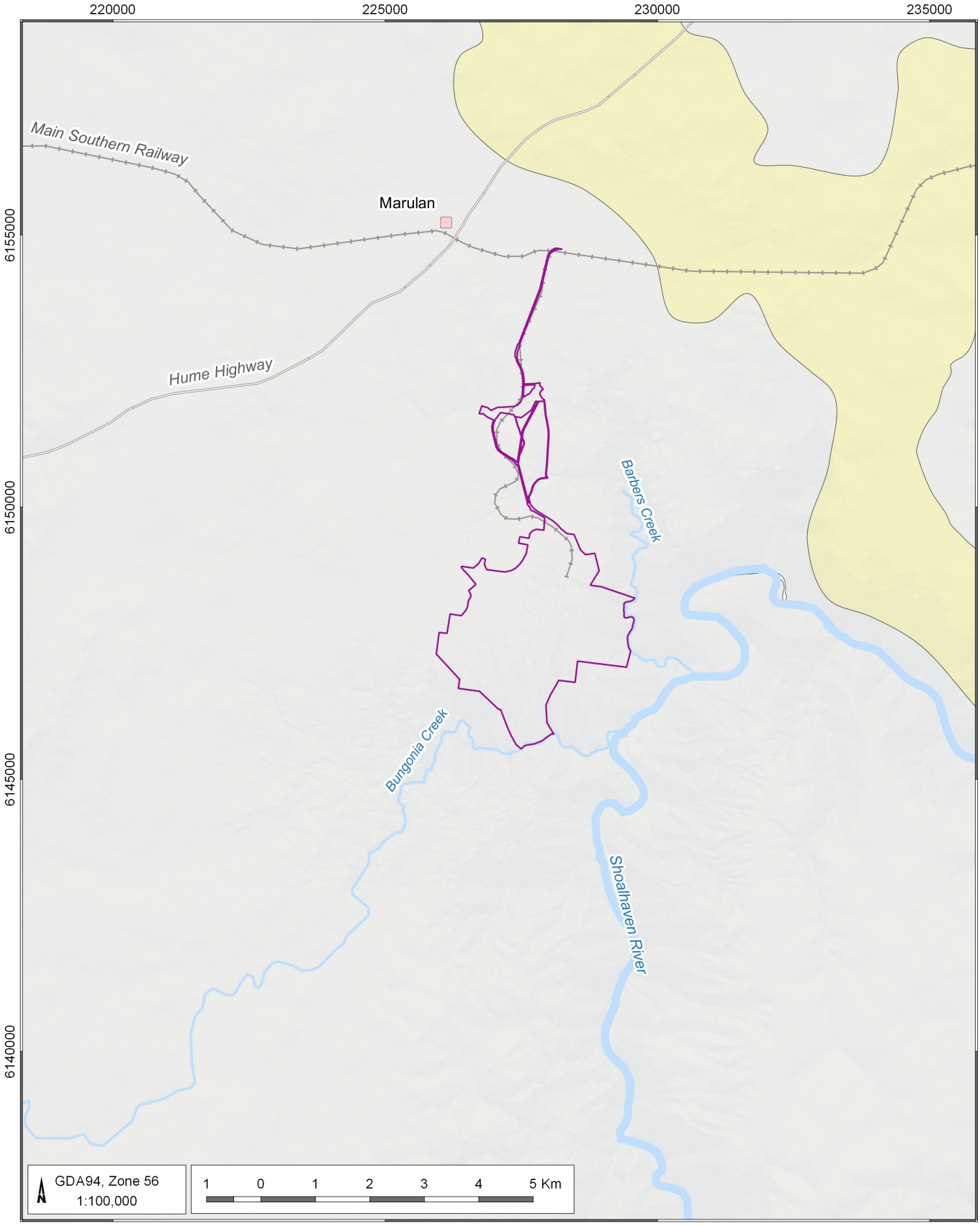
3.3 Groundwater resource

The Aquifer Interference Policy (AIP[3]) describes minimal impact considerations for aquifer interference activities and includes a series of acceptable thresholds for water level and quality changes. The minimal impact consideration thresholds depend upon whether the water source is highly productive or less productive and whether the water source is alluvial or porous/fractured rock in nature.

Groundwater sources in the Project area are managed under the 2011 Greater Metropolitan Region Groundwater Sources Water Sharing Plan (WSP). Under this particular WSP, the Project area falls entirely within Goulburn Fractured Rock Groundwater Source (GFRGS). Based on the AIP, the aquifer is classified as a 'less-productive" groundwater source (Figure 3.3).

The closest highly productive aquifer is associated with Sydney Basin Nepean Groundwater Source and comprise of talus, colluvium and weathered rock associated with the Permian-Triassic Sydney Basin units, including the Tallong Conglomerate and the Berry Siltstone. Due to the distance of the Project boundary to the highly productive aquifer/groundwater source (over 3 km to the east across highly varied and steep terrain), no impact on the highly productive aquifers is expected.

3 Department of Primary Industries – Office of Water, 2012. Aquifer Interference Policy.



LEGEND

- Populated place
- Project boundary
- Rail
- Watercourse, drainage

Groundwater productivity

- More productive
- Less productive

Marulan GWMP (MSL5000.001)

Regional AIP aquifer classification

AGE

DATE 08/12/2021

FIGURE No: **3.3**

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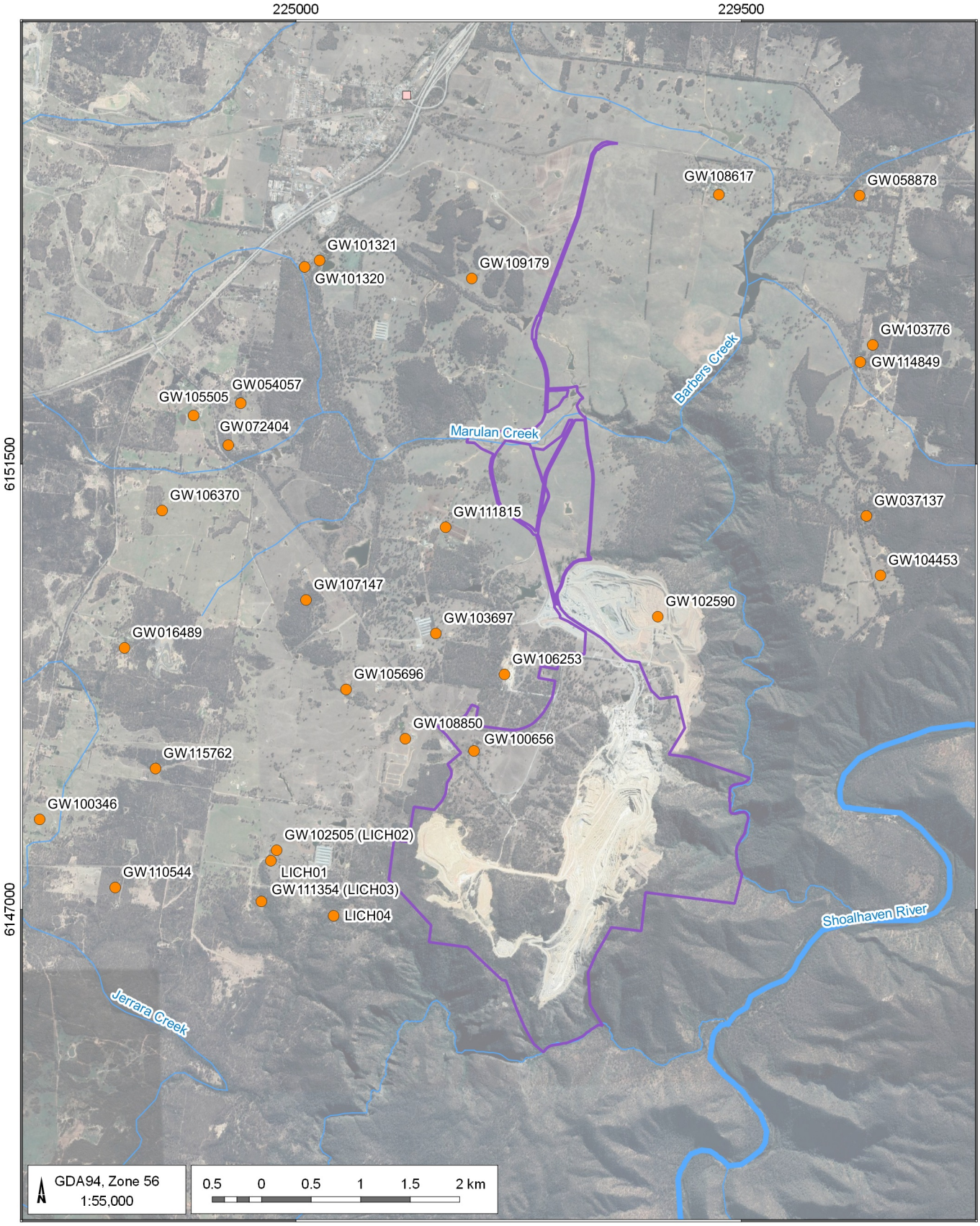
3.4 Groundwater users

The water supply bores registered on the NSW government water bore database[4], in the region surrounding the mine, are depicted on Figure 3.4. Although most of the registered bores are used for domestic water supply, several industrial water users (poultry farmers) are located in the vicinity of the mine. In February 2015, a hydrocensus was completed and relevant information was collected from registered groundwater users adjacent to the mine. Two additional bores were inspected (LICH01, LICH04) on an adjacent poultry farm. The farm uses the water to supply water for cooling and watering the poultry. Appendix C summarises details for each bore.

[4] https://waterregister.waternsw.com.au/water-register-frame



LEGEND

- Road
- Watercourse, drainage
- Project boundary
- Populated place
- Private bores

Marulan (MSL5000.001)

Locations of regional groundwater users

AGE

DATE 08/12/2021

FIGURE No: **3.4**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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4 GROUNDWATER MONITORING

4.1 Historic and existing groundwater monitoring network

Table 4.1 summarises the details for each of the historic and existing groundwater monitoring bores, with their locations shown in Figure 4.1. The bore logs are attached in Appendix A, describing the bore construction and lithology details. It is evident from available information that:

- MW1 and MW2 monitored the limestone formation and both bores were mined out in 2017 to 2018 respectively and are no longer operational;
- MW3 and MW4 have shallow and deep bore configurations and are situated west and outside the predicted 1m groundwater drawdown zone[5];
- MW5 and MW7 are located west on the edge of predicted groundwater drawdown;
- MW6 is located east on the escarpment and within the predicted groundwater drawdown zone;
- MW7 is dry; and
- Dual purpose groundwater production/monitoring bores WP16 and WP17 monitored seepages from plant infrastructure and limestone, were mined out in 2020 and are no longer operational.

[5] The numerical groundwater model is discussed in the Project EIS Groundwater Assessment (AGE, 2019) and used to predict regional drawdown.

Table 4.1 Summary of historic and existing groundwater monitoring bore network

Bore ID	Co-ordinates (GDA94 Zone 56)		Elevation (m AHD)	Standpipe stick-up (m)	Bore screen depths (m bgl)		Screened formation	Purpose
	East	North			From	To		
MW1*	228111	6147568	440.11	0.91	36.5	60.5	Limestone – north pit	Water quality and level monitoring - mined out
MW2**	227722	6146555	380.22	0.6	41.4	59.4	Limestone – south pit	Water quality and level monitoring - mined out
MW3S	226618	6148365	618.37	0.75	39	48	Weathered regolith	Water quality and level monitoring
MW3D	226608	6148370	618.38	0.66	72	102	Weathered volcanics (dacite)	Water quality and level monitoring
MW4S	226718	6147140	596.33	0.88	26	38	Weathered regolith, volcanics (tuffs)	Water quality and level monitoring
MW4D***	226717	6147129	595.46	0.87	83	123	Volcanics (tuffs)	Water quality and level monitoring
MW5	227826	6148352	574.41	0.7	73	97	Weathered regolith, weathered volcanics (dacite)	Water quality and level monitoring
MW6	228482	6147186	567.71	0.9	109.5	127.5	Sandstone	Water quality and level monitoring
MW7^	227525	6147816	610.00	0.7	68.0	80.0	Volcanics (andesite)	Water quality and level monitoring
WP16 [1)]	228535	6148530	546.50	~1	Not known		Limestone	Water supply/production and water quality and level monitoring - mined out
WP17 [2)]	228555	6148492	546.50	~1	Not known		Limestone	Water supply/production and water quality and level monitoring - mined out
WB07	228001	6148555	565.29		Not Known		volcanic breccia+siltstone	Water supply/production
WB08	227991	6148551	565.29		Not Known		volcanic breccia+siltstone	Water supply/production

Notes: * Bore mined out in North Pit, discontinued monitoring, Feb 2017.

** Bore mined out in South Pit, discontinued monitoring, June 2018.

*** Bore damaged, no groundwater quality sampling since May 2019.

^ Bore dry since installed in 2016.

1) Bore mined out and has alternative identifiers: EPL944 identifies this bore as EPL Monitoring Point 13 – North Pit Bore; the DPI Water registered number for this bore is ‘GW110267’.

2) bore mined out and has alternative identifiers: DPI Water registered number for this bore is ‘GW110268’.

4.2 Proposed monitoring boreholes

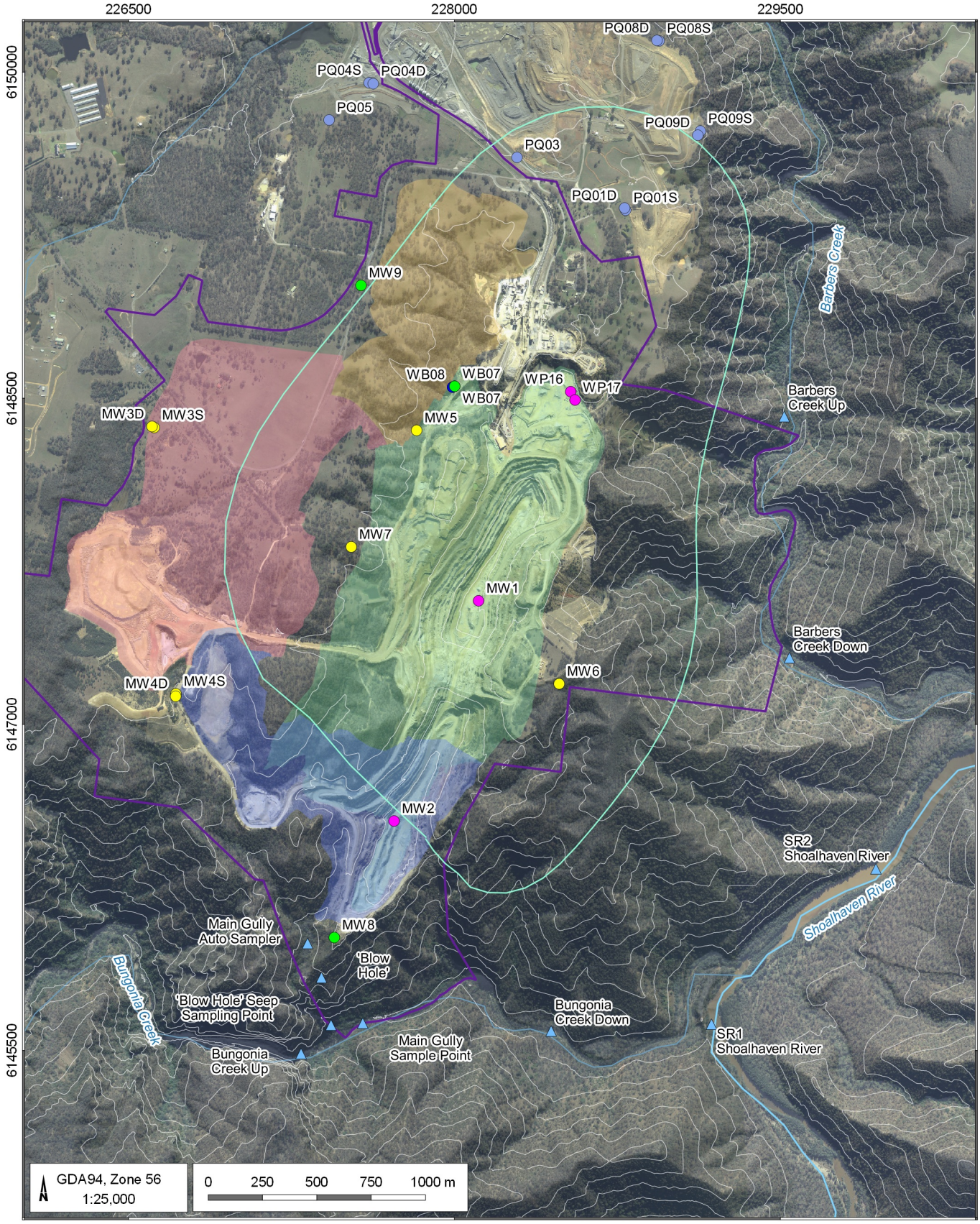
Condition B42 of the development consent requires *"within 12 months of the commencement of development under this consent, or other timeframe as agreed by the Planning Secretary, the Applicant must install a groundwater level and quality monitoring network within and adjacent to the Mt Frome Middle Limestone, or a suitable alternative location, in consultation with DPIE Water and to the satisfaction of the Planning Secretary"*.

Accordingly, to augment the existing groundwater monitoring network it is proposed to install additional groundwater monitoring bores as shown in Figure 4.1 and listed in Table 4.2. The proposed additional groundwater monitoring bores will assist in validating the hydrogeological conceptual and numerical groundwater models. Figure 4.1 also shows the estimated zone of influence (drawdown) derived from the numerical groundwater model (AGE, 2019). Figure 4.2 shows the geology map and the proposed drilling locations. The proposed drilling locations are based on site access, surface drainage, geology and hydrogeology, and the final drilling localities will be within close proximity of the proposed locations upon final confirmation.

In addition, groundwater monitoring data from the Peppertree Quarry groundwater monitoring network will be used to evaluate groundwater levels in the annual groundwater review, specifically the four monitoring bores closest to Marulan South Limestone Mine, namely PQ01, PQ03, PQ04 and PQ05.

Table 4.2 Proposed additional groundwater monitoring bore descriptions

Proposed bore ID	East (GDA94 Zone 56)	North (GDA94 Zone 56)	Elevation (m AHD)	Estimated depth (m)	Purpose and description	Replace old monitoring bore
WB07	228001	6148555	565	40 to 70	Monitoring any potential seepages and pollutants from the processing infrastructure from existing production bore WB07. Groundwater production from the bore will develop a cone of depression and flow gradients will be towards the bores.	WP16, WP17
MW8	227447	6146019	455	80 to 130	Monitoring seepage and mine pit environments, south (downgradient) of the South Pit area, south of the proposed southern overburden emplacement toe along the Main Gully. Aim to install in Mt Frome Middle Limestone, otherwise adjacent lithology.	MW2
MW9	227570	6149019	621	60 to 120	West of the mine. Overall groundwater level impact, west.	Additional monitoring



LEGEND

- Watercourse, drainage
- Elevation contour
- Potential zone of drawdown
- Project boundary
- Mine pit
- Overburden emplacement (north)
- Overburden emplacement (south)
- Overburden emplacement (west)
- Surface water monitoring locations

Groundwater monitoring bores

- Peppertree monitoring bores

Marulan monitoring bores

- Current monitoring bores
- Historic monitoring bores
- Proposed monitoring bores
- Water supply bores

Marulan GWMP (MSL5000.001)

Historical, current and proposed groundwater monitoring bores

AGE

DATE 09/12/2021

FIGURE No: **4.1**

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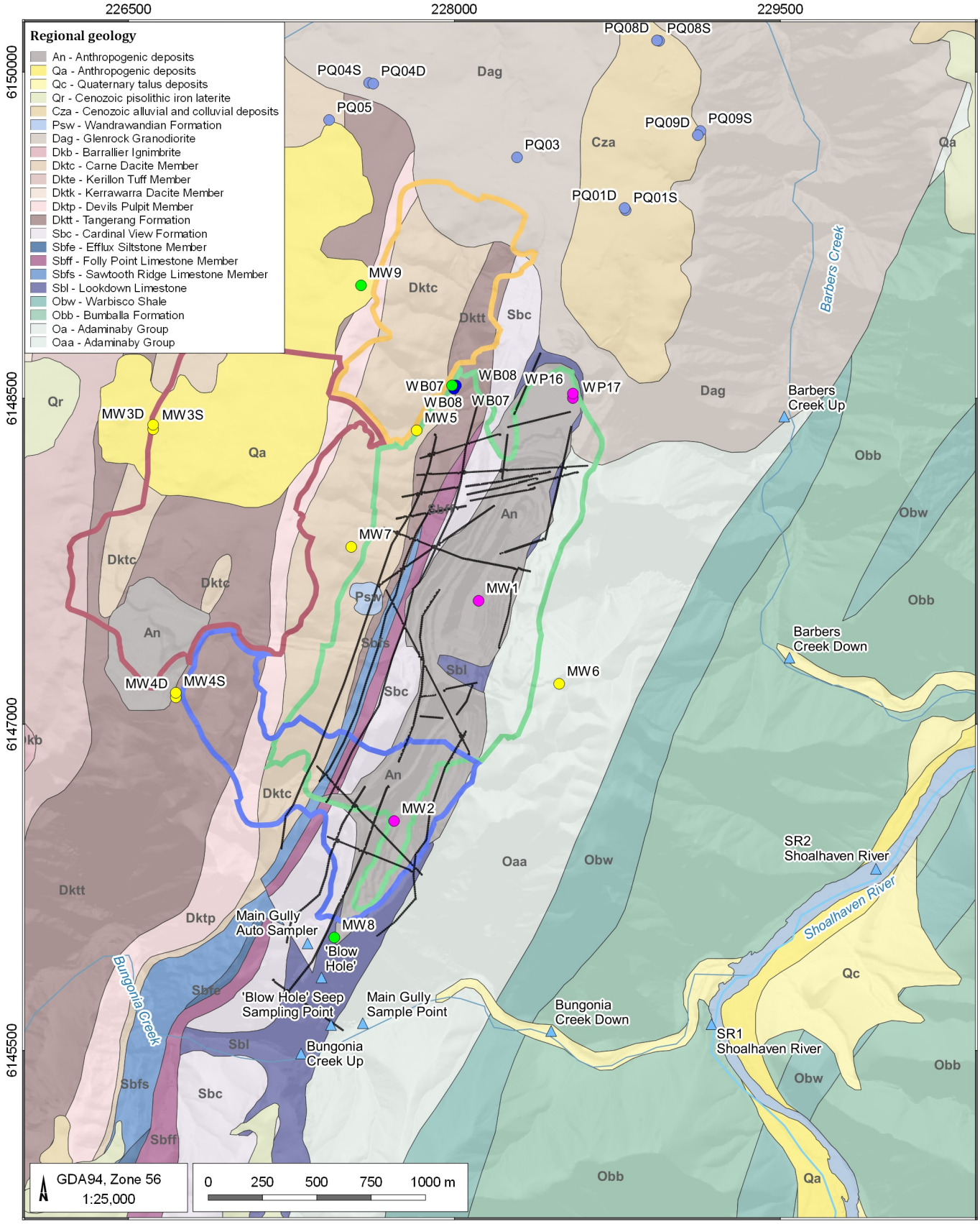

LEGEND

- Watercourse, drainage
- Project boundary
- Geological structures
- Mine pit
- Overburden emplacement (north)
- Overburden emplacement (south)
- Overburden emplacement (west)
- Surface water monitoring locations

Groundwater monitoring bores

- Peppertree monitoring bores

Marulan monitoring bores

- Current monitoring bores
- Historic monitoring bores
- Proposed monitoring bores
- Water supply bores

Marulan GWMP (MSL5000.001)

Geological map – regional geology

AGE

DATE 09/12/2021

FIGURE No: **4.2**

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5 SUMMARY OF BASELINE DATA

As discussed in Section 1.1, mining activities commenced on site in 1929 and therefore true baseline data prior to mining is not available. However, Boral recognised the need for major projects to collect baseline data to comply with the AIP and the baseline data is discussed in the EIS. The mine has been collecting groundwater data through the existing and expanding monitoring infrastructure since 2014. The borehole logs of the groundwater monitoring bores are attached in Appendix A, depicting the lithologies of each monitoring bore.

5.1 Groundwater level

Recent rainfall years have been put into historical context using the Cumulative Rainfall Departure (CRD) method (Bredenkamp, et al. 1995). This method is a summation of the monthly departure of rainfall total from the long-term average monthly rainfall. A rising trend in the CRD plot indicates periods of above average rainfall, whilst a falling slope indicates periods when rainfall is below average. In the context of a groundwater assessment, below average CRD may represent periods of below average recharge to groundwater systems. This can often correspond to naturally decreasing trends in groundwater levels in these systems. The CRD is depicted on the hydrographs in Appendix B.

Groundwater levels have fluctuated over this period due to a range of factors, including climatic conditions (i.e., drought), groundwater abstraction for mine use and groundwater recharge through the open pits. The hydrographs presented in Appendix B indicate that the water level fluctuations measured in the bores installed within the mine pit contrast strongly with the bores outside the pit. The bores outside the pit generally show less seasonal fluctuation and the monitoring bores inside the pit more significant seasonal fluctuations.

Monitoring bores MW3S, MW3D and MW4D shows stable trends with slightly increased groundwater levels between 2014 and 2021. In contrast, the groundwater level in bore MW05 declined gradually, since about 2017, with approximately 19 m drawdown. Monitoring bore MW03S also recorded a declining trend, whilst correlating with the CRD trend more closely. This response can probably be attributed to the drought conditions between 2018 to mid-2020.

The baseline period (2014 to 2016) was applied for setting groundwater level and quality triggers. The CRD trend for the first two years of groundwater monitoring and data gathering (2014 to 2016) shows stable rainfall conditions and can be regarded as a suitable period for the application of baseline data (refer to Appendix B for the hydrographs).

5.2 Groundwater quality

Recorded trends in groundwater quality for pH and electrical conductivity (EC), at each monitoring location are shown graphically in the charts in Appendix B. Generally stable trends for groundwater quality parameters, including physio-chemical parameters, major ions and metal concentrations, have been recorded at the monitored standpipe bores. Except for bore MW04S which indicates elevated total iron concentrations (Appendix B).

Table 5.1 summarises the average pH and EC measurements for each bore and the range in the available baseline data. The data indicates the groundwater is typically neutral to slightly alkaline (and alkaline in places) and fresh to slightly brackish. Generally, the groundwater samples from the limestone (MW1, MW2, and WP16) recorded lower electrical conductivity than the volcanics and sandstones, ranging from 270 µS/cm to 1,060 µS/cm. Samples from the volcanics and sandstones recorded higher electrical conductivity values, as high as 2,500 µS/cm in MW6.

Ranges in pH was also observed due to the host geology, ranging between 6.9 in sandstone up to 12[6] in the volcanics. Limestone pH values were all slightly alkaline to alkaline ranging between 7.4 and 8.

The EC and pH of the sample from the 'Blow Hole' sampling point was within the range typical for the limestone.

The measured EC range (concentration of dissolved salts) in the groundwater samples generally indicates the groundwater is of marginal use for drinking water, but suitable for other uses such as stock water and aquatic ecosystems.

Table 5.1 Summary statistics of groundwater quality indicators - pH and EC

Bore ID	Geology	pH (-)				Electrical conductivity @ 25°C (µS/cm)			
		min	mean	max	# Samples	min	mean	max	# Samples
MW1	limestone	7.22	7.67	8.14	26	330	777	1020	26
MW2	limestone	7.23	7.75	8.02	30	566	662	796	30
MW3D	volcanics	7.29	7.69	8.18	29	1060	1252	1450	29
MW3S	regolith	7.34	7.67	7.89	29	1180	1358	1470	29
MW4D	volcanics	7.39	8.08	9.59	29	1070	1250	1450	29
MW4S	volcanics	7.16	7.47	7.77	29	1400	1631	1760	29
MW5	volcanics	6.45	10.21	12	30	765	1213	3870	30
MW6	sandstone	6.92	7.40	8.20	28	476	1763	2500	28
WP16 (North Pit Bore)	limestone	7.45	7.65	7.88	19	486	880	1060	19
'Blow Hole' sampling point*	limestone	7.61	8.00	8.22	26	524	619	690	26

Note: *Sample collected from the cliff wall seepage under the B68 cave is presumed to represent the water from B68 spring.

Boral updates its groundwater monitoring database quarterly. Table 5.2 provides a summary of the periods over which groundwater monitoring data has been collected from each monitoring bore.

Table 5.2 Groundwater monitoring data periods

Monitoring bore ID	Groundwater level data period	Groundwater quality data period	Comments
MW1	Jul 2014 to Feb 2017	Jun 2014 to Dec 2016	Bore mined out
MW2	Jul 2014 to June 2018	Jun 2014 to Oct 2018	Bore mined out
MW3S	Jul 2014 to March 2021	Jun 2014 to March 2021	No groundwater level records from Jan 2020 to Dec 2020
MW3D	Jul 2014 to March 2021	Jun 2014 to March 2021	
MW4S	Jul 2014 to March 2021	Jun 2014 to March 2021	No groundwater level records from Feb 2019 to Sept 2020
MW4D	Jul 2014 to March 2021	Jun 2014 to May 2019	No groundwater quality data since May 2019 due to bore damaged ("cracked by a truck')

[6] The initial alkaline pH readings (between 11 and 12) in bore MW5 is most likely a results of the cement grout used to construct the bore.

Monitoring bore ID	Groundwater level data period	Groundwater quality data period	Comments
MW5	Jul 2014 to May 2021	Jun 2014 to June 2021	Groundwater level data gaps between Aug 2019 and Dec 2020
MW6	Jul 2014 to Sept 2020	Jun 2014 to March 2021	Groundwater level data gaps since Oct 2020
MW7	None	None	Bore dry since installation (2016)
WP16	None	Nov 2014 to March 2020	Bore mined out
WP17	None	None	Bore mined out

6 DATA COLLECTION METHODOLOGY

Groundwater data will be collected through a monitoring program for the life of the Project. Groundwater data collection is and will be undertaken at regular intervals by suitably qualified and experienced personnel. Water level measurements, water sample collection, as well as storage and transportation will be conducted following the Standard Operating Procedures (SOPs) included in Appendix E. The SOPs are drawn from relevant aspects of the following industry standards:

- The Australian/New Zealand Standard Water quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998); and
- The Australian/New Zealand Standard Water quality – Sampling, Part 11: Guidance on sampling of groundwaters (AS/NZS 5667.11:1998).

Groundwater data collected from each monitoring event will be collated into a database. The database will include, as a minimum, the following:

- records of manual standing level water measurements and electronic pressure logger download;
- records of field water quality parameters and sampling methodologies to achieve representative samples (see Appendix E);
- tabulated water quality laboratory results and comparison to trigger values;
- a chain of custody supplied to the laboratory of the water samples collected;
- records of original laboratory analysis certificates; and
- records of any issues encountered.

In addition, this section also describes the data collection required to meet the following CoCs (refer to Section 2):

- *water loss/seepage from water storages into the groundwater system, including from any final voids;*
- *groundwater inflows, outflows and storage volumes, to inform the Site Water Balance;*
- *any indirect impacts from the development on alluvial aquifers, springs and GDEs; and*
- *impacts on groundwater supply for other water users.*

6.1 Groundwater levels

Natural fluctuations in groundwater levels occur in response to a range of stresses. These stresses can range from short term events, such as short rainfall recharge events, or long-term events, such as multi-year droughts. Groundwater levels will be measured manually, and automated data loggers installed to capture all possible events.

6.1.1 Mine monitoring bores

Standing groundwater levels will be measured in all the mine monitoring bores with a decontaminated electronic water level meter and recorded to the top of the bore casing. Electronic pressure transducers equipped with data loggers were installed in July 2014 to automatically monitor groundwater levels from the existing monitoring bores. To allow for barometric correction of water pressure recorded by the standpipe transducer/logger, a barometric logger was installed in one of the standpipe bores.

Manual level gauging and pressure logger sensor downloads will occur as part of each quarterly monitoring round. Data loggers will also be installed in the proposed monitoring bores.

The two shallow bores located along the Main Gully drainage line (MW3S and MW4S) monitor the potential interaction between groundwater and surface water associated with climatic conditions.

6.1.2 Groundwater users

The groundwater assessment prepared for the Project (AGE, 2019) used a numerical groundwater flow model to predict regional groundwater drawdown. The predicted zone of drawdown is depicted in Figure 4.1 and indicates that no private groundwater bores are likely to have a drawdown greater than two metres[7] during the lifetime of the mine.

The existing and additional monitoring bores proposed in Section 4 will monitor the regional groundwater levels and potential drawdown towards the groundwater users situated to the west and south-west of the mine.

The groundwater monitoring network will be adjusted to include any privately registered bores that may fall within the two-metre drawdown prediction on completion of model validations using the monitoring data. In addition, Boral may consider monitoring particularly concerned landholders or those in relatively close proximity and according to groundwater level trends observed in the monitoring bores.

6.2 Groundwater quality

To ensure groundwater quality samples collected are representative of the monitored aquifer unit, bore purging will be conducted prior to the collection of water samples. Field measurement/observations of parameters, including pH, electrical conductivity, temperature, redox potential, colour, odour and sediment load will be recorded. The water quality analytical suite, to be analysed by a NATA accredited laboratory, includes the following parameters:

- pH, electrical conductivity and total dissolved solids (calc.);
- sodium adsorption ratio (SAR);
- total hardness;
- anions - fluoride, bromide, sulphate, chloride;
- alkalinity - hydroxide, carbonate, bicarbonate and total alkalinity;
- cations – calcium, magnesium, sodium, potassium;
- total and dissolved metals - aluminium, arsenic, beryllium, barium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, strontium, vanadium, zinc, boron, iron;
- dissolved and total recoverable mercury;
- dissolved silica; and
- suspended solids and oil and grease (WP16 only as required by EPL944 and to be replaced by the proposed groundwater monitoring WB07, discussed in Section 4.2).

In addition, nitrates and total nitrogen will be analysed for groundwater monitoring bores MW5 andMW8. This is to detect any diffuse contamination associated with general mining activities, such as chemicals used for rock blasting seeping into underlying groundwater.

Groundwater quality samples will be collected from the mine monitoring bores bi-annually, after the wet season (March/April) and after the dry season (August/Sept). The SOP in Appendix E describes the process for the collection of groundwater quality samples.

[7] NSW Aquifer Interference Policy (DPI-Water, 2012) minimal impact criteria of 2 metres. Department of Primary Industries – Office of Water, 2012. Aquifer Interference Policy.

6.3 Groundwater quantity

6.3.1 Project water supply and groundwater production bores

The mine's water supply, including dust suppression, processing activities, and some non-potable amenities is from existing and new on-site dams (Advisian (2019). Refer to Figure 6.1 for the localities of the mine dams.

In addition, groundwater was previously abstracted from two groundwater production bores, VP16 and VP17 (refer to Figure 4.1 and Table 4.1). Both these bores were mined out and production stopped. Two additional production bores were installed in 2021 (WB07 and WB08 in Table 4.1 and Figure 4.1) and will be used to supplement mine water supply. The combined abstraction volume is estimated to be in the order of 6 litres per second (L/s) or ~518 m^3/day and ~189 mega litres per year (ML/year).

Groundwater abstraction from production bores is measured through installed flow meters. The monthly production rates will be calculated from the flow meter readings and reported in the Annual Review and used to inform the Water Balance.

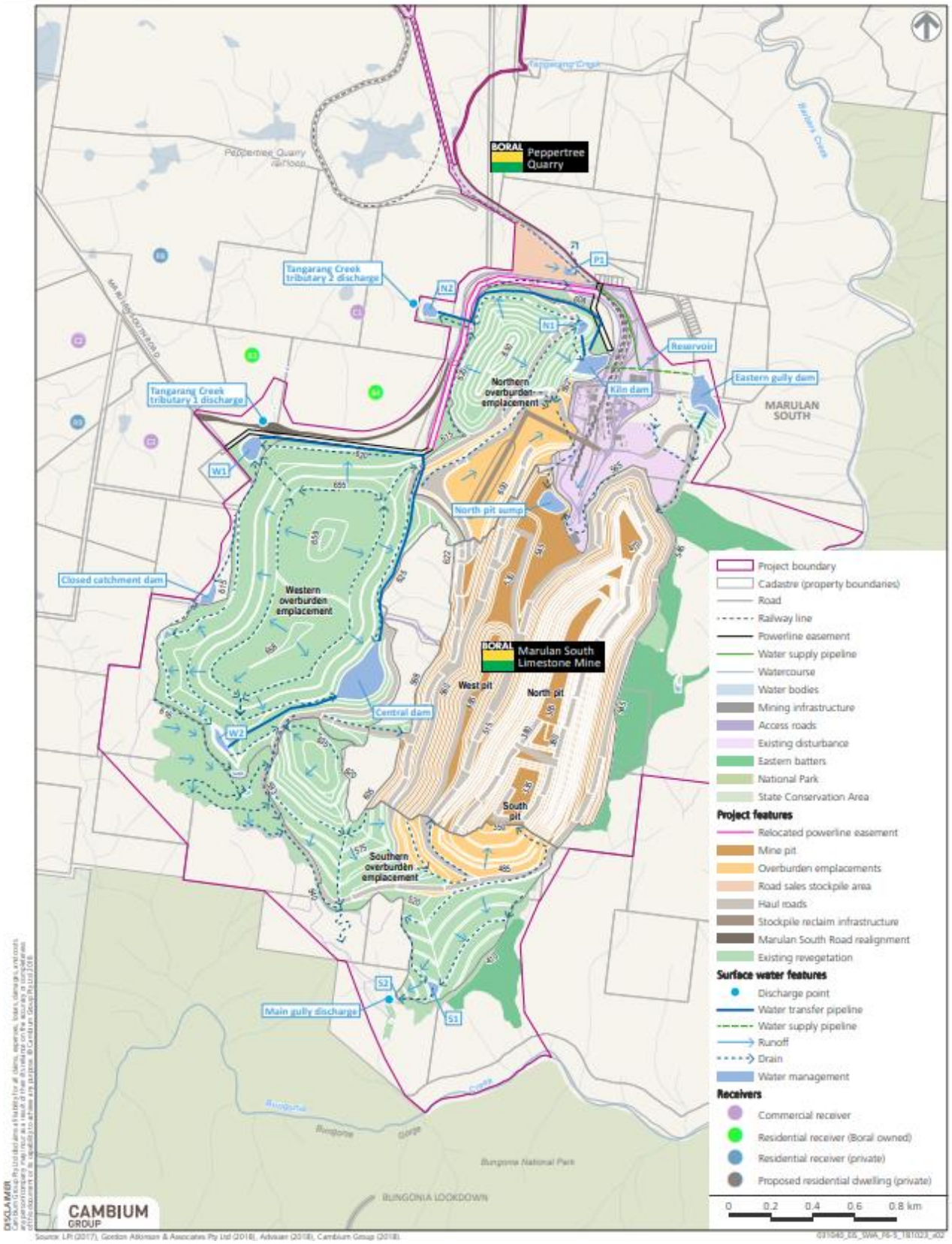


Figure 6.1 Surface water management - Stage 4 (Advisian, 2019)

6.3.2 Groundwater take from mining

The groundwater seepage rates are commonly difficult to measure as continuous pumping out of the pits is not required. This is because the groundwater table is mainly below the lowest level of the floor of the pit and the area of the pit walls and floors is relatively large and promotes evaporation of any superficial inflows. Recent groundwater monitoring data shows that the groundwater table is intercepted by the mine pit along its western wall and drawdown within the direct vicinity of the mine pit (i.e. at monitoring bore MW5) will increase over time.

Proponents of aquifer interference activities are required to provide predictions of the volume of water to be taken from a water source as a result of the activity. These predictions need to occur prior to development consent and during operations. The estimated volumes need to be measured and reported in an Annual Review. Boral must hold a sufficient share component and water allocation to account for the take of water from the relevant water source when the take occurs.

The groundwater assessment prepared for the Project (AGE, 2019) used a numerical groundwater flow model to estimate direct, and indirect groundwater take. The estimated take from the consolidated limestone ('ore body'), sandstone and shale (overburden) aquifers, varies from 7 ML/year to 23 ML/year with an average take of 14.2 ML/year.

The model predicts groundwater flow from bedrock to Bungonia and Barber's Creek systems to decrease on average by 1.8 ML/year, peaking at the end of the mining period at 4.2 ML/year.

Groundwater in the mine area is managed under the Water Sharing Plan (WSP) for the Greater Metropolitan Region Groundwater Sources. The WSP includes 13 groundwater sources on the east coast of NSW and divides the area into management zones based on geology and aquifer properties. The Project area is within the Goulburn Fractured Rock Groundwater Source (GFRGS, refer to Figure 6.2).

As indicated above, the groundwater assessment prepared for the Project (AGE, 2019) used a numerical groundwater flow model to provide estimates of:

- incidental [8]groundwater take occurring through groundwater seepages into the open pit (Section 8.7.3);
- consumptive[9] groundwater take via pumping from proposed water supply pumping bores; (Section 8.7.5); and
- passive[10] water take occurring within the surrounding alluvium and connected surface waters (Section 8.7.4 and Appendix A-2).

Table 6.1 compares the predicted groundwater takes to the Water Access Licences held by Boral to determine if the latter are adequate to account for the impact of the Project as well as the legacy operations combined. Table 6.1 shows that the Water Access Licences held by Boral are more than adequate to account for the incidental water take occurring due to the proposed and legacy open pit, and also for the consumptive use via pumping proposed from the water supply bores.

[8] Incidental water is defined in the Aquifer Interference Policy 2012 as "Water that is taken by an aquifer interference activity that is incidental to the activity; including water that is encountered within and extracted from mine workings, tunnels, basements or other aquifer interference structures that must be dewatered to maintain access, serviceability and/or safe operating conditions. This water is not actually required to be used as part of the process of carrying out that activity".

[9] Consumptive water is defined as water directly taken from an aquifer by pumping and consumed by the activity.

[10] Passive water take is defined as water losses from a groundwater system that occur indirectly due to an adjacent activity.

Table 6.1 Water Access Licences - Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources - Goulburn Fractured Rock Groundwater Source

Management zone	Predicted Water Take (ML / annum)[1,2]			Share component held by Boral	WAL No.	Units (ML / annum)
	Incidental (to pit)	Passive	Consumptive (bores)			
None in water source	23	0	189	850	41976	838
					24697	12

Notes: 1: all estimated water take volumes are rounded to the nearest 1 ML.
2: water take less than 1 ML is considered zero for licensing purposes.

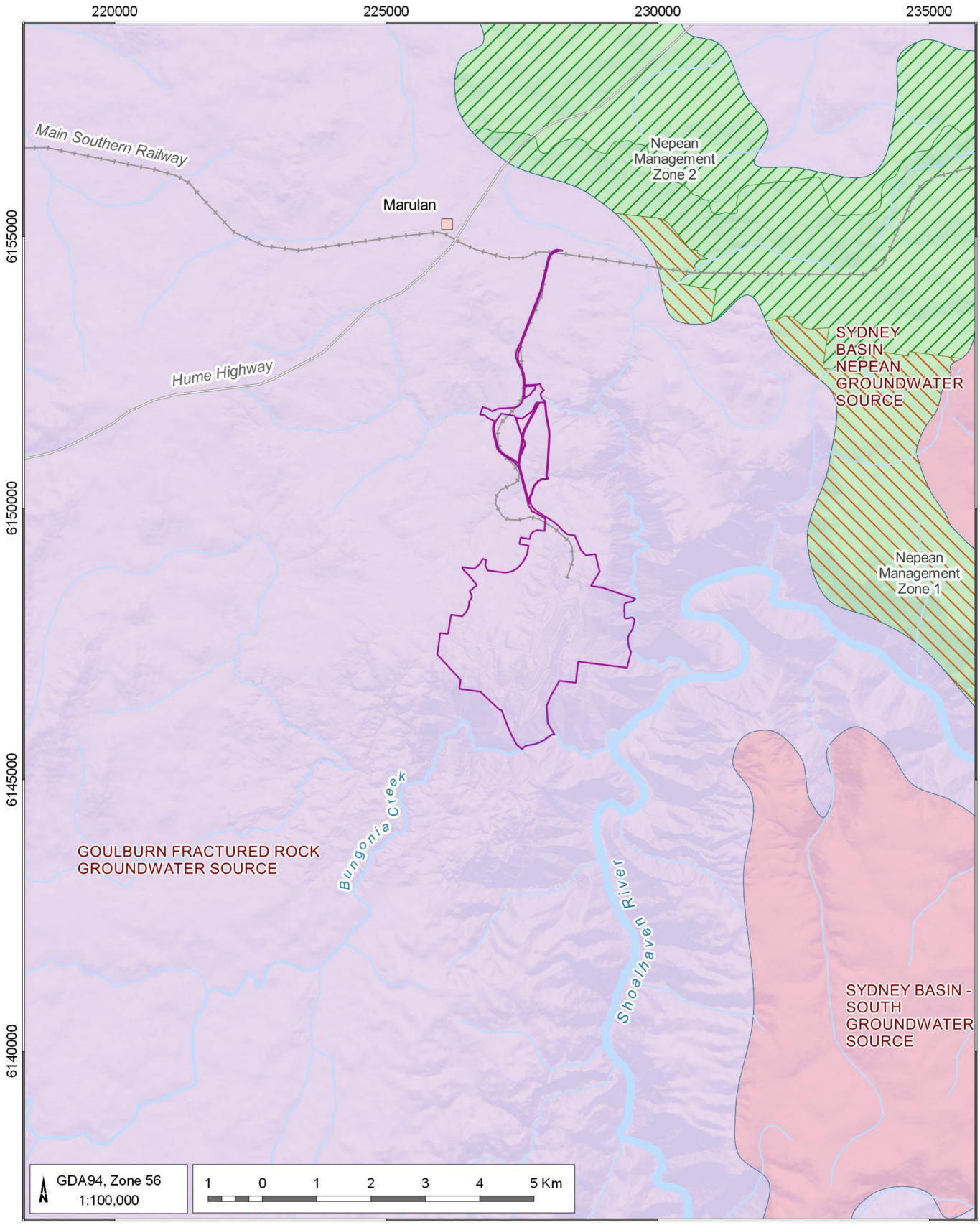
Surface water in the Project area is managed under the Water Sharing Plan for Greater Metropolitan Region Unregulated River Water Sources. The plan area is divided into water sources, which are further subdivided into extraction management areas. The Project area is within the Shoalhaven Water Source and within the Bungonia Creek and Barbers Creek management zones as shown in Figure 6.3. Currently, the mine has surface water use licences under the water sharing plan as shown in Table 6.2.

The passive surface water take presented in Table 6.2 is based on the assumption that the reduction in groundwater flow to the Bungonia Creek alluvium and the Barbers Creek alluvium predicted by AGE (2019) translates to a 1:1 loss in baseflow. Table 6.2 shows that Water Access Licences held by Boral are more than adequate to account for the passive take of baseflow from the Barbers Creek Management Zone.

Table 6.2 Water Access Licences - Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources - Shoalhaven River Water Source

Water source/management zone	Predicted Water Take (ML / annum)[1,2]			Share component held by Boral	WAL No.	Units (ML)
	Incidental (to pit)	Passive	Consumptive			
Bungonia Creek Management Zone	0	2[3]	0	0	-	-
Barbers Creek Management Zone	0	2[3]	0	86	25373	10
					25207	76

Notes: 1: all estimated water take volumes are rounded to the nearest 1 ML.
2: water take less than 1 ML is considered zero for licensing purposes.
3: value calculated by rounding down predicted peak water take (4.2 ML/year in AGE 2019 Table A2) from Bungonia and Barbers Creek alluvium and dividing evenly across the Bungonia Creek and Barbers Creek management zones.



LEGEND

- Populated place
- Rail
- Watercourse, drainage
- Project boundary

Groundwater Sources and Groundwater Management areas

- Goulburn Fractured Rock Groundwater Source
- Sydney Basin - South Groundwater Source
- Sydney Basin Nepean Groundwater Source
  - Nepean Management Zone 1
  - Nepean Management Zone 2

Marulan GWMP (MSL5000.001)

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011

AGE

DATE 30/09/2021

FIGURE No: **6.2**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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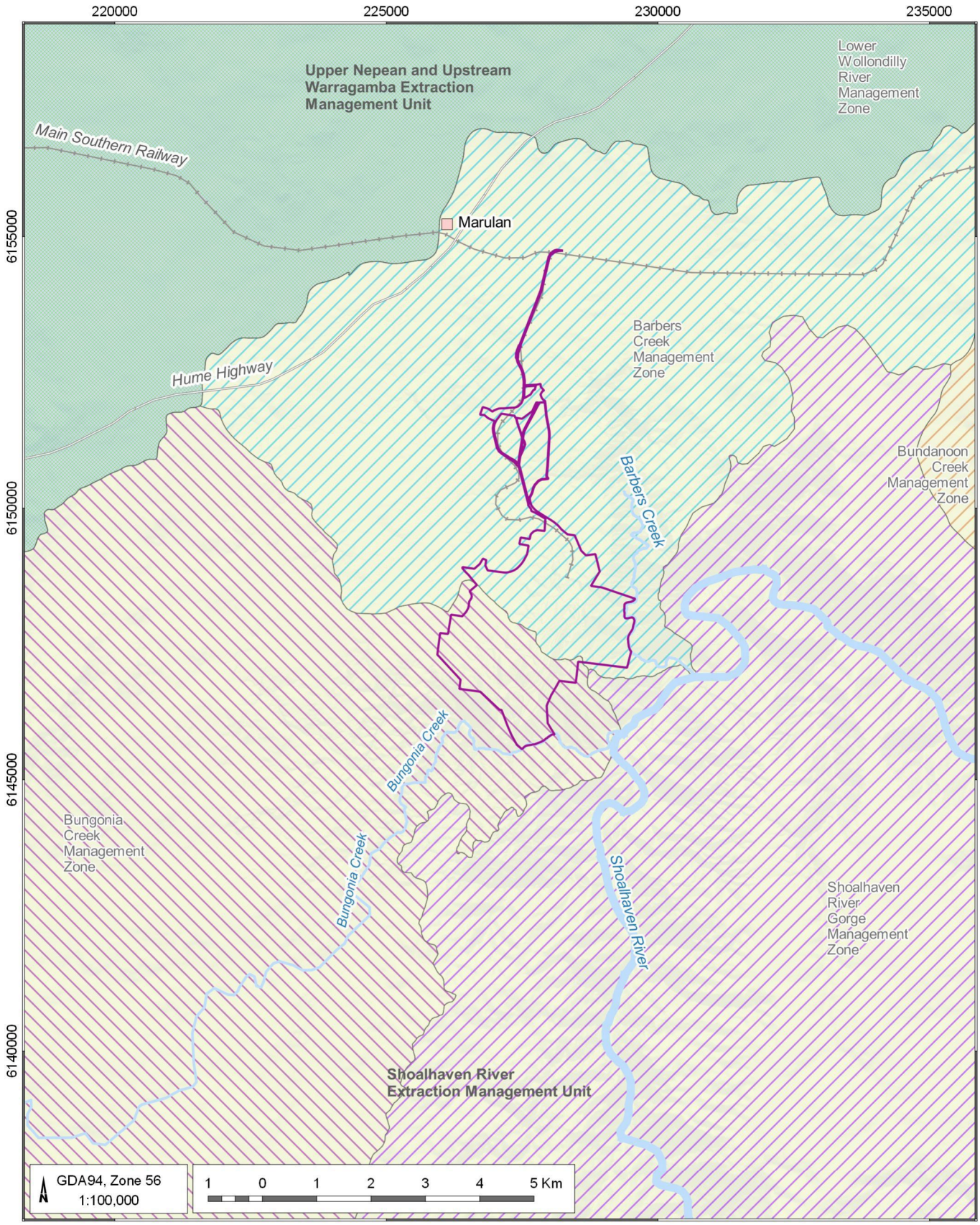

LEGEND

- Populated place
- Rail
- Watercourse, drainage
- Project boundary

Extraction Unit

- Upper Nepean and Upstream Warragamba Extraction Management Unit
  - Lower Wollondilly River Management Zone
- Shoalhaven River Extraction Management Unit
  - Barbers Creek Management Zone
  - Bundanoon Creek Management Zone
  - Bungonia Creek Management Zone
  - Shoalhaven River Gorge Management Zone

Marulan GWMP (MSL5000.001)

Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011

AGE

DATE 30/09/2021

FIGURE No: **6.3**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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6.4 Groundwater dependent ecosystems

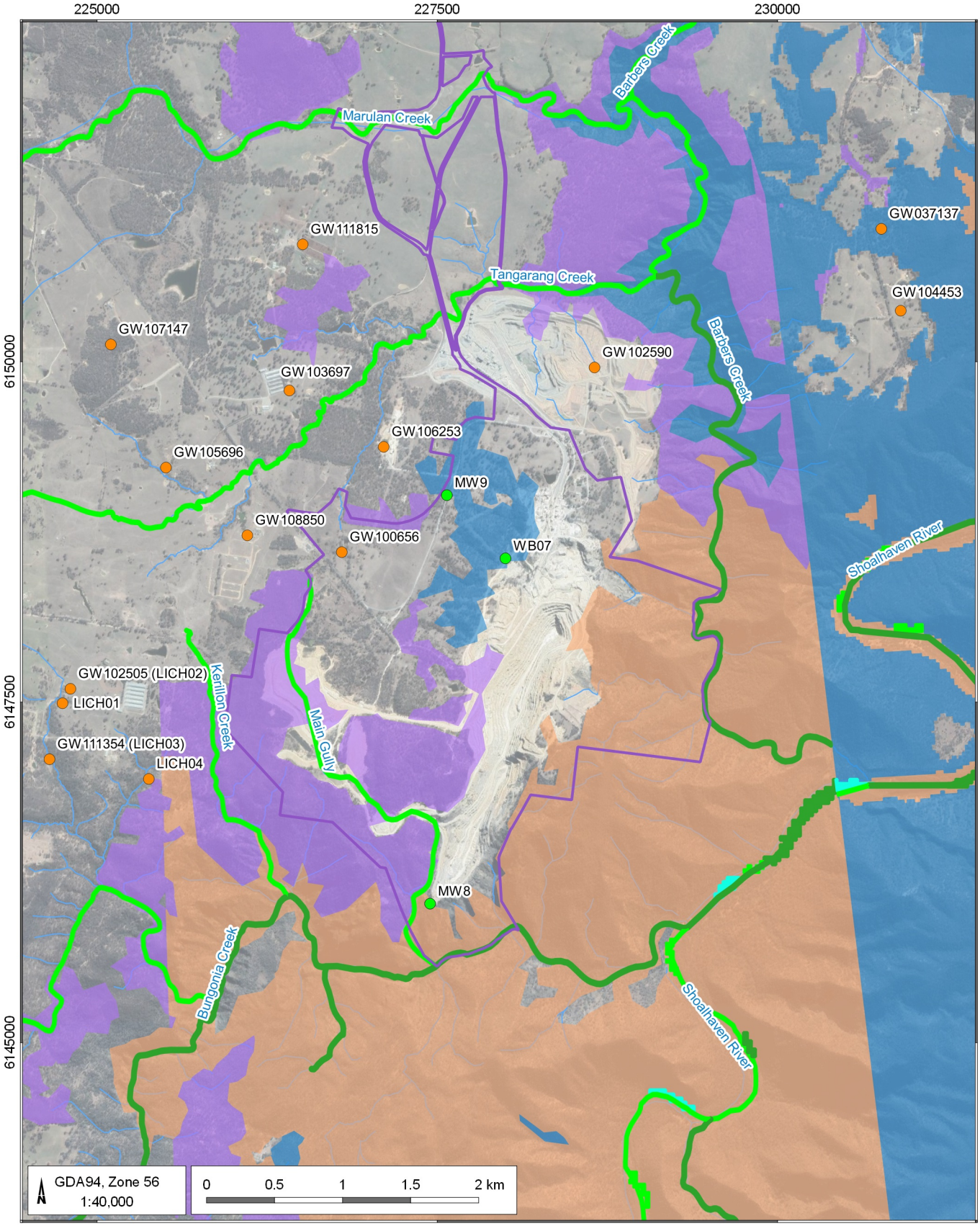
A Groundwater Dependent Ecosystem (GDE) is one in which the plant and animal community is dependent on the availability of groundwater to maintain its structure and function. The Bureau of Meteorology (BoM, 2017) GDE Atlas shows ecosystems including springs, wetlands, rivers, and vegetation that interact with the subsurface presence of groundwater or the surface expression of groundwater. The Atlas categorises groundwater-dependent ecosystems into two classes in New South Wales. These are ecosystems that potentially rely on the:

- surface expression of groundwater - this includes all the surface water ecosystems which may have a groundwater component, such as rivers, wetlands, and springs; and
- subsurface presence of groundwater - this includes all vegetation ecosystems.

The groundwater dependent assets associated with the Project are private water supply bores described in Section 3.4and the groundwater dependent ecosystems described in this section.

6.4.1 Bungonia and Barbers Creek area

The eastern slopes towards Barbers Creek as well as the southern slopes towards Bungonia Gorge are classified as having high potential for groundwater interactions (relying on the subsurface presence of groundwater). Equally, the area of Bungonia Gorge (along Bungonia Creek) and Barbers Creek are classified as having high potential for groundwater interaction (relying on surface expression of groundwater) (Figure 6.4). Accordingly, and based on the field survey undertaken by Niche (2018), aquatic fauna and spring-dependent flora of high ecological value were found along these drainage lines.



LEGEND

- Populated place
- Watercourse, drainage
- Project boundary
- Private bores
- Proposed monitoring bores

GDE reliant on surface expression of groundwater

- High potential for GW interaction
- Moderate potential for GW interaction
- Low potential for GW interaction

GDE reliant on subsurface expression of groundwater

- High potential for GW interaction
- Moderate potential for GW interaction
- Low potential for GW interaction

Marulan (MSL5000.001)

Mapped Groundwater Dependent Ecosystems

AGE

DATE 21/01/2022

FIGURE No: **6.4**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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6.4.2 The area southwest of the mine

The Main Gully drainage line, which drains the southwestern mining area towards Bungonia Creek, is classified as having “a moderate potential for groundwater interaction”. The zone immediately west of the existing pit is classified as having moderate to low potential for interaction with groundwater (refer to Figure 6.4).

Groundwater monitoring bores MW03S and MW04S are situated along the Main Gully drainage line and indicate that groundwater levels are between 18 and 34 metres below the drainage lines (Figure 6.5). Groundwater levels are deep, and it is therefore unlikely that groundwater is discharging into the drainage line or affecting vegetation.

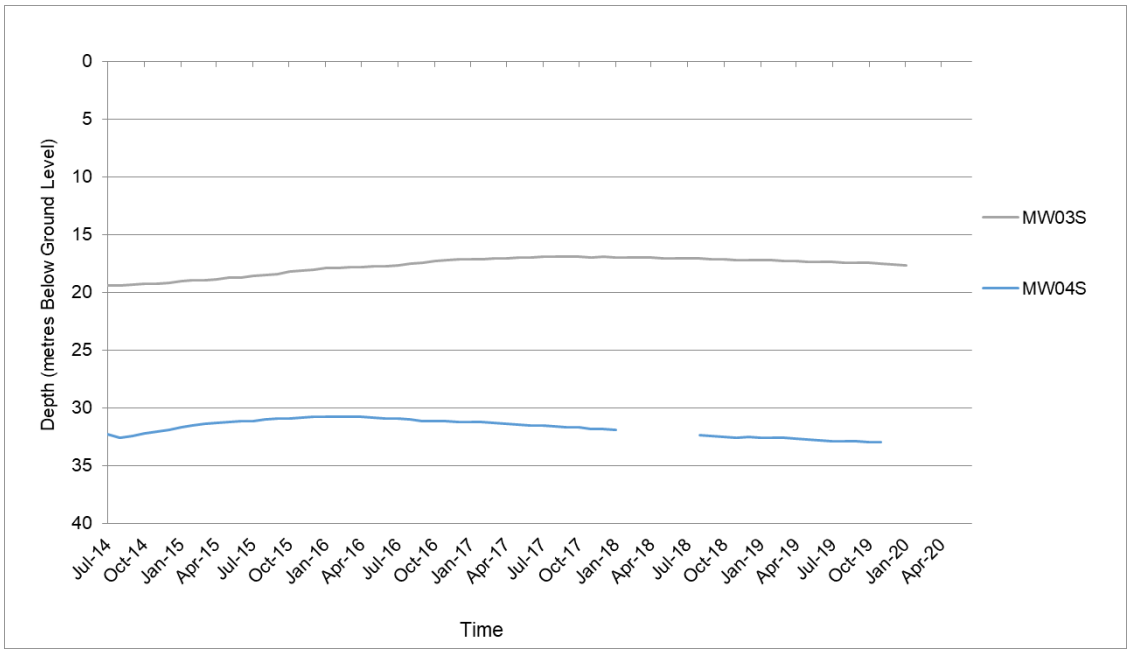

Figure 6.5 Groundwater level data for bores MW03S and MW04S

6.4.3 Monitoring of GDEs

The groundwater management plan allows for the monitoring of groundwater levels and groundwater quality as specified in Section 4 above. The location of the high priority groundwater dependent ecosystems identified within the mine area are shown on Figure 6.4, along with the groundwater monitoring infrastructure. The figure shows that the high potential groundwater dependent ecosystems are predominantly located in riparian zones discussed above. The intention of the routine groundwater monitoring plan at the mine site is to identify any mine related impacts on the local aquifer systems. No specific groundwater monitoring will be initiated within the Bungonia Creek and Barbers Creek gorge due to the impracticality of installing groundwater monitoring infrastructure. For this reason, quarterly inspections of stream and vegetation health as outlined in the Water Management Plan will identify any changes in stream and vegetation health which is an indicator of any impact on both GDEs and general terrestrial and aquatic ecology. During these events, visual inspections will be undertaken, and photo logs compared to previous baseline observations. Any detrimental groundwater level and quality anomalies from the mine’s groundwater monitoring bores will initiate additional climatic and hydrogeological assessment through the TARPs (Section 9).

6.4.4 Springs

Monitoring of the spring (also known as the “Blowhole” – location shown in Table 6.3) is covered in the Surface Water Management Plan, together with the locations of the other surface water monitoring sites, shown in Figure 4.1. The EIS Surface Water Study (Advisian, 2019) discusses these monitoring points in more detail.

Spring flow is regarded as groundwater which becomes surface water in this case, and hence there is an overlap between surface water and groundwater monitoring. The flow characteristics of the springs will be recorded visually during monitoring events as it will be difficult and impractical to monitor flow continuously through automated flow measurement apparatus. Figure 6.6 and Figure 6.7 supply a better overview of the location and the geographical characteristics of the Blowhole.

Table 6.3 Spring water sample location

Monitoring location	Co-ordinates (GDA94 Zone 56)		Elevation (m AHD)
	Easting	Northing	
‘**Blowhole’ Sampling Point**	227432	6145617	179.00

Figure 6.6 View North from Bungonia Gorge lookout - 'Blowhole' overflow after heavy rainfall, 7/6/2016

Figure 6.7 Main Gully Spring cave ('Blowhole') - opening and flowing water inside (August 2017)

6.5 Alluvial aquifers

As discussed in Section 3.2, no alluvial aquifer exists within the direct vicinity of the mine (on the plateau) or along the Barbers and Bungonia creek lines (in the gorge). The Barbers and Bungonia creek lines will be visually inspected during the quarterly surface water monitoring events, and no direct groundwater monitoring will be undertaken.

Any detrimental groundwater level and quality anomalies from the mine's groundwater monitoring bores will initiate additional climatic and hydrogeological assessment through the TARPs (Section 9).

7 DATA ANALYSIS METHODS

The methods for analysing groundwater level and quality data are described in the following sections.

7.1 Groundwater level

The methods for analysis of groundwater level data are summarised in the flowchart in Figure 7.1. The flowchart outlines the pre-processing steps, including quality assurance/quality control (QA/QC), that will be undertaken for groundwater level data analysis.

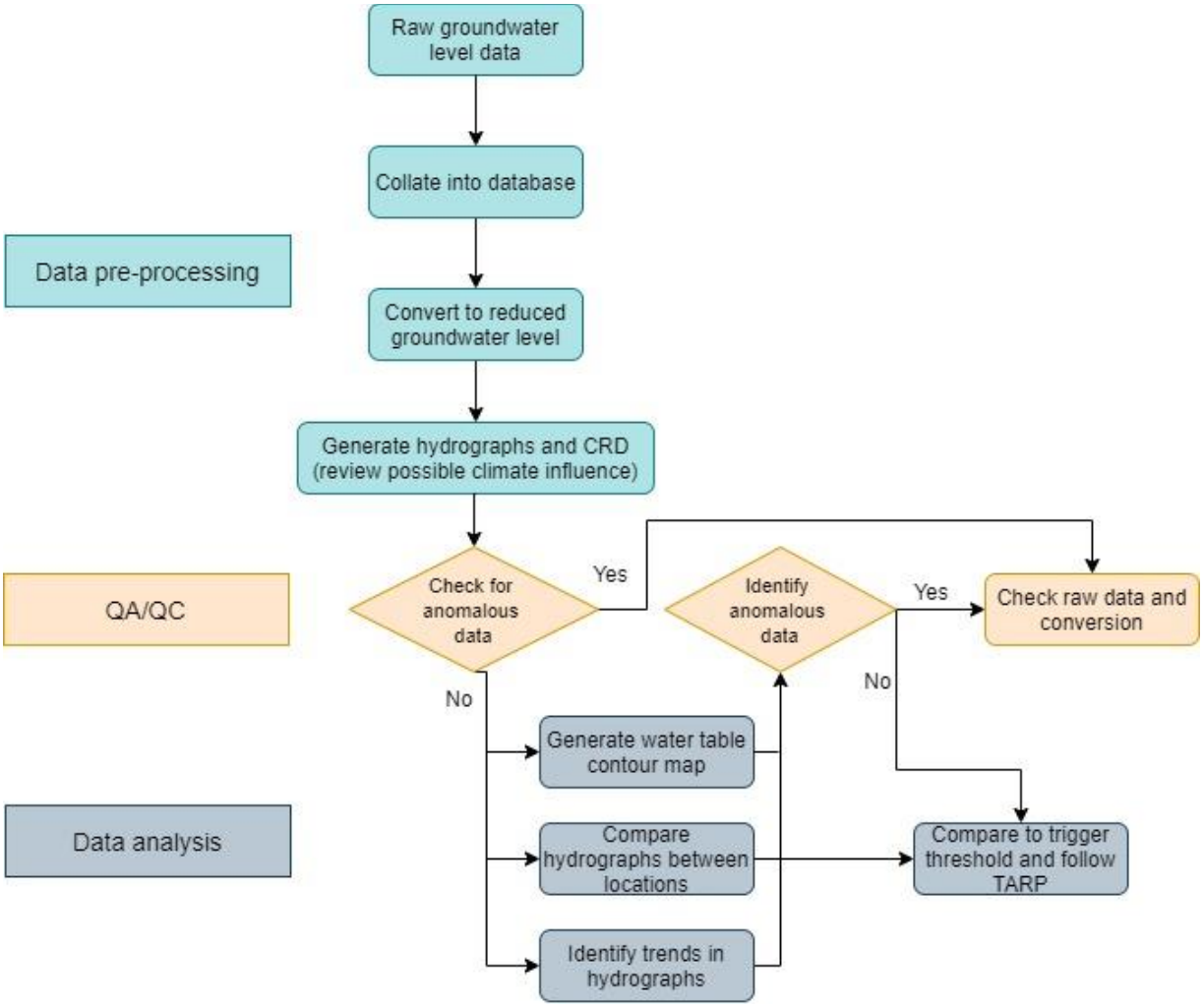

Figure 7.1 Groundwater level data pre-processing and analysis flowchart

As indicated in the flowchart, manual standing water levels and electronic pressure logger data will be converted to a reduced water level with respect to Australian heigh datum (m AHD). Pressure logger data will be adjusted to remove the effects of barometric pressure changes where required.

The reduced water level data will be visualised as time series charts (hydrographs). An example hydrograph is provided in Figure 7.3 and Appendix B. Hydrographs will be utilised as a tool to identify the occurrence of anomalous data points, which will form part of the QA/QC process.

Once anomalous data points are rectified or removed, the hydrographs will be used to understand the behaviour of water in the groundwater regime, including:

- recharge/discharge events as indicated by the relationship to the CRD;
- the influence of regional abstraction from irrigation, stock and domestic bores; and
- any effects from mining.

Hydrographs will be compared between monitoring locations to reveal more significant water level changes that could be a result of the Project activities. Where water level measurements are outside the trigger threshold the TARP process (as outlined in Section 9.1) will be initiated.

Water table contour maps will illustrate horizontal flow directions within key hydrostratigraphic units with sufficient spatial data. These contour maps will be generated from monitoring data by connecting areas of equal groundwater elevation to create a two-dimensional representation of the piezometric surface. Comparison of contour maps with previous time periods will show changes in groundwater levels and flow directions over time.

7.2 Groundwater quality

The groundwater monitoring bores, will have water samples collected for water quality analysis biannually. The methodology for the analysis of groundwater quality data is summarised in the flowchart in Figure 7.2. Similar to the water level flowchart in Figure 7.1, this flowchart outlines the pre-processing, including QA/QC, as well as the steps that will be undertaken for groundwater quality data analysis.

The Project is unlikely to change the current groundwater quality as the current recharge pathways are not proposed to be altered, except in the mine pit area. Changes to groundwater levels and quality will be investigated if monitoring results deviate from historical monitoring results. The geochemical investigation of the overburden and limestone ore (AGE, 2019) demonstrated that overburden emplacement and ore stockpiling would have a minimal to negligible impact on groundwater quality.

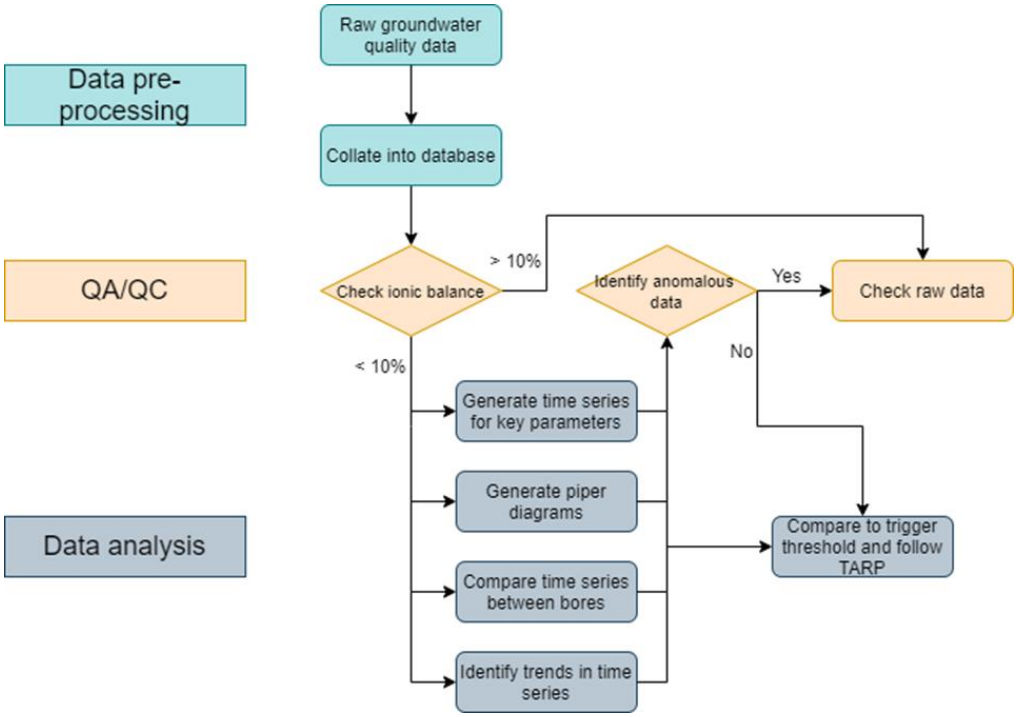

Figure 7.2 Groundwater quality data pre-processing and analysis procedures

Groundwater quality data will be pre-processed for analysis similar to the method adopted for groundwater levels. Field and laboratory results will be collated and tabulated in a single database that will identify:

- key parameters including pH and EC concentrations that are either greater than the 95th percentile of baseline data or less than the 5th percentile of baseline data;
- ionic balance results which exceed the >± 10% margin (charge of cations should balance that of anions in natural groundwater); and
- dissolved metal concentrations that exceed ANZECCC guidelines for beneficial use (refer to Appendix D for the guidelines). Dissolved metals are used for guideline comparison because of their higher bio-availability when compared to total metals. The ANZECC & ARMCANZ 2000 water quality guidelines (referenced in ANZG 2018) are not directly applicable for groundwater where water extraction for beneficial purposes is not occurring, or the groundwater is not supporting a groundwater dependent ecosystem.

Groundwater samples with ionic balance beyond the ± 10% range will be identified and the cause determined. If necessary, an additional sample will be collected for laboratory analysis within seven days of the original sample. Samples that are determined not to be representative will be flagged and removed in subsequent data analysis. The sampling method, sample transportation and laboratory consistency of reporting limits, are also some items that could influence the occurrence of nonrepresentative values.

Time series plots will be generated for water quality indicators with trigger values based on the 5th and 95th percentile of baseline data for pH and EC and compared with short- and long-term water level trends. Figure 7.3 shows an example of the stacked charts that will be generated for each monitoring bore, and the trigger thresholds based on baseline data.

In addition to location-specific trigger thresholds for pH and EC all field and laboratory analytes will be tabulated and compared against ANZECC guideline values for stock and/or irrigation water (refer to Appendix D). Exceedances against the ANZECC stock and/or irrigation guidelines will form water quality trigger thresholds for dissolved metal concentrations as discussed in Section 8.

Piper diagrams will be generated as a visualisation tool to understand the relative major ion abundance and water chemistry at each monitoring site and different geology types. Piper diagrams are useful in identifying differing or mixing, chemistry signatures between hydrostratigraphic units and how signatures change over time. Figure 7.4 shows an example of a Piper diagram generated from the available baseline data.

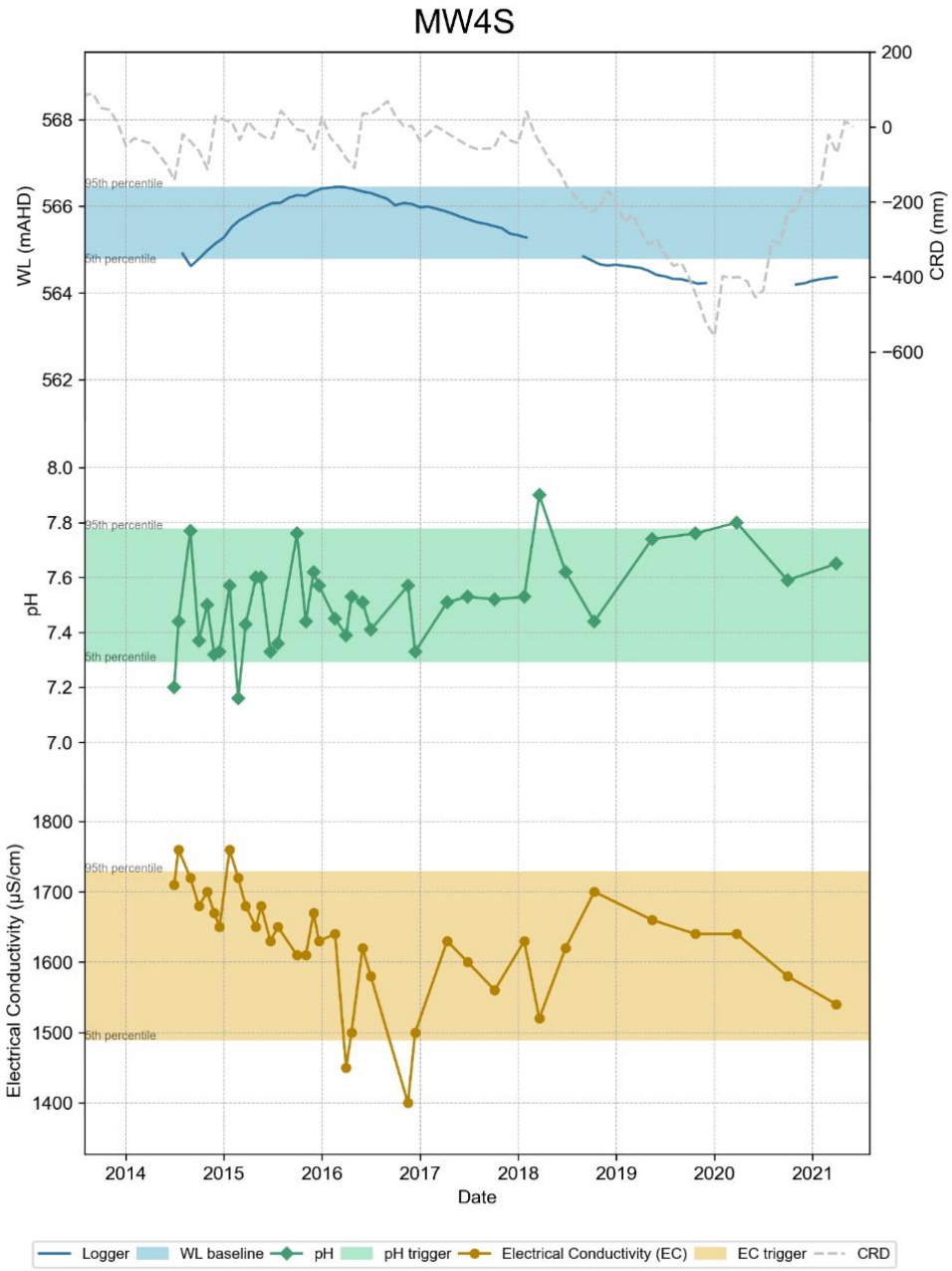

Figure 7.3 Example stacked water quality and water level charts

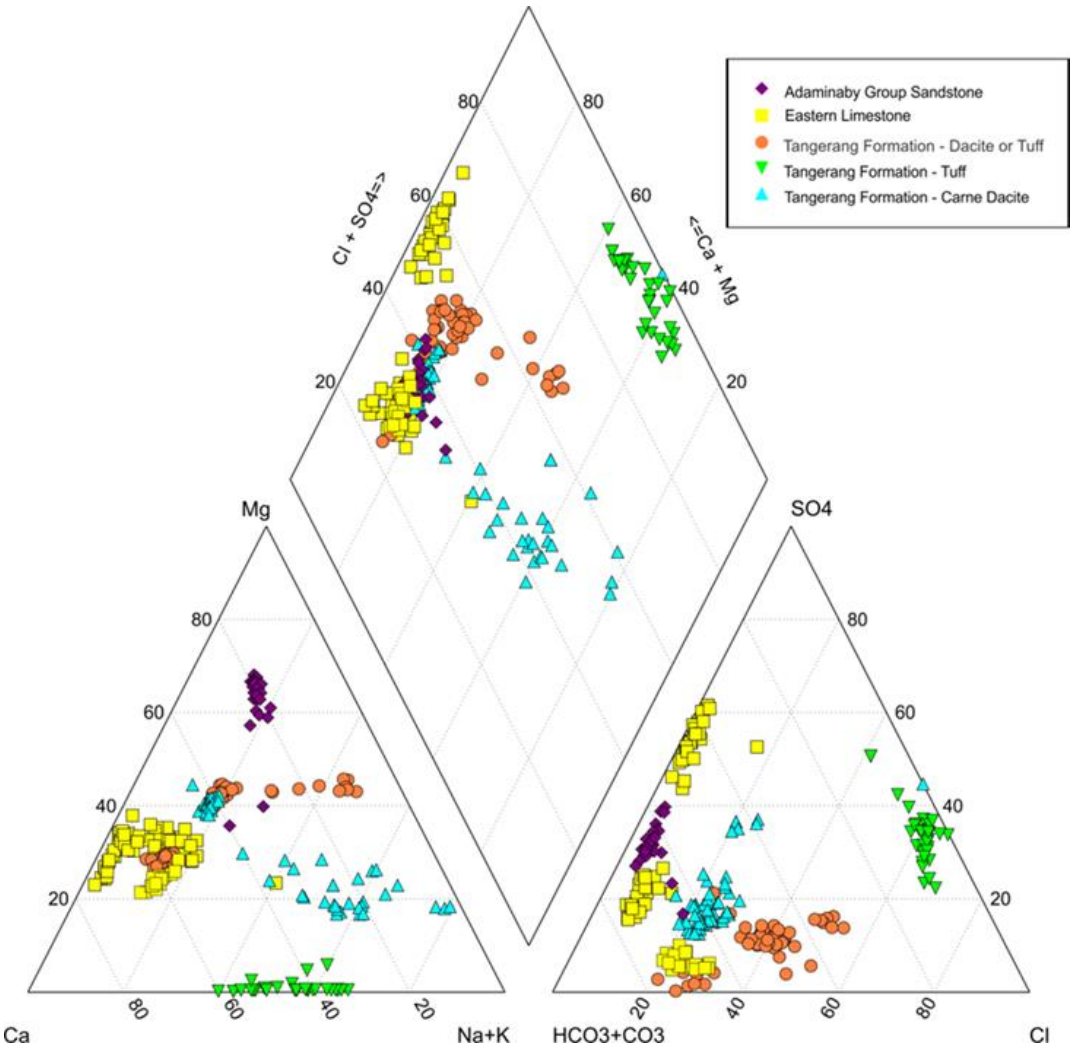

Figure 7.4 Example Piper Diagram

7.3 Groundwater quantity

The volume of incidental groundwater intercepted in the mining areas will be estimated using the site water balance model each calendar year. The site water balance method compares rainfall and runoff inputs to the pits with pumping outputs and storage changes to estimate incidental groundwater take from the mining areas. The site water balance model is updated annually with the results of the annual groundwater review (refer to the WMP).

The development consent requires *"a program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years (unless otherwise agreed by the Planning Secretary), and comparison of monitoring results with modelled predictions"*. Every three years the numerical groundwater flow model will be reviewed, validated and if necessary updated. The process will be undertaken with the input of a third-party reviewer. The numerical model simulates the subsurface flow of groundwater and provides estimates of incidental water take from the mine pits and passive take from the surrounding aquifers. These water takes will be reviewed as part of the annual review and be used as the basis for determining entitlements required to account for groundwater taken by the mine each calendar year.

The total volume of incidental, passive and consumptive groundwater take will be tabulated each year and compared quantitatively with the licenced entitlements in the annual review.

Different incidental take estimated by the site water balance method and groundwater modelling is not uncommon due to different underlying methodologies and assumptions. Where the site water balance and the numerical model provide differing estimates of groundwater inflow, commentary on the potential cause will be provided within the annual review.

A conservative approach will be undertaken utilising the highest estimates of groundwater inflow to the mining area to ensure adequate water licenses are held to account for the groundwater intercepted.

7.4 Spring flow and GDEs

Spring flow will be monitored through the surface water monitoring plan as discussed in Section 6.4. Data gathered through the surface water monitoring program will be reported by comparing it with the annual groundwater level data in the annual groundwater review. Hydrographs will be compared between monitoring locations to reveal more significant changes in water level from climatic conditions and are linked with spring flow observations. The TARP process (as outlined in Section 9.1) will initiate water level measurements that fall outside the trigger threshold. The surface water management plan provides trigger parameters for observed spring flow.

Similarly, any ecological and environmental anomalies observed through ongoing ecological and environmental monitoring will be compared with the annual groundwater level data in the annual groundwater review.

7.5 Alluvial aquifers

Recharge from the bedrock into Bungonia Creek is likely to only reduce by 1% due to the Project and it is unlikely to have a detrimental impact on creek flow (EIS, Element Environment [2019]). Therefore, impacts on the water quality of the creeks caused by incidental water take are likely to be minimal. Reporting on alluvial aquifers will be handled similarly to spring flow (Section 7.4).

8 GROUNDWATER LEVEL AND QUALITY CRITERIA AND PERFORMANCE INDICATORS

8.1 Performance measures

The following performance measures from Table 4, Condition B43 of the development consent are applicable to this GWMP:

Barbers Creek, Bungonia Creek and Shoalhaven River alluvial aquifers:

- *Negligible impacts to alluvial aquifers as a result of the development, beyond those predicted in the document/s listed in condition A2(c), including:*
    - *negligible change in groundwater levels;*
    - *negligible change in groundwater quality; and*
    - *negligible impact to other groundwater users*

Groundwater springs:

- *Negligible impacts to groundwater springs as a result of the development, beyond those predicted in the document/s listed in condition A2(c), including:*
    - *negligible change in groundwater supply; and*
    - *negligible change in groundwater quality*

In addition, the development consent specifies that *"the groundwater management plan must include groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts (or trends) associated with the development, on:*

- *regional and local aquifers (alluvial and hardrock);*
- *groundwater springs; and*
- *groundwater supply for other water users such as licensed privately-owned groundwater bores;"*

Direct groundwater performance criteria for Barbers Creek and Bungonia Creek are deemed not appropriate due to the following reasons:

- these are gorge systems and no significant alluvial plains exist beyond the creeks;
- the alluvium under the Bungonia and Barbers creek beds is expected to be very thin (if occurring);
- the area is completely inaccessible for installing bores and is also a national park; and
- groundwater expresses as baseflow (spring flow) in the creeks and therefore monitoring surface water is effectively monitoring discharging groundwater.

Mining activities that intercept the water table or interfere with groundwater systems are considered aquifer interference activities under the New South Wales AIP. The AIP describes minimal impact considerations for aquifer interference activities and includes a series of acceptable thresholds for water level and quality changes. The minimal impact consideration thresholds depend upon whether the water source is highly productive or less productive and whether the water source is alluvial or porous/fractured rock in nature. The minimal impact considerations described in the AIP have been adopted as the groundwater performance measures.

As indicated in Section 6.3, groundwater sources in the mine area are managed under the 2011 Greater Metropolitan Region Groundwater Sources Water Sharing Plan and are within Goulburn Fractured Rock Groundwater Source (GFRGS). Based on the AIP, the aquifer is classified as 'less productive" groundwater source.

The performance measures of each monitored groundwater system with respect to groundwater receptors and the appropriate monitoring locations are presented in Table 8.1.

In the event that groundwater level readings for these monitoring bores fall below the historical 5th percentile (based on all previous data) for three consecutive groundwater level monitoring events, a review of monitoring information will be carried out by a suitably qualified hydrogeologist. The review will consider trends in monitoring data, mining activities, water supply bores and climatic conditions and may recommend management, monitoring and/or mitigation measures. The annual groundwater level assessment reviews resulting from trigger level exceedances will be reported in the Annual Review.

Table 8.1 Groundwater performance measures

Potential mining issue or impact	Receptor	Water source type	Applicable to	Performance measures
Water level changes due to water take, drawdown and aquifer interconnectivity	Water supply bores	Less productive fractured and porous rock (Goulburn Fractured Rock Groundwater Source (GFRGS))	Regional water supply bores monitored through existing and proposed mine groundwater monitoring bores (MW3D, MW4D, MW8 and MW9)	No more than 2 m drawdown attributable to mining activities (AIP) at regional water supply bores.
	GDEs and Springs	Less productive fractured and porous rock	GDEs are monitored through the aquatic survey and surface water monitoring. Springs monitored through the surface water monitoring program	Visual observations during surface water monitoring events compared to historical data and climatic conditions.
	Barbers Creek, Bungonia Creek and Shoalhaven River alluvial aquifers	No alluvial aquifers are mapped along Barbers Creek, Bungonia Creek and the Main Gully south west of the mine. The Shoalhaven River alluvial aquifers are situated outside the predicted zone of drawdown and not deemed necessary for groundwater monitoring		
	Regional standpipe monitoring bore	Less productive porous rock (Goulburn Fractured Rock Groundwater Source (GFRGS))	MW03S, MW03D, MW04S MW04D MW05 and MW06 Proposed groundwater monitoring bores at the mine (MW8 and MW9)	No more than 2 m drawdown attributable to mining activities (AIP) at regional monitoring bores.

Potential mining issue or impact	Receptor	Water source type	Applicable to	Performance measures
Water quality changes due to mining activities, final void and emplacement waters	Water supply bores	Less productive porous rock	Regional water supply bores monitored through existing and proposed mine groundwater monitoring system	No change in existing beneficial use category* due to mining.
	GDEs and Springs	Less productive porous rock	No monitoring bores to monitor GDEs and springs. Monitoring through surface water sampling and captured in the WMP.	No change in existing beneficial use category** due to mining
	Alluvial aquifers	Less productive fractured and porous rock. No alluvial aquifers mapped along Barbers Creek, Bungonia Creek and the Main Gully south west of mine.	Surface water monitoring program	No change in existing beneficial use category due to mining
	Mine standpipe monitoring bores	Less productive porous rock	MW03S, MW03D, MW04S MW04D MW05 and MW06 Proposed groundwater monitoring bores at the mine (WB07, MW8 and MW9)	No change in existing beneficial use category due to mining
Groundwater inflows into the mine pit	Incidental, passive and consumptive groundwater take	Less productive porous rock	Mine pit	Calculated inflows into mine pit > 100 % of Water Access Licences units for each applicable water source affected by the mine
Water loss/seepage	. Water loss/seepage from water storages into the groundwater system, including from any final voids	Less productive porous rock	Monitoring bores MW8, WB07 and MW6	No change in existing beneficial use^ category due to mining

Notes: * Water supply bores: the beneficial use for the regional supply bores is based on the EIS information and associated hydrocensus. The highest beneficial use category is for domestic use and drinking water and based on the NHMRC Health Guidelines for Drinking Water (2019). Although most of the registered bores are used for domestic water supply, there are several industrial water users (poultry farmers) in the vicinity of the mine.

** Beneficial use for the GDE's and Springs: ANZECC (2000) Fresh Water Aquatic

^ Beneficial use in this case considered to be in line with baseline groundwater quality.

8.2 Triggers and control charts

Control charting is a graphical and statistical tool to track changes in recorded data over time. The inclusion of appropriate thresholds on control charts is used to inform trigger management actions. Control charts and threshold triggers developed for the monitoring network are shown on the charts included in Appendix B.

8.2.1 Groundwater levels

The groundwater level baseline period of 2014 to 2016 was selected to derive trigger values for the bores. The baseline dataset is used to calculate the 5th and 95th percentile of measured groundwater levels for each monitoring location which is set as the trigger threshold on the control charts in Appendix B. Groundwater levels are expected to exceed the 5th / 95th percentile threshold on ten percent of measurements given future fluctuations are representative of baseline conditions. If groundwater levels at the nominated bores fall below the 5th percentile water level for three consecutive monitoring events or more, a trigger level event occurs. The groundwater level trigger thresholds for each monitoring location are summarised in Table 8.2.

Table 8.2 Groundwater level trigger thresholds for standpipe bores

Monitoring Location	Baseline period	Rationale behind baseline period selection ^	Trigger threshold calculated from baseline data (m AHD)	
			5th %	95th %
MW3S	2014 to 2016	2, 3	599.9	602.13
MW3D	2014 to 2016	2, 3	600.00	602.20
MW4S	2014 to 2016	2, 3	564.25	565.78
MW4D	2014 to 2016	1, 2	547.02	548.89
MW6	2014 to 2016	1, 2	468	468.2
Additional proposed monitoring bores WB07, MW8 and MW9		4, 6	TBC	TBC

Notes: ^ = Classification of rationale behind baseline period selection for each standpipe monitoring location and includes:

1. Stable trends exhibited in groundwater levels;
2. Stable trends exhibited in groundwater quality parameters
3. Groundwater level fluctuations reflective of climate influences
4. Groundwater level fluctuations reflective of agricultural abstractions
5. Groundwater level fluctuations reflective of mining
6. To derive baseline and trigger levels after two years of monitoring

8.2.2 Groundwater quality

As discussed in Section 7.2, significant impacts to groundwater quality are not anticipated (AGE, 2019). Currently, the limestone aquifer is recharged directly by rainfall, surface runoff and groundwater flow from adjacent geological units. On the condition that this recharge mechanism remains unchanged, and with surface runoff management in place (Advisian, 2019) then the groundwater quality of the limestone will not be altered significantly.

As discussed in Section 8.2.1, groundwater level and quality data, including the wide range of parameters, have been analysed to identify location-specific baseline conditions/period. Review of the baseline data have identified representative parameters to adopt for groundwater quality thresholds. 5th and 95th percentile triggers for pH and EC levels have been calculated and are presented on the control charts included in Appendix B. If groundwater quality triggers at the nominated bores fall outside the 95th percentile for EC and the 5th and 95th percentile for pH for three consecutive monitoring events or more, a trigger level event occurs.

The trigger thresholds for each monitoring site and water quality indicator are summarised in Table 8.3.

Table 8.3 Groundwater quality trigger thresholds

Monitoring location	Water quality baseline period		Trigger threshold calculated from baseline data			
	WQ date from	WQ date to	pH		EC (µS/cm)	
			5th %	95th %	5th %	95th %
MW3S	30/06/2014	29/09/2020	7.4	7.9	1208	1452
MW3D	30/06/2014	30/03/2021	7.4	8.1	1096	1375
MW4S	30/06/2014	30/03/2021	7.3	7.8	1490	1728
MW4D	30/06/2014	14/05/2019	7.7	8.8	1076	1384
MW5	30/06/2014	15/06/2021	6.5	11.5	765	1386
MW6	16/07/2014	30/03/2021	7.1	7.9	1039	2315
Blow Hole	10/11/2014	13/04/2021	7.7	8.2	565	687
* WB07, MW8 and MW9	-	-	-	-	-	-

Note: * To derive baseline and trigger thresholds after two years of monitoring for the additional proposed monitoring bores.

Dissolved metals

The control charting method has not been adopted for metal concentrations as these are typically less variable. Dissolved metal concentrations will be compared to the most appropriate ANZECC guidelines depending on the environmental value (beneficial use), which is water for stock, domestic and irrigation purposes.

Monitoring wells MW03 and MW05 are upgradient (i.e. north and west of operational areas) whereas MW04 and MW06 are within or downgradient of the mine. When the maximum concentrations of metals recorded during the historical monitoring are compared, the concentrations in the up and downgradient parts of the mine are similar in magnitude.

Noting that aluminium, arsenic, chromium, copper, lead, nickel, selenium and zinc were occasionally elevated during the monitoring periods, the results are generally considered to be representative of typical background concentrations and not indicative of significant environmental impacts from site operations.

An exception is bore MW04S which indicates elevated total and dissolved iron concentrations (Appendix B). These results are unique for this bore only and the likely cause is the geological properties of the hydrostratigraphy the bore is installed in. The site-specific dissolved iron concentration trigger value is as follows for monitoring bore MW04S:

- 5th percentile: 0.05 mg/l; and
- 95th percentile: 2.15 mg/l.

8.2.3 Groundwater quantity

The total volume of incidental, passive and consumptive groundwater take will be tabulated each year and reported in the annual review. Should the estimated annual groundwater take be greater than the water access licenses held by the Project then additional units will be acquired on the water market.

8.2.4 Summary of monitoring plan and triggers

The control chart triggers for groundwater levels, quality and water take are summarised in Table 8.4.

Table 8.4 Summary of the groundwater monitoring plan, control chart triggers for groundwater levels, quality and pit inflows

Bore ID	East	North	Purpose	Groundwater level monitoring frequency	Groundwater quality monitoring frequency	GW level trigger value		GW Q (EC) trigger [uS/cm]		GW Q (pH) trigger		Metals	Other site specific triggers
						5th %	95th %	5th %	95th %	5th %	95th %		
Marulan South monitoring bores													
MW3S	226618	6148365	GW Level and quality	Download logger and manual dip quarterly	bi-annually	599.9	602.13	1208	1452	7.4	7.9	Three exceedances of appropriate ANZECC guidelines based on beneficial use	None
MW3D	226608	6148370	GW Level and quality	Download logger and manual dip quarterly	bi-annually	600	602.2	1096	1375	7.4	8.1		None
MW4S	226718	6147140	GW Level and quality	Download logger and manual dip quarterly	bi-annually	564.25	565.78	1490	1728	7.3	7.8		dissolved Fe [mg/l]
MW4D	226717	6147129	GW Level and quality	Download logger and manual dip quarterly	bi-annually	547.02	548.89	1076	1384	7.7	8.8		None
MW5	227826	6148352	GW Level and quality	Download logger and manual dip quarterly	bi-annually ^			765	1386	6.5	11.5		None
MW6	228482	6147186	GW Level and quality	Download logger and manual dip quarterly	bi-annually	468	468.2	1039	2315	7.1	7.9		None
MW7	227525	6147816	GW Level and quality	Download logger and manual dip quarterly	bi-annually	bore dry, no sufficient baseline data available							
WB07	228001	6148555	Water supply GW Level and quality	Download logger and manual dip quarterly	bi-annually ^^	TBC (trigger levels derived after two years of monitoring)							
MW8	227447	6146019	GW Level and quality	Download logger and manual dip quarterly	bi-annually ^								
MW9	227570	6149019	GW Level and quality	Download logger and manual dip quarterly	bi-annually								

*** Peppertree monitoring bores: groundwater level data reported on in annual report**													
PQ01S	228788	6149365	To include data in annual review and 3-year model validation										
PQ01D	228783	6149375											
PQ03	228288	6149608											
PQ04S	227607	6149951											
PQ04D	227626	6149947											
PQ05	227423	6149780											
PQ06	227796	6150247											
**** Monitoring groundwater towards private bores at Marulan South monitoring bores**													
MW3D	226608	6148370	GW Level and quality	Download logger and manual dip quarterly	bi-annually	Review groundwater level data against 5th percentile and drawdown >2m due to mine influence. Assess groundwater quality against 95th percentile and beneficial use.							
MW9	227570	6149019	GW Level and quality	Download logger and manual dip quarterly	bi-annually								
MW4D	226717	6147129	GW Level and quality	Download logger and manual dip quarterly	bi-annually								
***** Monitoring groundwater seepage as spring flow at "Blow hole" through surface water monitoring plan**													
Blowhole' Sampling Point	227432	6145617	Spring flow and water quality	Quarterly	bi-annually								
Groundwater take													
Incidental, passive, and consumptive groundwater take:			> 100 % of Water Access Licences units for each applicable water source affected by the Project										

Notes: ^ nitrates and total nitrogen will be analysed for groundwater monitoring bores MW5 and MW8. This is to detect any diffuse contamination associated with general quarrying mining activities, such as chemicals used for rock blasting, seeping into underlying groundwater.

^^ suspended solids and oil and grease (historical from WP16 only as required by EPL944 and to be replaced by the proposed groundwater monitoring WB07.

* Groundwater monitoring data from the Peppertree Quarry groundwater monitoring network will be used to evaluate groundwater levels in the annual groundwater review. This relates especially to the four monitoring bores closest to the Marulan South mine complex, namely PQ01, PQ03, PQ04 and PQ05. All Peppertree piezometers were installed into granitic bedrock that Boral quarries at Peppertree.

** The groundwater monitoring network will be adjusted to include any privately registered bores that may fall within the two-metre drawdown prediction on completion of model validations using the monitoring data from these monitoring bores.

*** Monitoring and trigger information WMP.

9 GROUNDWATER MANAGEMENT AND CONTROL MEASURES

9.1 Trigger Action Response Plans (TARPs)

The performance measures and control thresholds described in the previous two sections form the basis of the trigger action response plan (TARP) summarised in the flowchart in Figure 9.1. 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 (discussed in Section 8.1) 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. An “incident” is defined in Section 13.1.

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 GWMP will be updated.

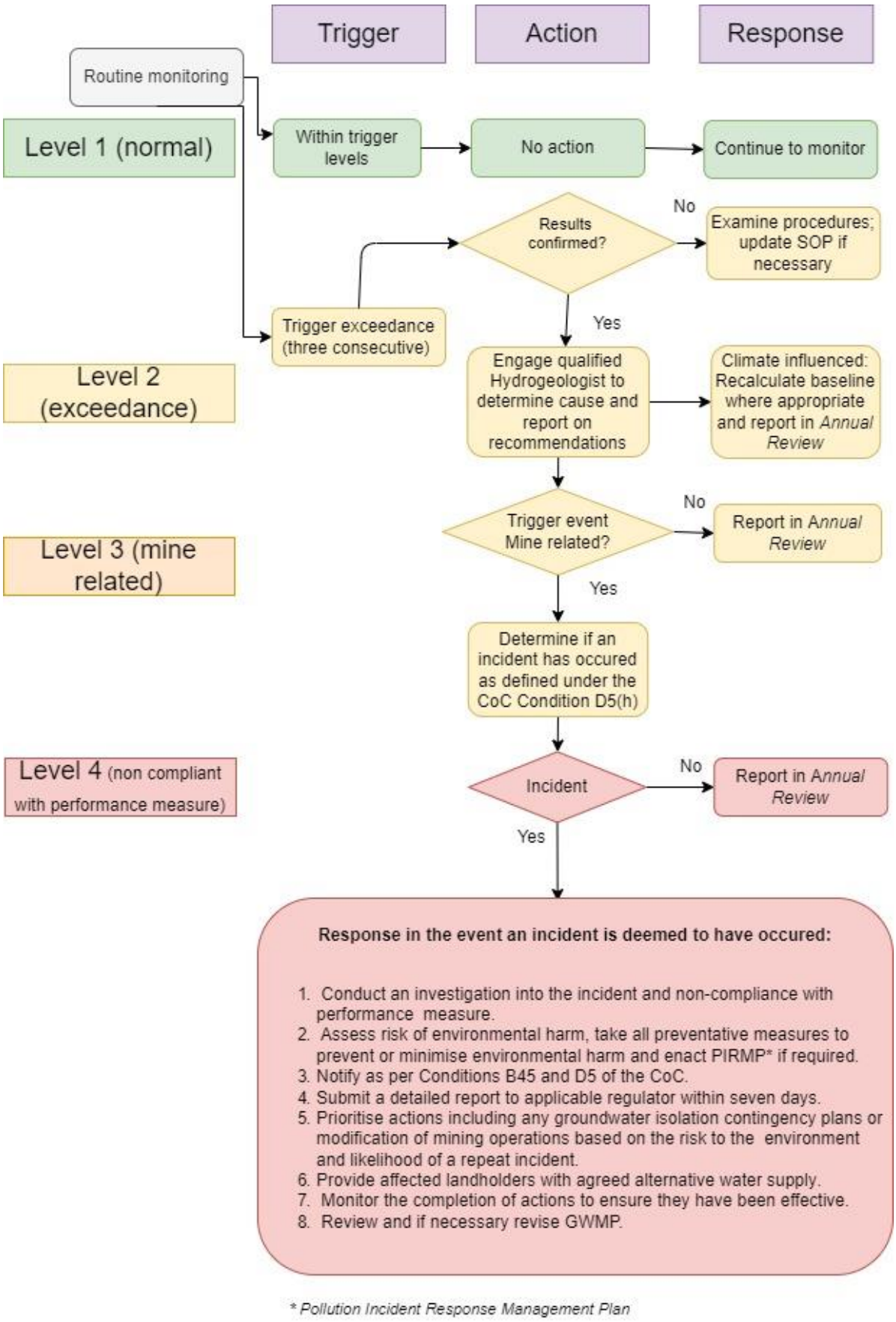

Figure 9.1 Flowchart and decision tree of procedures to be undertaken for trigger events

9.2 Impacts on water supply

Where a landowner of a privately registered bore reports that their water supply is adversely and directly impacted by the abstraction of groundwater from the Project, an investigation will be undertaken by a suitably qualified hydrogeologist. The investigation will consider the potential causes of the impact including, private landowner and mining activities, local groundwater abstraction rates, climatic conditions, condition of water supply works and assess if the impact has occurred as a result of the Project operations and if it resulted in a material incident.

9.3 Groundwater take

Where groundwater take significantly exceeds the modelled predictions and water balance estimations, a suitably qualified hydrogeologist will undertake a review of the potential cause(s) of the exceedance and provide recommendations for monitoring and management.

9.4 Impacts on Groundwater Dependent Ecosystems

The TARPs outline the actions and responses in the event trigger thresholds are exceeded in the monitoring bores.

If impacts to GDEs in the gorge are identified through vegetation and ecological surveys these will be assessed against groundwater levels in monitoring bores and climatic conditions to identify the causes of the impacts. The results of the assessment will be reported in the Annual Review.

10 CUMULATIVE IMPACTS AND MONITORING LOCATIONS

Peppertree Quarry, located immediately to the north of the mine, is also owned by Boral. The current Peppertree Quarry pit is relatively shallow and any impact to groundwater from this quarry operation is considered to be negligible. It is proposed to review the Peppertree Quarry groundwater level and quality data trends annually to inform any anomalies identified at the mine groundwater monitoring locations.

The groundwater model predicts the impact from mining will be spatially constrained to the mined limestone body and the adjoining geological units that immediately surround the mine. The geological constraints described in AGE, 2019 (such as heterogeneity in hydraulic properties limiting flow in the west-east direction) are predicted to nullify impacts on surrounding groundwater users.

Should a trigger threshold be exceeded for the monitoring bores identified to monitor any potential impacts on the private groundwater users located to the west of the mine, MW3, MW4 and MW9, and it is attributed to mining, then the significance of cumulative impacts will be considered by the resultant investigation according to the TARP process outlined in Section 9.1.

Should the investigation conclude that the trigger exceedance has resulted in performance measures not being met, then the process outlined in Section 9 must be followed to investigate and implement measures to repair, mitigate and/or offset any adverse groundwater impacts.

11 CONTINGENCY PLAN

11.1 Contingency measures

The identification process and response protocol to adverse outcomes are provided in the trigger action response plan (TARP). The responses proposed incorporate a staged assessment and development of management measures deemed appropriate for each individual event should it occur.

Specific trigger levels have been designed to alert Boral to observed parameter responses which are outside of normal variation and predicted responses, or where observed parameter values do not follow anticipated trends.

The triggers for instigation of response actions would occur when observed changes to monitored parameters exceed specified levels. Such changes in observed parameters or conditions include:

- sudden inrush of groundwater into the mine in exceedance of predicted inflows;
- trigger value exceedances in observed water quality or groundwater levels between sampling rounds; and
- significant variation from model predictions.

11.2 Unforeseen impacts protocol

Table 11.1 outlines the procedure to be followed (in general accordance with the criteria exceedance protocols detailed in Section 8) in the event that any unforeseen groundwater impacts are detected.

Table 11.1 Unforeseen Impact Procedure

Stage	Procedure
1	Review the unforeseen impact including consideration of: • Any relevant monitoring data; and • Current mine activities and land management practices in the relevant catchment
2	Commission an investigation by an appropriate specialist into the unforeseen impact, if considered appropriate by the Environmental Specialist.
3	Develop appropriate ameliorative measures based on the results of the above investigations, in consultation with the relevant authorities.
4	Implement additional monitoring where relevant to measure the effectiveness of the improvement measures.

12 ENVIRONMENTAL PERFORMANCE REVIEW AND IMPROVEMENT PROGRAM

12.1 Groundwater model validation

The CoC B45(e)(v) *requires "a program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years (unless otherwise agreed by the Planning Secretary), and comparison of monitoring results with modelled predictions"*.

Accordingly, every three years the numerical groundwater flow model will be reviewed, validated and if necessary, updated. The numerical model simulates the subsurface flow of groundwater and provides estimates of incidental water take from the mine pits and passive take from the surrounding aquifers. These water takes will be reviewed as part of the annual review and be used as the basis for determining entitlements required to account for groundwater taken by the mine each calendar year. The validity of the groundwater model predictions will be reviewed every three years against water level data and estimates of water take to determine if the model is providing useful predictions. If the numerical model predictions do not compare well with the observations over the previous three-year period, then the numerical model will be updated and if necessary, recalibrated. Predictions of water level changes and water take will be undertaken using the updated model. The uncertainty in predictions will also be assessed.

Where changes to the nature of predicted impacts is identified through the updated model, then the suitability of the monitoring network will be reviewed to determine if changes are warranted.

12.2 Independent model review

In accordance with CoC B45(e)(v), an independent review of the groundwater model will be carried out every three years when the groundwater model is validated. At the time of independent review, a comparison of monitoring results with modelled predictions will be undertaken Annual review and compliance reporting

In accordance with CoC D11, by the end of July each year after the commencement of development, or other timeframe agreed by the Planning Secretary, a report will be submitted to DPIE reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary.

The activities and performance outcomes of the GWMP will be presented in the Annual Environmental Management Report (AEMR). The report includes a detailed assessment of monitoring results, an evaluation of any trends occurring across the site, any community/stakeholder complaints or non-conformances with licences/criteria and recommendations for management actions.

12.3 GWMP review and revision

Each year following the independent model review outlined in Section 12.2, the annual review outlined in Section 0, and every three years after the independent environmental audit detailed in CoC D13, Boral will review this GWMP. This GWMP will also be reviewed when there is a significant variation between groundwater model results and monitoring results and if the groundwater model requires recalibration following an annual review or three-year independent review.

This GWMP will be updated if necessary, with findings from the independent model review, annual review, independent environmental audit and groundwater monitoring, to promote continuous improvement.

If changes are required to the GWMP, it will be resubmitted to the Planning Secretary for approval within six weeks of the review. The most recent version of this GWMP, as approved by the Planning Secretary, will be implemented.

13 INCIDENT, NON-COMPLIANCE, AND COMPLAINT MANAGEMENT AND REPORTING PROTOCOL

13.1 Incident reporting

In accordance with CoC D9 Boral will immediately notify DPIE and any other relevant agencies after it becomes aware of an incident resulting in unauthorised groundwater impacts. The notification will be in writing through DPIE's Major Projects Website and identify the development (including the development application number and name) and set out the location and nature of the incident.

The development consent defines an 'incident' as:

"An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance".

Material harm is defined as:

"*harm to the environment that:*

- *involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or*
- *results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000 (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)*

This definition excludes "harm" that is authorised under either this consent or any other statutory approval"

Any incidents resulting or having the potential to result in material harm to the environment, as defined by Section 147 of the Protection of the Environment Operations Act New South Wales (1997) are managed in accordance with the Mine's environmental management system (EMS).

13.2 Non-compliance reporting

The development consent defines a 'non-compliance' as:

"An occurrence, set of circumstances or development that is a breach of this consent".

In accordance with CoC D10 Boral will, within seven days of becoming aware of a groundwater non-compliance, notify DPIE of the non-compliance. The notification will be in writing through DPIE's Major Projects Website and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.

The Site Manager is responsible for reporting exceedances or incidents causing (or threatening to cause) material harm to groundwater to DPIE.

13.3 Complaint management

In addition to monitoring of groundwater quality, the mine records all complaints made by the community. For each complaint, the following information is recorded:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by the mine in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken, the reason why no action was taken.

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APPENDIX A

Bore Logs

RPS
Level 9, 17 York St, Sydney, NSW, Australia, 2000
GPO Box 4401, Sydney, NSW, 2001.
Tel: (+61) (02) 8270 8388
Fax: (+61) (02) 8270 8399

COMPOSITE WELL LOG

Well No: MW1

Client: Boral Pty Ltd
Project: Marulan South Limestone Quarry

Commenced: 15/04/2014
Completed: 16/04/2014
Drilled: Macquarie Drilling
Logged By: Jonathon Tait

Method: Air/Hammer
Fluid: Air
Bit Record: 145mm (0-1.5m)
102mm (1.5-61m)

Area: Southern Highlands
East: 0228111
North: 6147568
Elevation: 440.11 mAHD

Drilled Depth: 61 mbgl
Static Water Level: 418.4 mAHD
Date: 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0			LIMESTONE: White, angular blocky, unconsolidated loose rock.			Stickup (0.91m)
			LIMESTONE: White, angular/platy, fine grained.			155mm PVC surface casing (0-1.5m)
10			LIMESTONE: White, angular/platy, fine grained with secondary porosity.			
			LIMESTONE: White, sub angular/platy, fine grained.	Mineralisation with rust stained grannules at ~11m		
			LIMESTONE: White/orange, sub angular/platy, fine grained.			
20			LIMESTONE: White, sub angular/platy, fine grained.			Grouted annulus (0-34.25m)
			LIMESTONE: Blue/white, sub angular/platy, fine grained.	Static Water Level 22.62 mbTOC (16/07/2014)		
			LIMESTONE: Orange/white, sub angular/platy, fine grained.			50mm Cl18 blank PVC casing (0-36.5m)
30			LIMESTONE: White/pink, angular/platy fine grained.			
						Bentonite seal (32.25-34.25m)
40						3.2-5mm graded gravel pack (34.25-61m)
50			GRANITE: Black/blue, angular/platy, fine grained.			
			LIMESTONE: Browny/white, angular/platy, fine grained.	Damp at ~52.5m		50mm Cl18 slotted PVC casing (36.5-60.5m)
			LIMESTONE: Blue/white, some granite, angular, fine grained.			
			GRANITE: Bluey/grey, angular/platy, fine grained.			
60			LIMESTONE: White/orange, angular/platy, fine grained, minor granite.			
70						

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COMPOSITE WELL LOG

Well No: MW2

Client: Boral Pty Ltd
Project: Marulan South Limestone Quarry

Commenced:	07/04/2014	**Method:**	Air/Hammer	**Area:**	Southern Highlands
Completed:	08/04/2014	**Fluid:**	Air	**East:**	0227722
Drilled:	Macquarie Drilling	**Bit Record:**	145mm (0-0.5m)	**North:**	6146555
Logged By:	Sam Cook		102mm (0.5-61m)	**Elevation:**	380.79 mAHD

Drilled Depth: 61 mbgl **Static Water Level:** 341 mAHD **Date:** 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0			LIMESTONE: Light grey/white, sub angular/angular.			Stickup (0.6m)
						155mm PVC surface casing (0-0.5m)
10				Some yellow clay infill at 10-14m.		
20						Grouted annulus (0-35.4)
						50mm Cl18 blank PVC casing (0-41.4m)
30				Rust colouring at ~34-36m.		
				Static Water Level 39.79 mbTOC (16/07/2014)		Bentonite seal (35.4-37.4m)
40			LIMESTONE: Blue/grey, highly weathered.			3.2-5mm graded gravel pack (37.4-61m)
				Cavities present at ~43m		
			LIMESTONE: Light grey/white, sub angular/angular.			50mm Cl18 slotted PVC casing (41.4-59.4m)
50			CLAY: Yellow with moderate weathered blue/grey limestone chips.	Wet yellow clay infill.		
			LIMESTONE: Blue/grey, sub angular, medium grained platy chips.			
60						
70						

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COMPOSITE WELL LOG

Well No: MW3S

Client: Boral Pty Ltd **Project:** Marulan South Limestone Quarry

Commenced:	20/05/2014	**Method:**	Air/Hammer	**Area:**	Southern Highlands
Completed:	21/05/2014	**Fluid:**	Air	**East:**	0226618
Drilled:	Macquarie Drilling	**Bit Record:**	145mm (0-12m)	**North:**	6418366
Logged By:	Jonathon Tait		102mm (12-49m)	**Elevation:**	619.12 mAHD

Drilled Depth: 49 mbgl **Static Water Level:** 599.69 mAHD **Date:** 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0			CLAY: Brown/red, minor fine grained silt.		Stickup (0.75m)	
			CLAY: Light brown with white mottles, minor medium to coarse grained gravel.			
10			GRAVEL: Brown/red, angular in brown/orange clay, minor fine grained silt and sand matrix.		155mm PVC surface casing (0-12m)	
			SAND: Light brown, medium to coarse grained, moderately sorted with minor light brown clay.			
20			GRAVEL: Grey/brown, coarse grained, angular, well sorted with grey brown clay.	Static Water Level 19.34 mbTOC (16/07/2014)	Grouted annulus (0-36m)	
			WEATHERED GRANITE: Yellow brown, angular/sub-angular with moderate brown clay.	Moist returns (25m)	50mm CI18 blank PVC casing (0-39m)	
30			WEATHERED GRANITE: Yellow brown/red, angular, weathered, poorly sorted.	First water strike <1.5L/s (31m)		
40					Bentonite seal (36-38m)	
					3.2-5mm graded gravel pack (38-49m)	
50					50mm CI18 slotted PVC casing (39-48m)	
60						
70						
80						
90						
100						
110						

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COMPOSITE WELL LOG

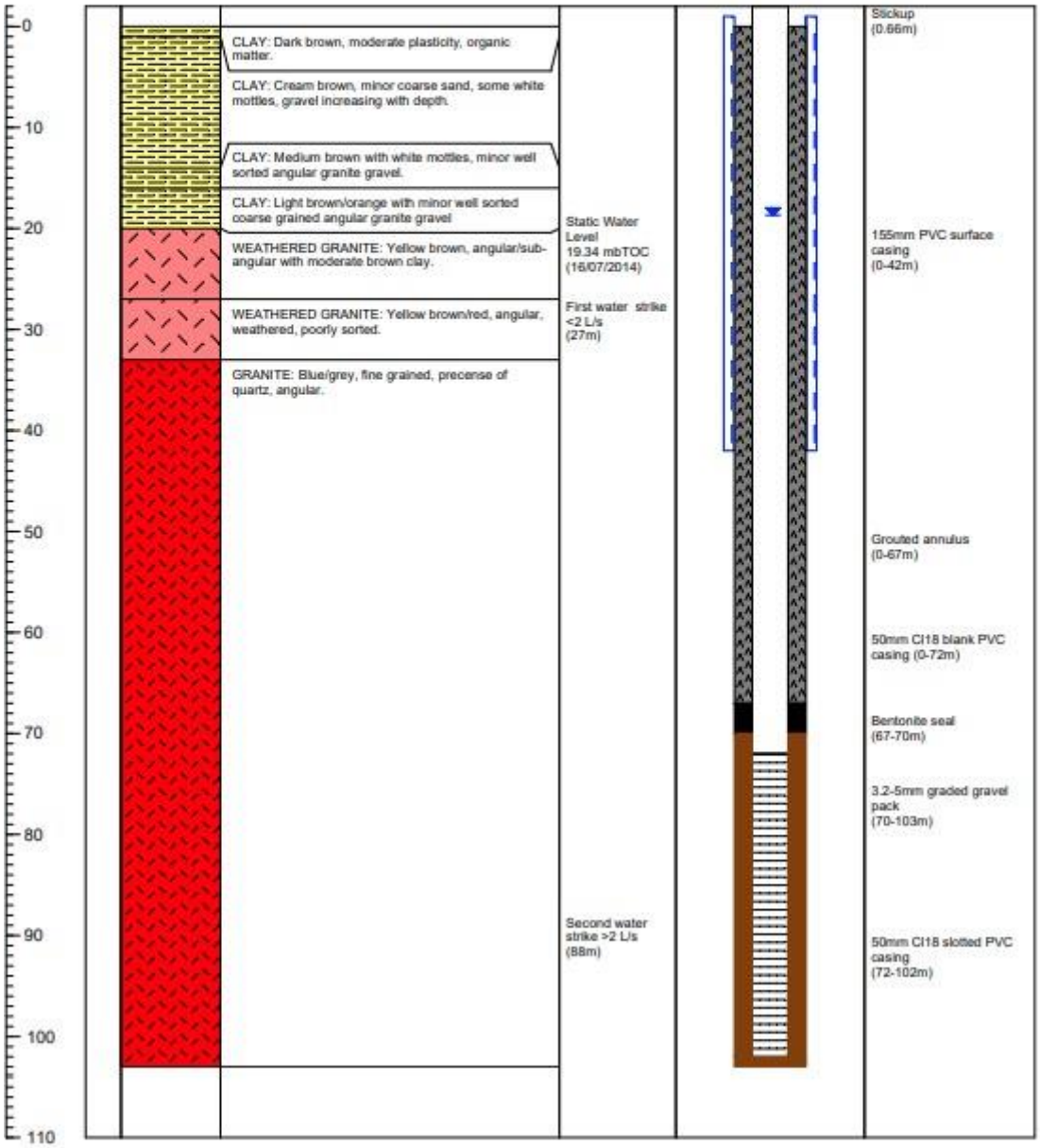
Well No: MW3D

Client: Boral Pty Ltd **Project:** Marulan South Limestone Quarry

Commenced:	20/05/2014	**Method:**	Air/Hammer	**Area:**	Southern Highlands
Completed:	25/05/2014	**Fluid:**	Air	**East:**	0226607
Drilled:	Macquarie Drilling	**Bit Record:**	145mm (0-42m)	**North:**	6148370
Logged By:	John Fennell		102mm (42-102m)	**Elevation:**	619.04 mAHD

Drilled Depth: 103 mbgl **Static Water Level:** 599.7 mAHD **Date:** 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes



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COMPOSITE WELL LOG

Well No: MW4S

Client: Boral Pty Ltd
Project: Marulan South Limestone Quarry

Commenced: 09/04/2014
Completed: 10/04/2014
Drilled: Macquarie Drilling
Logged By: Sam Cook
Method: Air/Hammer
Fluid: Air
Bit Record: 145 mm
Area: Southern Highlands
East: 0226718
North: 6147141
Elevation: 596.98 mAHD

Drilled Depth: 40 mbgl
Static Water Level: 563.23 mAHD
Date: 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0			GRAVEL: White/grey, sub angular with some silt.		Stickup (0.88m)	
			GRAVEL: Light brown, sub angular, medium/coarse grained, poorly sorted, moderate clay.		155mm PVC surface casing (0-6m)	
10			GRANITE: White/grey, medium/coarse grained, highly weathered with evidence of mineralisation.		Grouted annulus (0-20.3m)	
			GRANITE: Light brown, medium/coarse grained.			
			GRANITE: Blue/grey with some red/brown silt, sub angular, medium to coarse grained.		50mm Cl18 blank PVC casing (0-26m)	
20			GRANITE: White/grey, weathered, sub angular, medium/coarse grained, evidence of mineralisation, moderate grey clay.		Bentonite seal (20.3-23.6m)	
			GRANITE: Blue, sub angular, medium/coarse grained, fractured, some mineralisation.		3.2-5mm graded gravel pack (23.6-40m)	
30				Static Water Level 33.75 mbTOC (16/07/2014)	50mm Cl18 slotted PVC casing (26-38m)	
40						
50						

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COMPOSITE WELL LOG

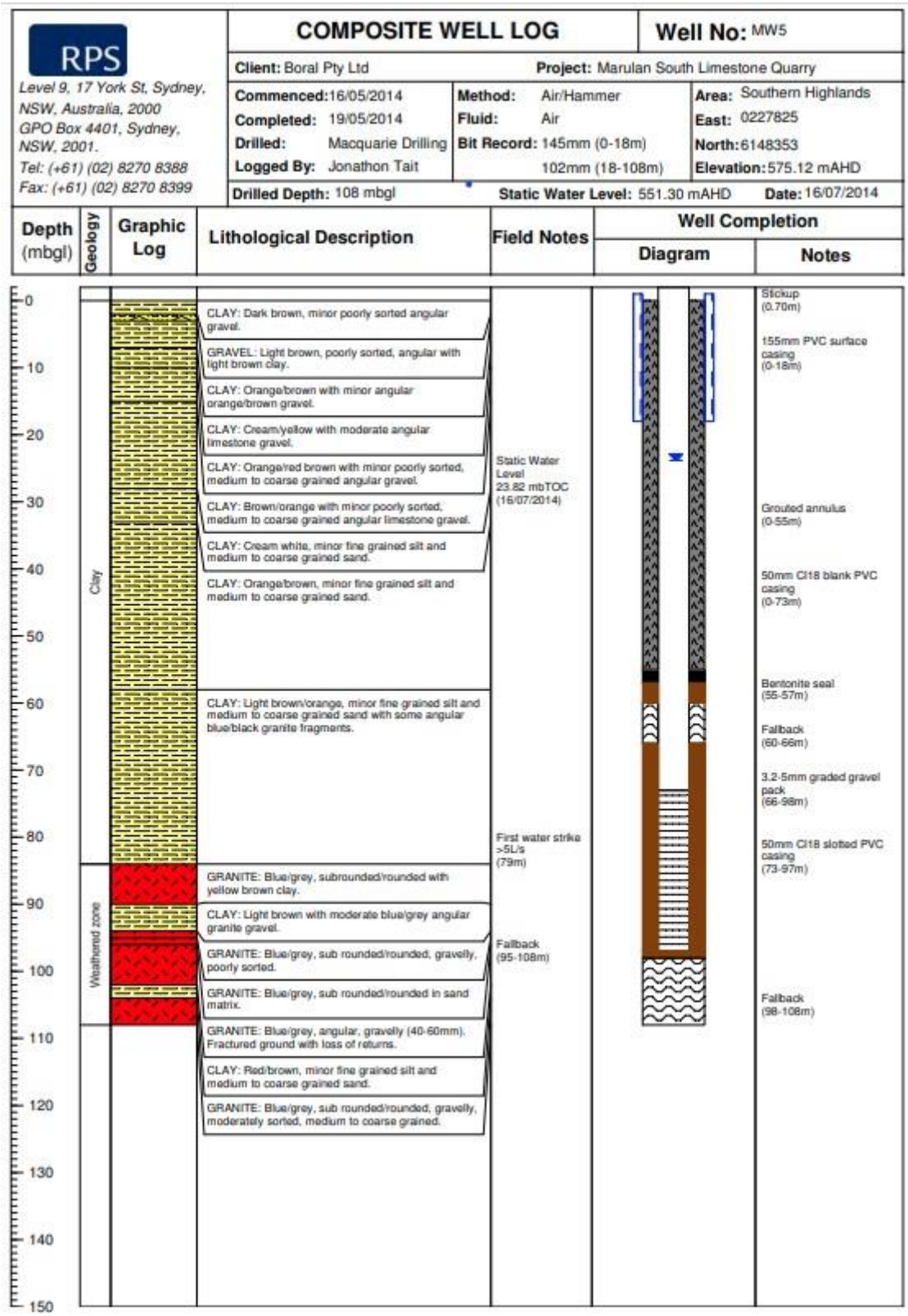
Well No: MW4D

Client: Boral Pty Ltd **Project:** Marulan South Limestone Quarry

Commenced:	05/05/2014	**Method:**	Air/Hammer	**Area:**	Southern Highlands
Completed:	08/05/2014	**Fluid:**	Air	**East:**	0226717
Drilled:	Macquarie Drilling	**Bit Record:**	145mm (0-23m)	**North:**	6147129
Logged By:	Jonathon Tait		102mm (23-128m)	**Elevation:**	596.23 mAHD

Drilled Depth: 128mbgl **Static Water Level:** 546.30 mAHD **Date:** 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0			GRAVEL: Light brown, poorly sorted, in silt matrix			Stickup (0.87m)
			GRAVEL: Light orange brown, poorly sorted, silt matrix			155mm PVC surface casing (0-15.5m)
10			GRAVEL: Light grey, poorly sorted, silty with angular, blue/grey granite fragments.			
20			GRANITE: Blue/grey, angular, some platy, some gravel fall back.			
30			GRANITE: Blue/black, angular, some platy, weathered.			50mm Cl18 blank PVC casing (0-83m)
40						
			GRANITE: Blue/black, angular, some rounded, minor grey clay.			Grouted annulus (0-77m)
50			GRANITE: Blue/black, angular/platy, minor angular limestone fragments.	Static Water Level 49.93 mbTOC (16/07/2014)		
60			GRANITE: Blue/black, angular/platy, minor quartz and limestone, evidence of grey clay, some subrounded chips at 82-83m.			
70						
80						Bentonite seal (77-79m)
90			GRANITE: Blue black, angular/platy, minor grey clay covering chips.	Moist returns (87-89m)		3.2-5mm graded gravel pack (79 - 124m)
100			GRANITE: Blue grey, angular platy, minor grey clay/silt.			50mm Cl18 slotted PVC casing (83-123m)
110			GRANITE: Blue grey, angular/some subangular rounded, minor grey clay covering chips.			
120			GRANITE: Blue black, subrounded/angular platy, evidence of weathering, minor medium grey clay.	First water strike <0.5 L/s (117m)		
			GRANITE: Blue black, angular/subrounded platy, weathered.			Fallback (124-128m)
130						
140						
150						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COMPOSITE WELL LOG
Well No: MW5
Client: Boral Pty Ltd
Project: Marulan South Limestone Quarry
Commenced: 16/05/2014
Completed: 19/05/2014
Drilled: Macquarie Drilling
Logged By: Jonathon Tait
Method: Air/Hammer
Fluid: Air
Bit Record: 145mm (0-18m)
102mm (18-108m)
Area: Southern Highlands
East: 0227825
North: 6148353
Elevation: 575.12 mAHD
Drilled Depth: 108 mbgl
Static Water Level: 551.30 mAHD
Date: 16/07/2014
Depth (mbgl)
Geology
Graphic Log
Lithological Description
Field Notes
Well Completion
Diagram
Notes
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Clay
Weathered zone
CLAY: Dark brown, minor poorly sorted angular gravel.
GRAVEL: Light brown, poorly sorted, angular with light brown clay.
CLAY: Orange/brown with minor angular orange/brown gravel.
CLAY: Cream/yellow with moderate angular limestone gravel.
CLAY: Orange/red brown with minor poorly sorted, medium to coarse grained angular gravel.
CLAY: Brown/orange with minor poorly sorted, medium to coarse grained angular limestone gravel.
CLAY: Cream white, minor fine grained silt and medium to coarse grained sand.
CLAY: Orange/brown, minor fine grained silt and medium to coarse grained sand.
CLAY: Light brown/orange, minor fine grained silt and medium to coarse grained sand with some angular blue/black granite fragments.
GRANITE: Blue/grey, subrounded/rounded with yellow brown clay.
CLAY: Light brown with moderate blue/grey angular granite gravel.
GRANITE: Blue/grey, sub rounded/rounded, gravelly, poorly sorted.
GRANITE: Blue/grey, sub rounded/rounded in sand matrix.
GRANITE: Blue/grey, angular, gravelly (40-60mm). Fractured ground with loss of returns.
CLAY: Red/brown, minor fine grained silt and medium to coarse grained sand.
GRANITE: Blue/grey, sub rounded/rounded, gravelly, moderately sorted, medium to coarse grained.
Static Water Level 23.82 mbTOC (16/07/2014)
First water strike >5L/s (79m)
Fallback (95-108m)
Stickup (0.70m)
155mm PVC surface casing (0-18m)
Grouted annulus (0-55m)
50mm Cl18 blank PVC casing (0-73m)
Bentonite seal (55-57m)
Fallback (60-66m)
3.2-5mm graded gravel pack (66-98m)
50mm Cl18 slotted PVC casing (73-97m)
Fallback (98-108m)

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COMPOSITE WELL LOG

Well No: MW6

Client: Boral Pty Ltd
Project: Marulan South Limestone Quarry

Commenced:	12/05/2014	**Method:**	Air/Hammer	**Area:**	Southern Highlands
Completed:	15/05/2014	**Fluid:**	Air	**East:**	0228482
Drilled:	Macquarie Drilling	**Bit Record:**	145 (0-18m)	**North:**	6147187
Logged By:	Jonathon Tait		102mm (18-205m)	**Elevation:**	568.53 mAHD

Drilled Depth: 208mbgl **Static Water Level:** 467.44 mAHD **Date:** 16/07/2014

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			CLAY: Light brown/orange, minor coarse sand.			Stickup (0.9m)
10			CLAY: Light brown/yellow, minor coarse gravel, claystone fragments present.			155mm PVC surface casing (0-18m)
20			CLAY: Light brown, minor angular gravel and fine grained claystone fragments.			
30			GRAVEL: Orange/brown, angular, weathered with light brown clay and fine grained claystone fragments.			
40			GRANITE: Light grey, angular with light brown clay.			
50			CLAY: Orange/brown with minor angular granite fragments.			Grouted annulus (0-103m)
60			GRANITE: Grey/yellow, gravelly, angular/platy, weathered with light brown/grey clay.			
70			GRANITE: Brown/red, angular/platy, weathered with brown/red clay.			
80			GRANITE: Grey/brown, angular/platy, with light brown/grey fine grained silt.			
90			GRANITE: Brown/grey, angular/platy, some subrounded, with brown/grey clay.			
100			GRANITE: Grey/brown, angular platy, some subrounded, with red/brown clay.			
110			GRANITE: Blue/grey, angular/platy, some sub rounded, with fine grained grey white silt.			
120			GRANITE: Blue/grey, angular/platy, with white grey fine grained silt, hard drilling, fragments smaller with depth.	Static Water Level 101.09 mbTOC (16/07/2014)		50mm CI18 blank PVC casing (0-109.5m)
130			GRANITE: Blue/grey, subrounded/platy, gravelly, minor fine grained white grey silt.	Chips moist (104-105m)		Bentonite Seal (103-105m)
140			GRANITE: Medium grey, angular to subrounded/platy, minor grey clay.	Chips moist (109-111m)		3.2-5mm graded gravel pack (105-128m)
150			GRANITE: Blue/black, angular platy.	First water strike <1.5L/s (115m)		50mm CL18 slotted PVC casing (109.5-127.5m)
160			GRANITE: Medium grey, gravelly, subrounded with fine grained grey clay.			
170			GRANITE: Medium grey, angular platy, minor fine grained grey clay, presence of limestone fragments.			
180			GRANITE: Medium grey, angular/platy, minor fine grained grey clay, presence of limestone fragments.			
190			GRANITE: Dark grey/black, angular platy some subrounded, minor limestone.			
200			GRANITE: Dark grey, angular/platy, minor limestone fragments, rounded granite pebbles and pyrite.			Fallback (128-205m)
			SHALE: Dark grey/black, angular/platy with some subrounded granite/limestone fragments, presence of pyrite.	Hard drilling		
			GRANITE: Blue grey, platy/angular, some subrounded, minor limestone fragments.			

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BOREHOLE LOG page:1 of 1

MW07

PROJECT No: **G1714B**
PROJECT NAME: **Marulan Limestone Quarry**
DATE DRILLED: **21-Sep-16**
LOGGED BY: **B. McKay (AGE)**

DRILLING COMPANY: **New Competitive Drilling**
DRILLER: **Jake**
DRILLING METHOD: **Air**
DRILL RIG: **Schramm RC**

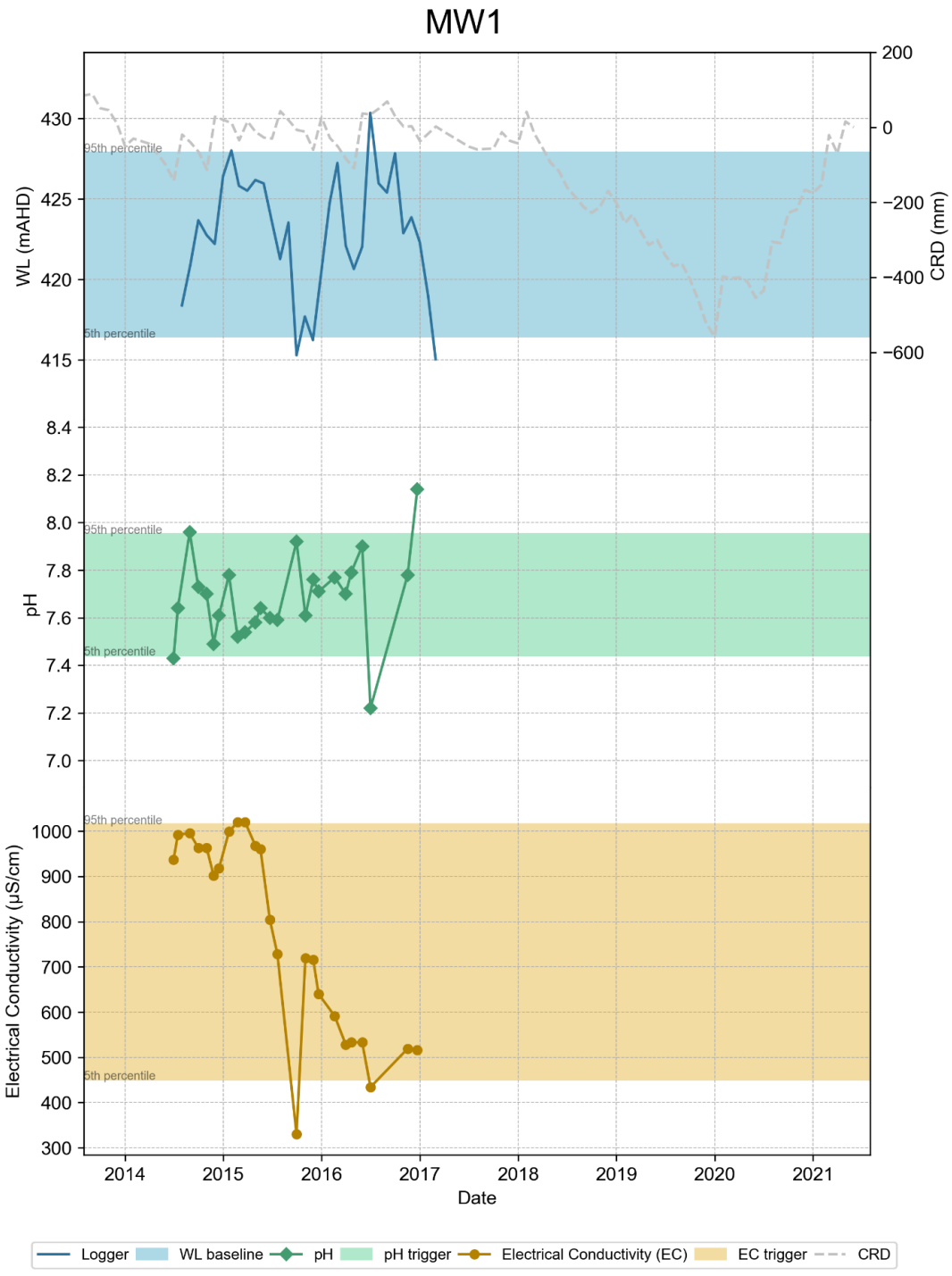
EASTING: **227525 mE**
NORTHING: **6147816 mN**
DATUM: **MGA94 (z56)**
RL: **610 mAHD**
EOH: **80.1 mBGL**

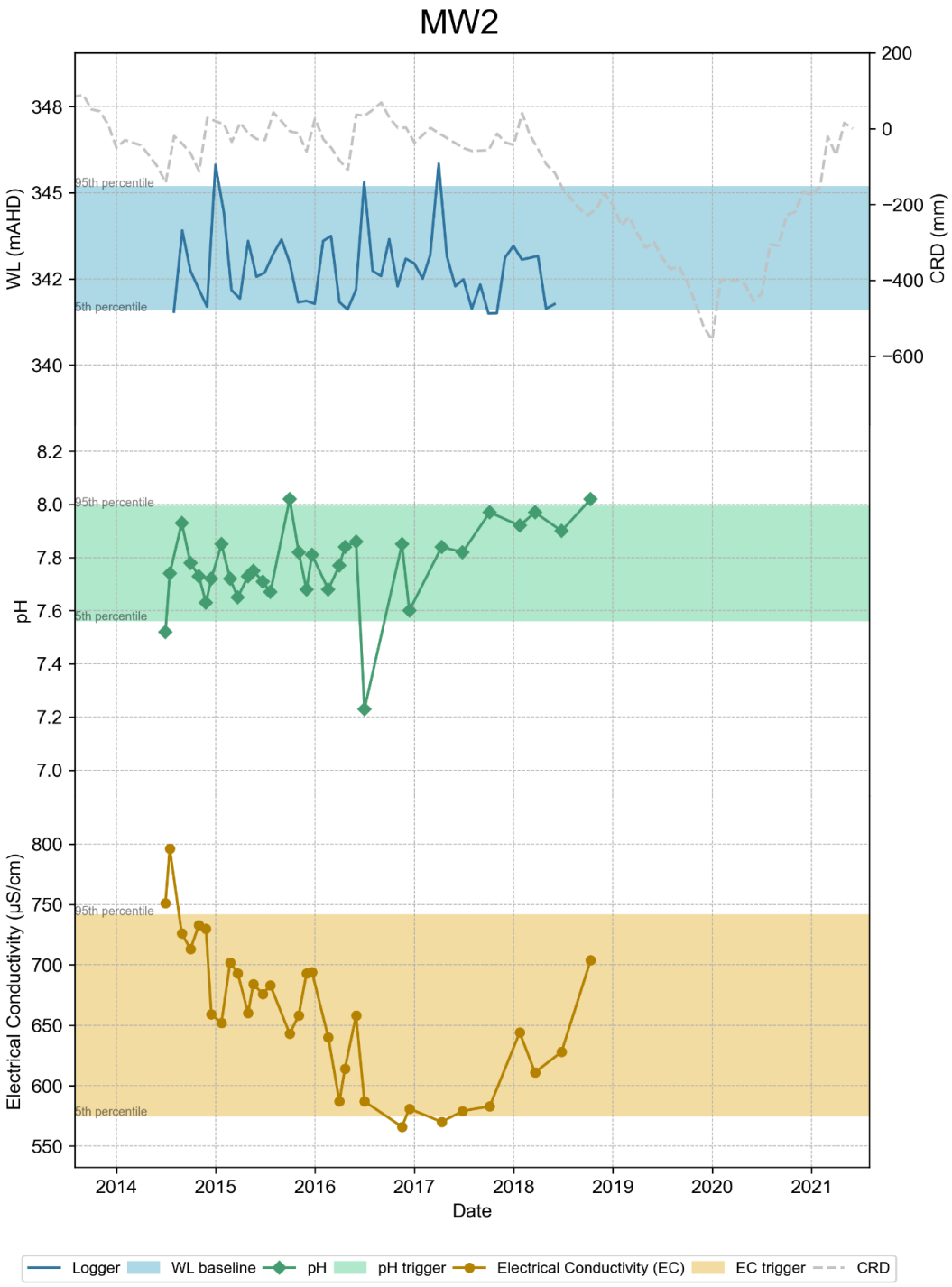
COMMENTS: **Dry bore**

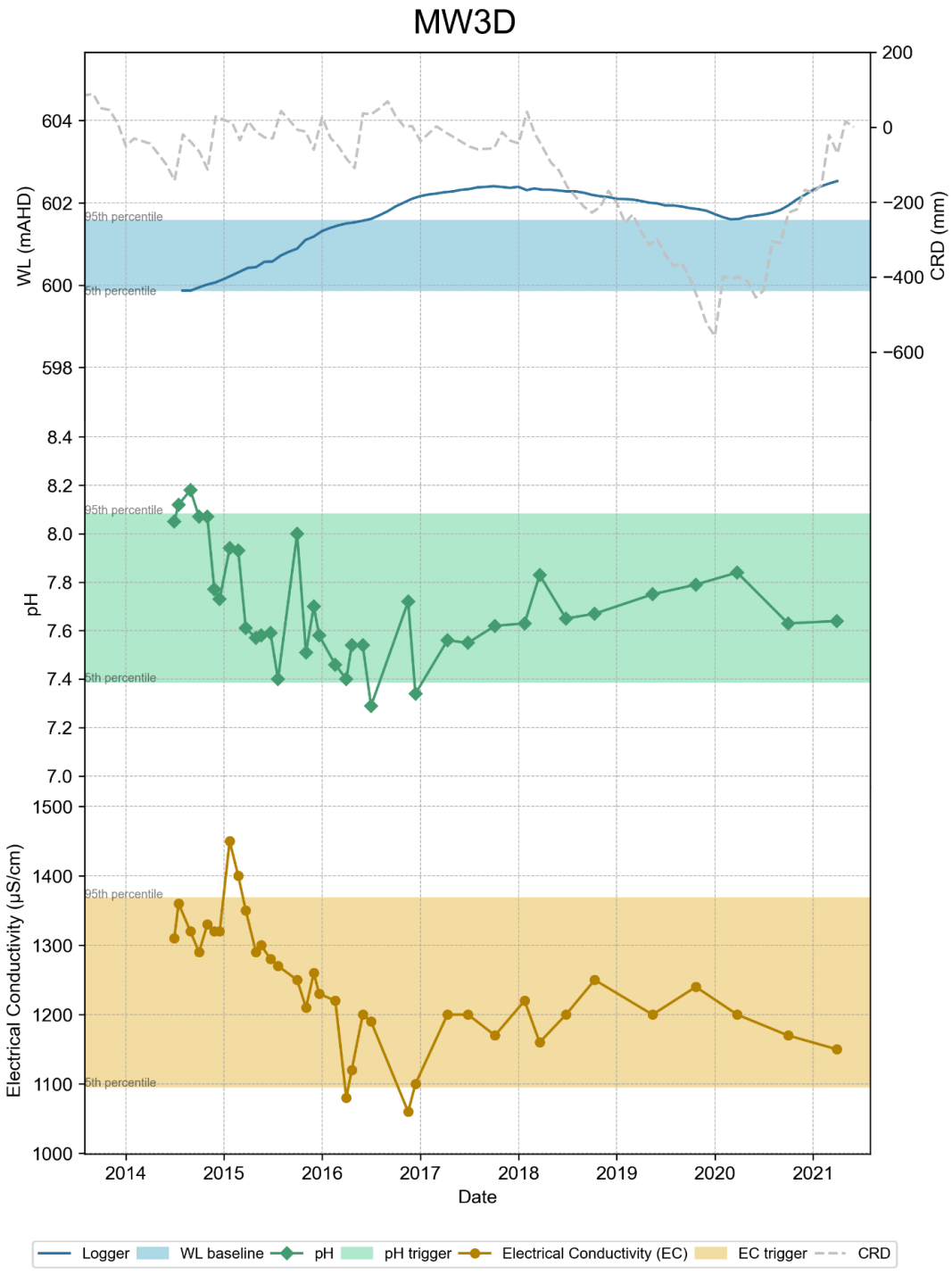
Soil or Rock Field Material Description	Graphic Log	Depth (mBGL) / RL (mAHD)	Bore Construction	Bore Description
		610 – 0		Protective lockable steel collar PVC stick up: + 0.71 m
No sample return		606 – 4		
Andesite, yellow/brown, extremely weathered to clay. Remnant silicious material (angular phenocrysts) comprises the bulk of sample return. Mafic angular fragments, where present and not weathered to clay, are only distinguishable due to hammer breakage. Higher clay fraction/increased weathering to clay at 7m, 9m and 12m; potentially from joints/fractures/fluid ingress		602 – 8		200mm hammer: 0m - 6m (air)
Andesite, khaki/brown, highly weathered. Small angular chip return due to extent of weathering		598 – 12		
Andesite, black/brown. Weathered to highly weathered. Joint at 25m; weathered to clay (khaki)		594 – 16		
Andesite, black/green/brown. Partially weathered (iron stained). Porphyritic; green silicious phenocrysts (up to 3mm across) within a black aphanitic groundmass.BOW 27m.		590 – 20		
		586 – 24		146mm hammer (air): 6m - 80.1m
		582 – 28		
		578 – 32		
		574 – 36		
		570 – 40		
		566 – 44		Bentonite grout 5%: specific gravity 1.44. 60% excess pumped down hole. 0m - 58.4m.
Andesite, black/green. Fresh. Black aphanitic groundmass and green silicious phenocrysts to 3mm across. Jointing at 34m, planar; no infill, iron stained. Clayey (khaki); weathered igneous material at 52m; potential fault. Driller stated felt noticeably softer at this depth. Iron stained joints at 53m, 56m, 62m. Quartz veining at 64m/65m. Hardened/silicified phenocrysts at 66m. Clayey (khaki) weathered igneous material at 67m; slightly damp. Small amount of quartz veining between 70 - 72m. Iron stained jointing (planar to irregular) at 71m and 75m		562 – 48		
		558 – 52		50 mm PN 18 uPVC blank casing: 0 m to 68.1 m
		554 – 56		
		550 – 60		Bentonite seal: 1/4 inch coated pellets (2 buckets). 58.4m - 60.2m. 1.6 - 3.2 mm washed, rounded, quartz gravel pack: 60.2m to 80.1 m
		546 – 64		
		542 – 68		
		538 – 72		
		534 – 76		50 mm PN 18 uPVC machine slotted casing, slot apperture: 0.5 mm, slot length: 50 mm, 672 slots / m, 68.1 m to 80.1 m
		530 – 80		End of bore: 80.1m
		526 – 84		

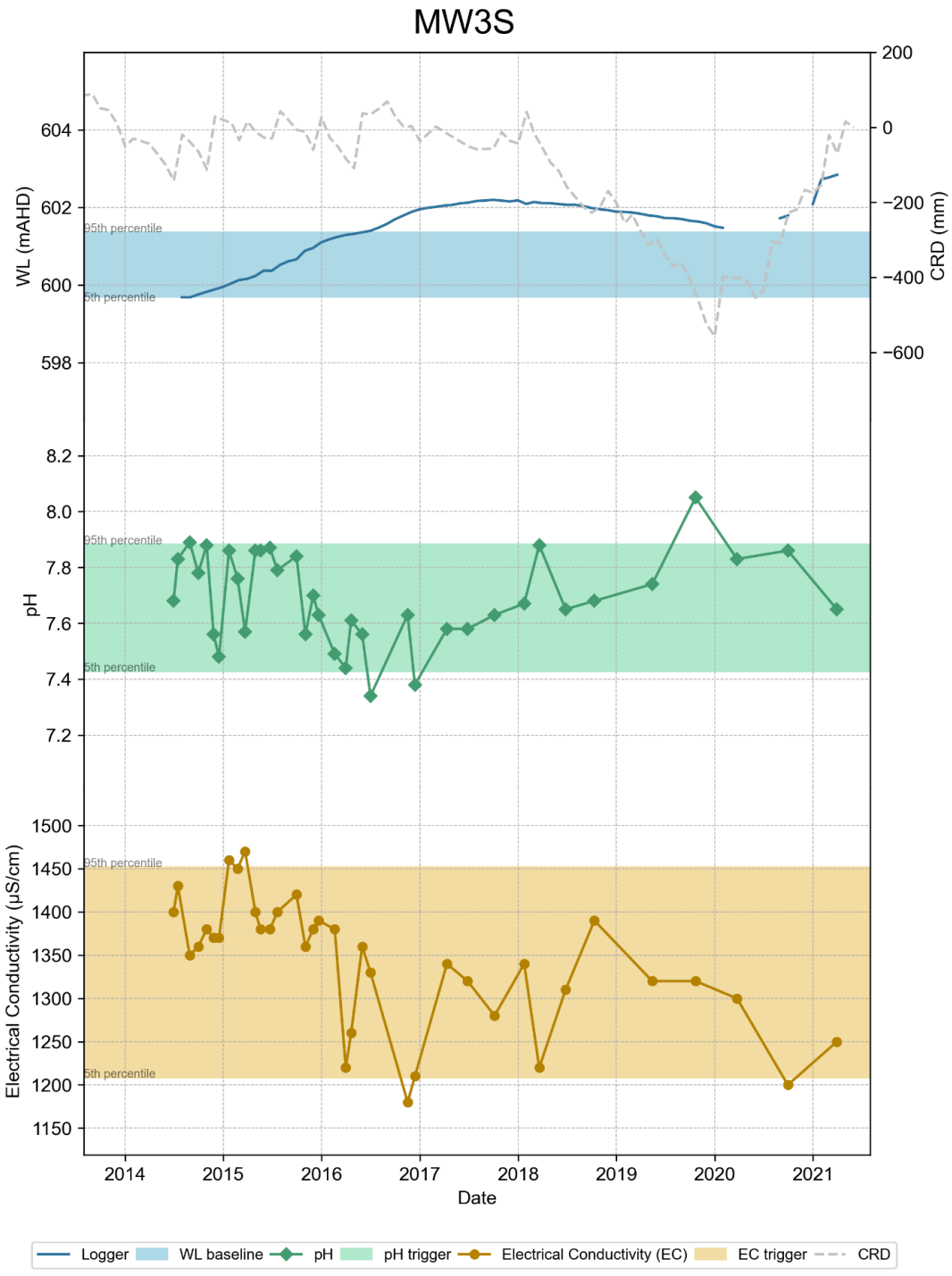
APPENDIX B

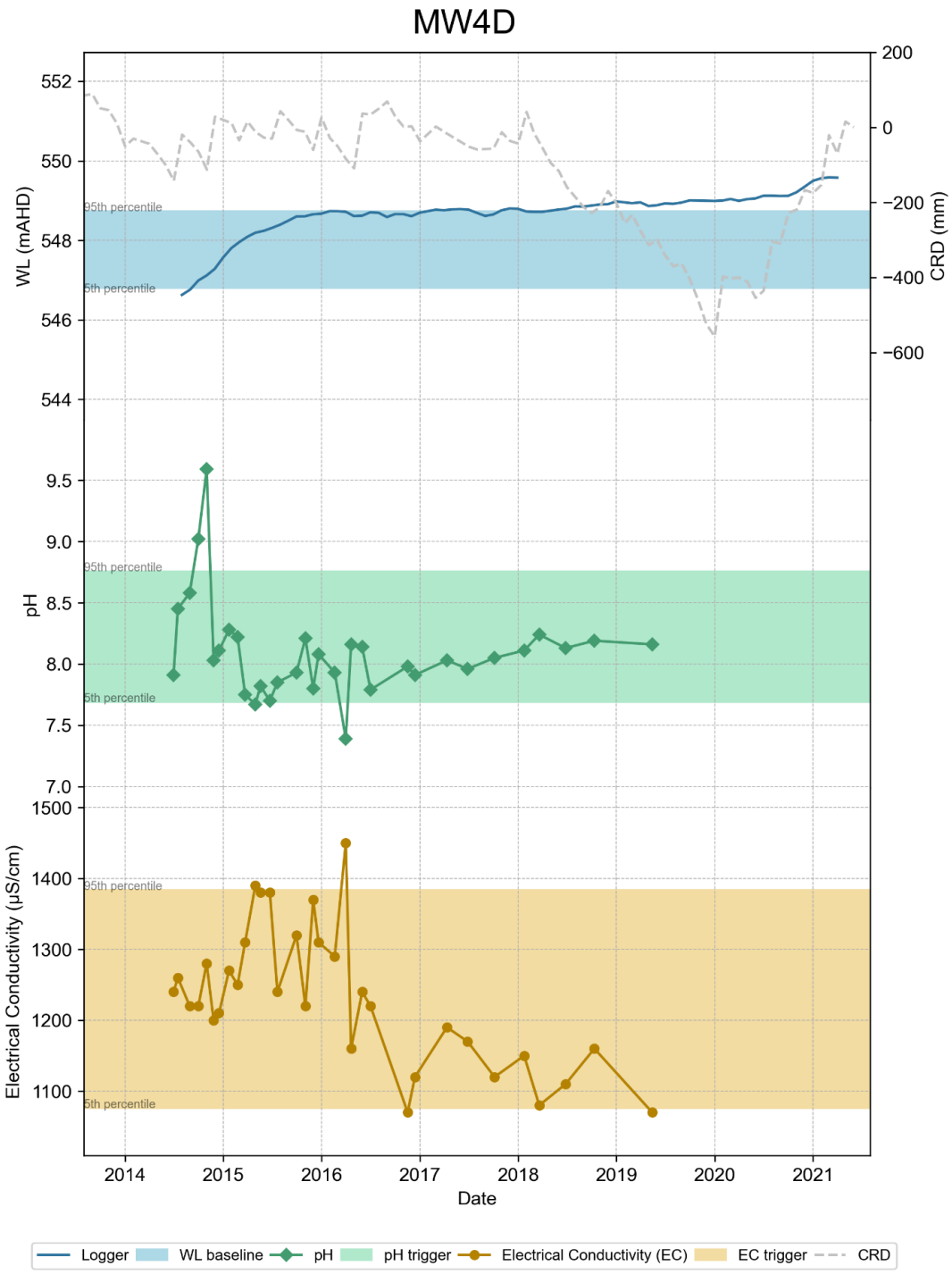
Summary of Groundwater Level and Quality

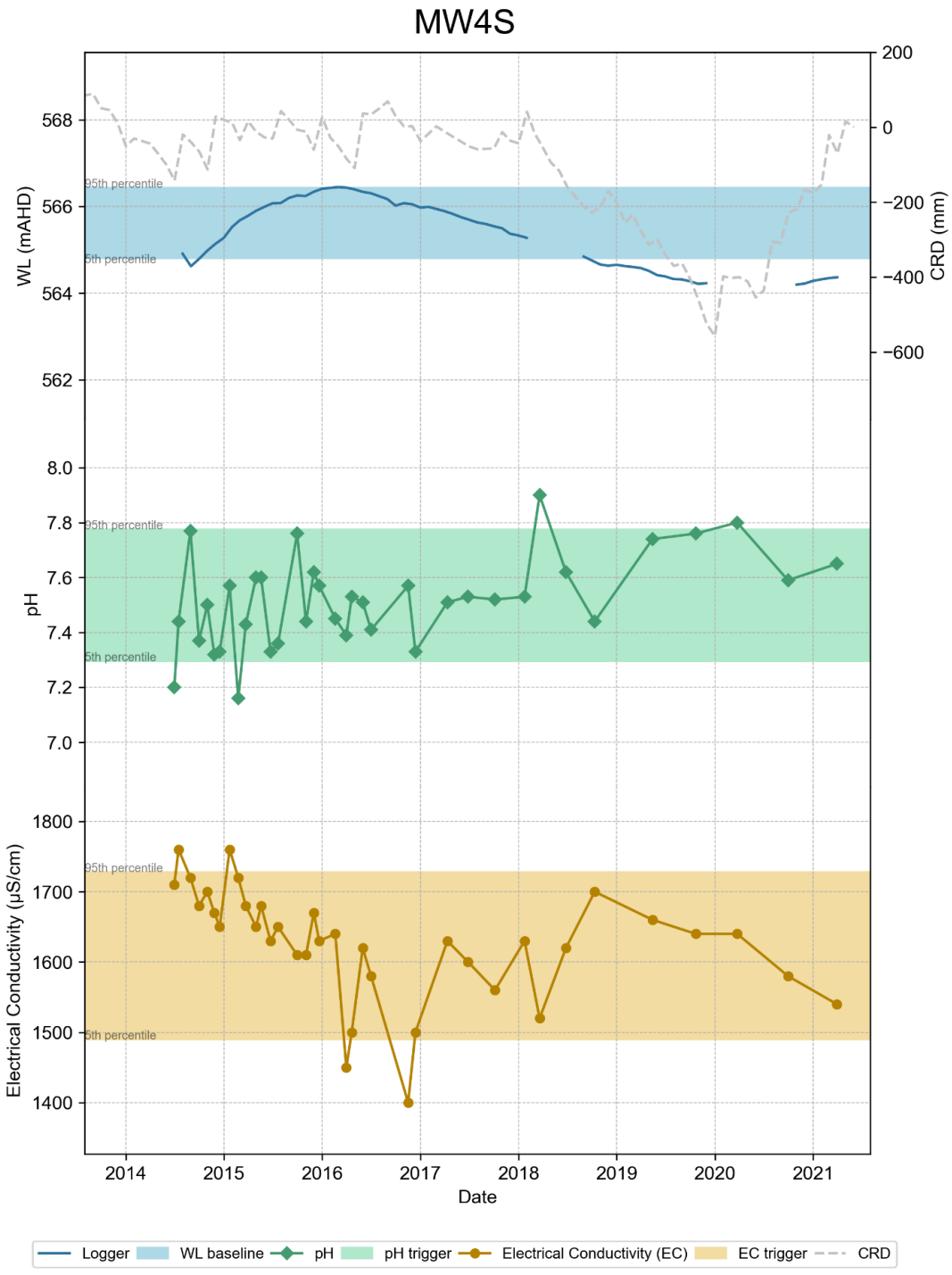

MW1
WL (mAHD)
CRD (mm)
pH
Electrical Conductivity (µS/cm)
95th percentile
5th percentile
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD

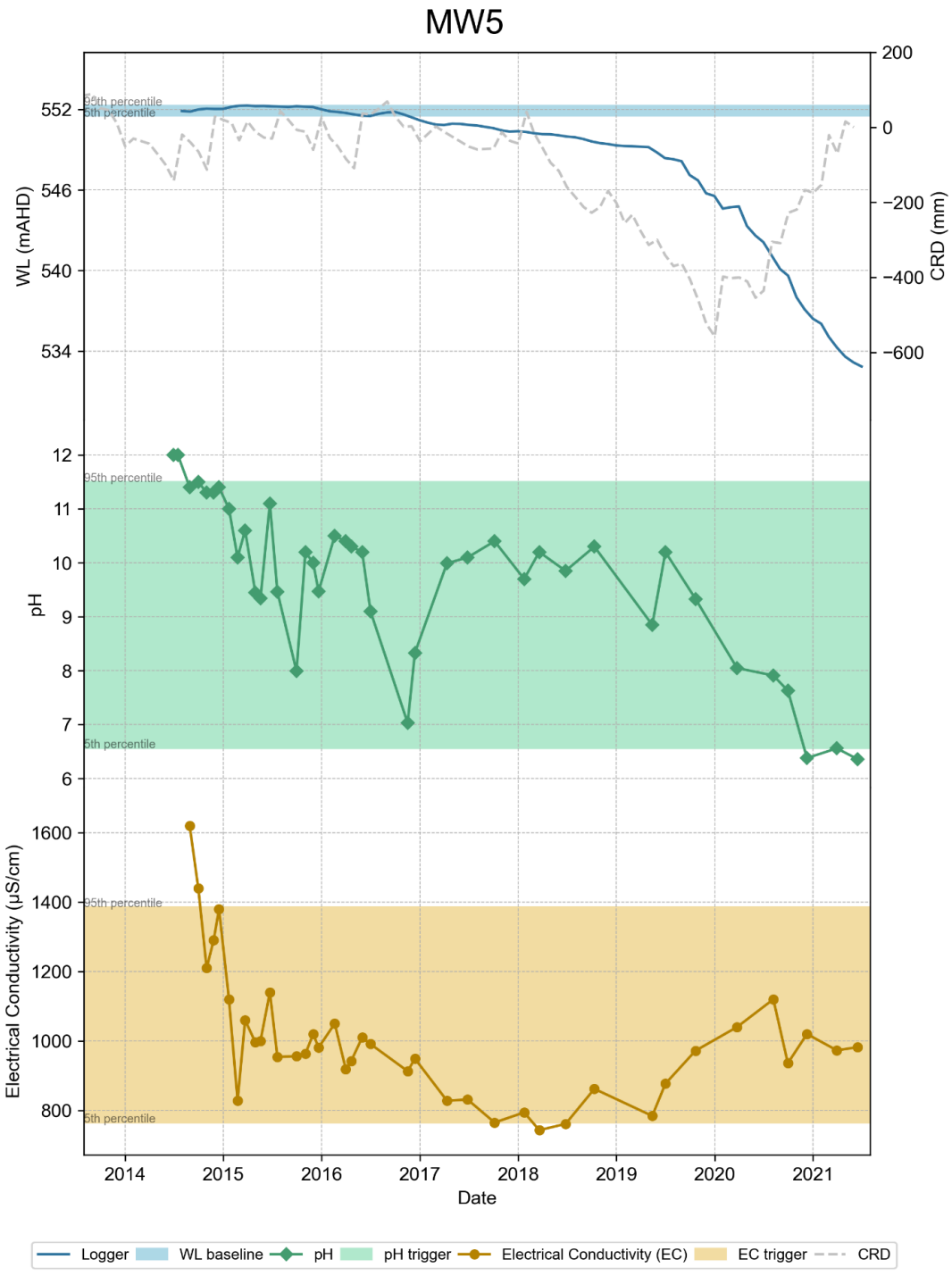

MW2
WL (mAHD)
348
345
342
340
95th percentile
5th percentile
CRD (mm)
200
0
−200
−400
−600
pH
8.2
8.0
7.8
7.6
7.4
7.2
7.0
95th percentile
5th percentile
Electrical Conductivity (µS/cm)
800
750
700
650
600
550
95th percentile
5th percentile
2014
2015
2016
2017
2018
2019
2020
2021
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD

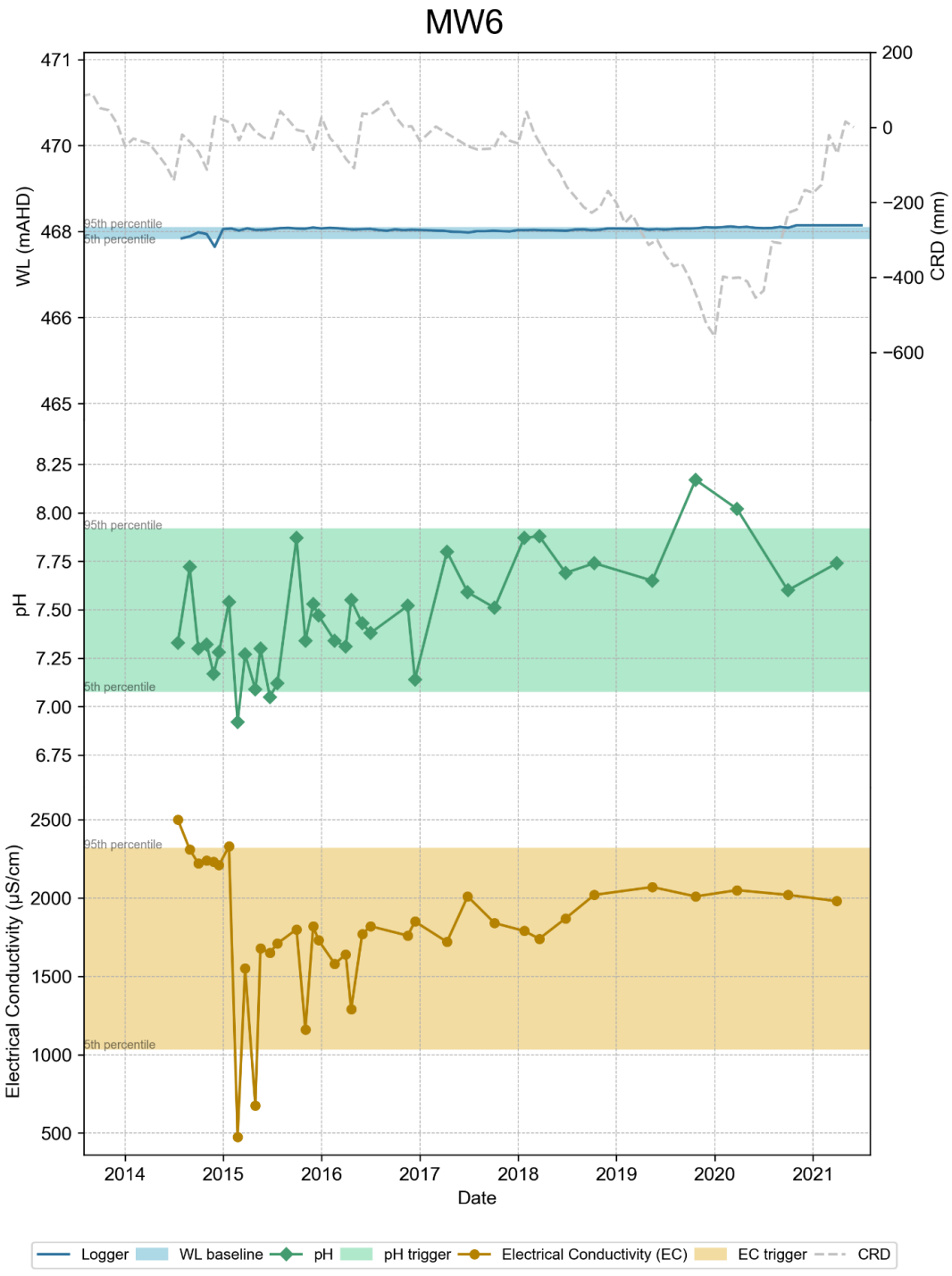

MW3D
WL (mAHD)
CRD (mm)
95th percentile
5th percentile
pH
Electrical Conductivity (µS/cm)
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD

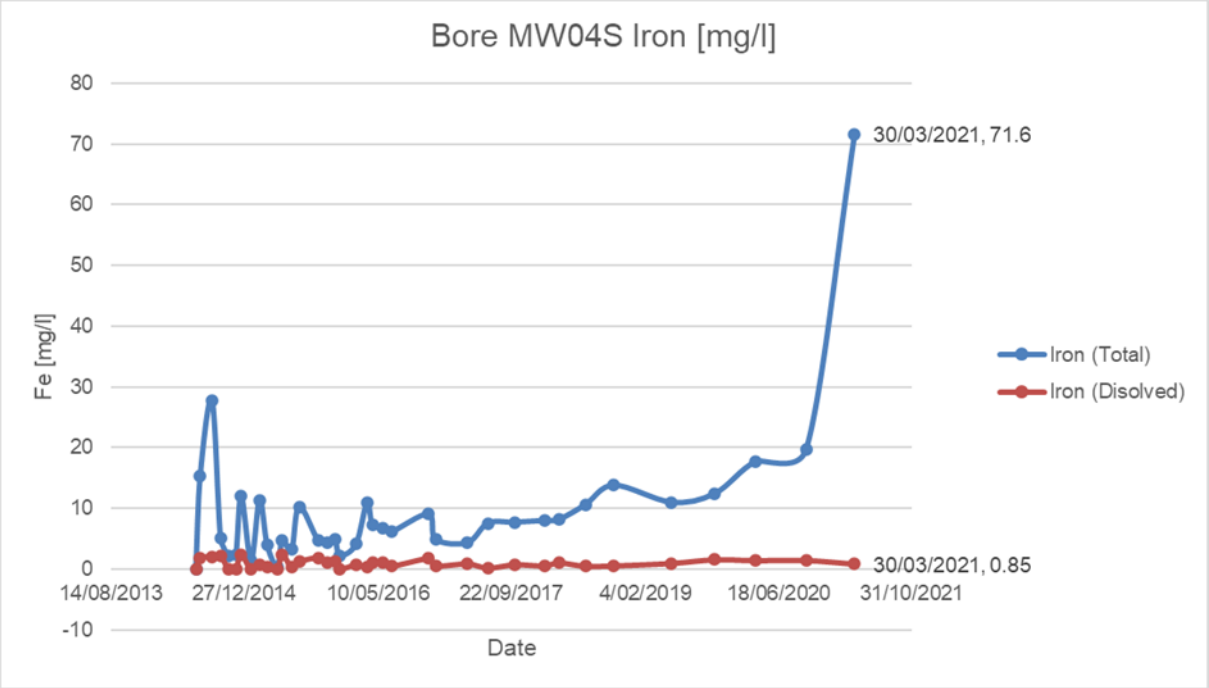

MW3S
WL (mAHD)
CRD (mm)
95th percentile
5th percentile
pH
Electrical Conductivity (µS/cm)
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD

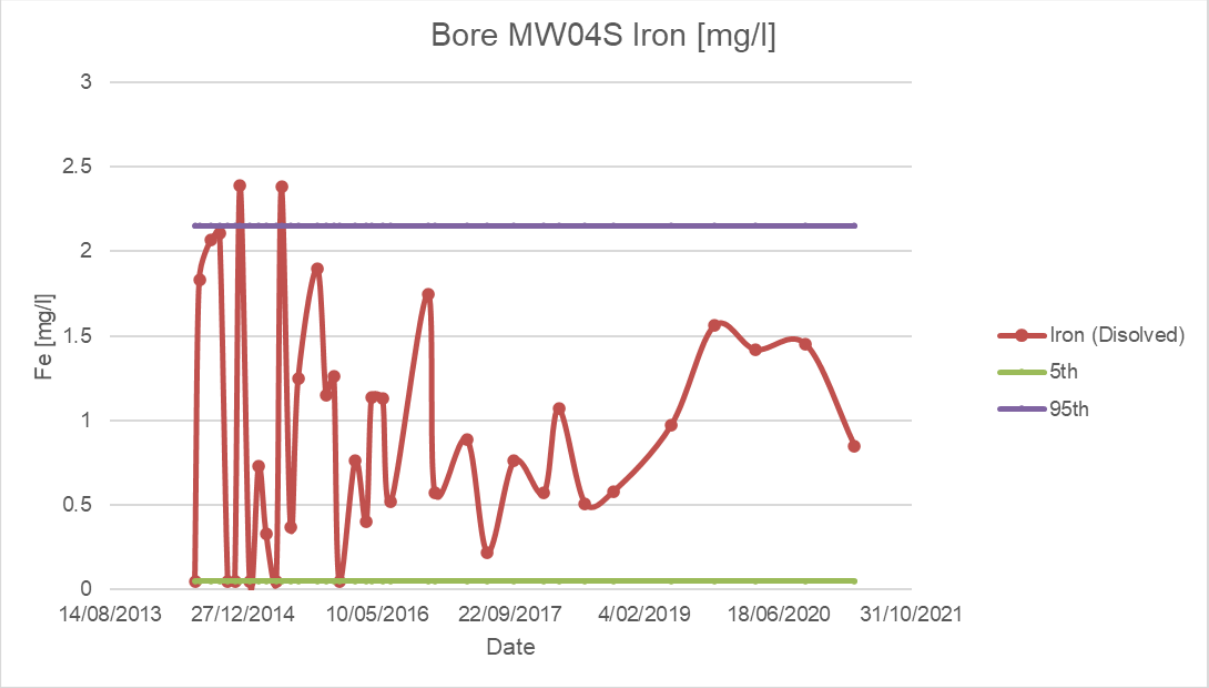

MW4D
WL (mAHD)
CRD (mm)
pH
Electrical Conductivity (µS/cm)
95th percentile
5th percentile
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD


MW4S
WL (mAHD)
568
566
564
562
95th percentile
5th percentile
CRD (mm)
200
0
−200
−400
−600
pH
8.0
7.8
7.6
7.4
7.2
7.0
95th percentile
5th percentile
Electrical Conductivity (µS/cm)
1800
1700
1600
1500
1400
95th percentile
5th percentile
2014
2015
2016
2017
2018
2019
2020
2021
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD


MW5
WL (mAHD)
CRD (mm)
pH
Electrical Conductivity (µS/cm)
95th percentile
5th percentile
Date
2014
2015
2016
2017
2018
2019
2020
2021
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD


MW6
WL (mAHD)
CRD (mm)
pH
Electrical Conductivity (µS/cm)
95th percentile
5th percentile
Date
Logger
WL baseline
pH
pH trigger
Electrical Conductivity (EC)
EC trigger
CRD


Bore MW04S Iron [mg/l]
80
70
60
50
40
30
20
10
0
-10
Fe [mg/l]
30/03/2021, 71.6
30/03/2021, 0.85
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
18/06/2020
31/10/2021
Date
Iron (Total)
Iron (Disolved)


Bore MW04S Iron [mg/l]
3
2.5
2
1.5
1
0.5
0
Fe [mg/l]
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
18/06/2020
31/10/2021
Date
Iron (Disolved)
5th
95th

APPENDIX C

Project areas registered bores (WaterNSW, 2021)

Bore ID	Easting (GDA94z56)	Northing (GDA94z56)	Depth (m)	Property lot no.	Source	Inspected
GW016489	223267.2	6149642.2	93	14/810374	1	No
GW037137	230763.1	6150975.3	33.2	1/588450	1	No
GW054057	224440.5	6152114.3	60	251/750029	1	No
GW072404	224315.6	6151691.2	48.8	252/657522	1	No
GW100346	222409.6	6147909.0	85	8/253177	1	No
GW100656	226797.5	6148600.8	90	112/830458	2	Yes
GW101320	225086.9	6153490.8	15.8	2/833561	1	No
GW101321	225237.7	6153557.0	15.7	1/804586	1	No
GW102505 (LICH02)	224804.4	6147596.8	70	1/1013487	2	Yes
LICH01	224745.6	6147490.5	-	1/1013487	2	Yes
GW111354 (LICH03)	224649.5	6147080.1	-	1/1013487	2	Yes
LICH04	225379.8	6146935.3	-	1/1013487	2	Yes
GW102590	228654.7	6149957.1	68	1/557562	1	No
GW103697	226412.9	6149788.1	31	1/1190667	2	Yes
GW103776	230827.4	6152702.9	54	3/233091	1	No
GW104453	230905.4	6150374.4	30	4/1010444	1	No
GW105505	223964.5	6151989.6	49	263/750029	1	No
GW105696	225506.3	6149221.6	76	9/1056566	1	No
GW106253	227106.0	6149374.3	78	21/867667	2	Yes
GW106370	223646.5	6151029.9	121	2/1056566	1	No
GW107147	225101.4	6150126.4	-	7/1056566	1	No
GW108617	229272.0	6154221.0	90	204/870194	1	No
GW108850	226103.6	6148723.7	24	11/1056566	2	Yes
GW109179	226776.1	6153375.2	54	203/870194	1	No
GW110544	223173.2	6147220.7	102	8/703477	1	No

Notes: Source: 1 – Pinneena data search; and
2 – coordinates updated during AGE bore census.

APPENDIX D

Groundwater Quality Guidelines (ANZECC, NHMRC)

AGE

Project ID:MSL.5000.001

Groundwater quality quality guidelines

Parameter	Units	LOR[#]	ANZECC GUIDELINES				NHMRC
			Fresh Water Aquatic (95th)	Short term irrigation	Long Term irrigation	Stock Water	Drinking Water
Physical Parameters							
pH	pH Units	0.1	**6.5 - 8.5**	**6.0 - 8.5**	**6.0 - 8.5**	**-**	**6.5 - 8.5[b]**
Electrical conductivity	µS/cm	1	**120 - 300**	**-**		**-**	**-**
Total Dissolved Solids (calc)	mg/L	1.00		**-**		**3000 - 13000***	**600[b]**
Total Hardness as $CaCO_3$	mg/L	1.00		**-**		**-**	**200[b]**
Major Ions							
Sulfate as SO_4 - Turbidimetric	mg/L	1		**-**		**1000 - 2000**	**500[a] / 250[b]**
Chloride	mg/L	1			**40**	**-**	**250[b]**
Fluoride	mg/L	0.1		**2.0**	**1.0**	**2**	**1.5[a]**
Calcium	mg/L	1		**-**		**1000**	**-**
Sodium	mg/L	1		**-**		**-**	**180[b]**
Nutrients							
Ammonia as N	mg/L	0.01	**0.9**	**-**		**-**	**0.5[b]**
Nitrite as N	mg/L	0.01		**-**		**30**	**3[a]**
Nitrate as N	mg/L	0.01	**0.7**	**-**		**-**	**50[a]**
Total Nitrogen as N	mg/L	0.1		**25 - 125**	**5**	**-**	**-**
Total Phosphorus as P	mg/L	0.01		**0.8 - 12**	**0.05**	**-**	**-**
Metals							
Aluminium	mg/L	0.01	**0.055**	**5**		**5**	**0.2[b +]**
Antimony	mg/L	0.001		**-**		**-**	**0.003[a]**
Arsenic	mg/L	0.001	**As (III) 0.024 As (V) 0.013**	**2.0**	**0.1**	**0.5**	**0.01[a]**
Barium	mg/L	0.001		**-**		**-**	**2[a]**
Beryllium	mg/L	0.001		**0.5**	**0.1**	**-**	**0.06[a]**
Boron	mg/L	0.05	**0.37**	**fer to guideli**	**0.5**	**5.0**	**4[a]**
Cadmium	mg/L	0.0001	**0.0002**	**0.05**	**0.01**	**0.01**	**0.002[a]**
Chromium	mg/L	0.001	**CrIII – ID Cr(VI) 0.001**	**1.0**	**0.1**	**1.0**	**0.05[a]**
Cobalt	mg/L	0.001		**0.10**	**0.05**	**1.0**	**-**
Copper	mg/L	0.001	**0.0014**	**5.0**	**0.2**	**0.5 - 5^**	**2[a] / 1[b]**
Iron	mg/L	0.05	**-**	**10.0**	**0.2**	**-**	**0.3[b]**
Lead	mg/L	0.001	**0.0034**	**5.0**	**2.0**	**0.1**	**0.01[a]**
Lithium	mg/L	0.001	**-**	**2.5**	**2.5**	**-**	**-**
Manganese	mg/L	0.001	**1.9**	**10.0**	**0.2**	**-**	**0.5[a] / 0.1[b]**
Mercury	mg/L	0.0001	**0.0006**	**0.002**	**0.002**	**0.002**	
Molybdenum	mg/L	0.001	**-**	**0.05**	**0.01**	**0.15**	**0.05[a]**
Nickel	mg/L	0.001	**0.011**	**2.0**	**0.2**	**1**	**0.02[a]**
Selenium	mg/L	0.01	**Total – 0.011 SeIV - ID**	**0.05**	**0.02**	**0.02**	**0.01[a]**
Silver	mg/L	0.001			**-**	**-**	**0.1[a]**
Uranium	mg/L	0.001	**-**	**0.10**	**0.01**	**0.2**	**0.017[a]**
Vanadium	mg/L	0.01	**-**	**0.5**	**0.1**	**-**	**-**
Zinc	mg/L	0.005	**0.008**	**2.0**	**2.0**	**20**	**3[b]**
Zirconium	mg/L	0.005			**-**	**-**	**-**
BTEX							
Benzene	µg/L	1	**900**				**0.001[a]**
Toluene	µg/L	2					**0.8[a]**
Ethylbenzene	µg/L	2					**0.3[a]**
ortho-Xylene	µg/L	2	**350**				
Naphthalene	µg/L	5	**16**				

#	Limit of Reporting
a	NHMRC Health Guidelines for Drinking Water (2019)
b	NHMRC Aesthetic Guidelines for Drinking Water (2019)

APPENDIX E

Standard Operating Procedures

Standard Operating Procedure on:

Field Documentation, Groundwater Level Gauging. Groundwater Sampling and Appropriate Storage and Handling Practices

1) Purpose

These procedures describe the approach to be taken for the collection, storage/handling and documentation of representative groundwater samples.

2) Scope

These procedures apply to groundwater monitoring and sampling activities for Marulan South Limestone Mine Continued Operations. Where there is substantial variation from these procedures, a note must be made in the job briefing sheets or field notes describing the procedure that is to be used.

3) Procedures

3.1) Field equipment

All necessary equipment to conduct the groundwater sampling will be checked prior arriving on site. Field equipment required to conduct the perform the groundwater sampling include:

- water level dipper;
- tape measure;
- GPS unit;
- tablet, Laptop or similar for pressure logger data download;
- water quality meter with sensor probes for pH, electrical conductivity, temperature and redox potential, and appropriate calibration solutions;
- appropriate personal protective equipment including long sleeve shirt and long pants, hard hat or broad brimmed hat, sun screen, gloves, protective eyewear and protective footwear;
- water quality sample bottles;
- filters and syringes;
- nitrile gloves;
- freshwater for rinsing;
- fridge or cooler box and ice;
- bailer or submersible pump; and
- decontamination liquid to rinse reusable equipment.

3.2) Field notes

Written or digital records must be maintained for groundwater monitoring and sampling activities. These records must cover field observations and give an account of daily works and events. Paper based records must protected from the elements and all entries made in indelible ink. Field data recorded digitally in the field using a tablet, laptop or similar device must be backed up to a secondary storage device on a regular basis (e.g. daily).

Field observations collected shall include the following:

- weather conditions;
- GPS coordinates and elevation of bore if survey has not been completed yet;
- health and safety issues on site;
- description of the conditions of the monitoring bore;
- total depth of bore (where possible);
- results of any field testing;
- calibration results of water quality meter;

- details of samples collected including time and date, sample, identification number and bore location, procedures used in sample collection, and instrument readings;
- descriptions of visual and olfactory characteristics during each measurement;
- including details such as elapsed time, volume purged, colour, turbidity, odour, sheen etc. when performing a well purge; and
- photographs of the monitoring location visited.

Supporting information such as safety plans, site plans, and a copy of this standard operating procedures must be accessible to the field sampler when conducting monitoring and sampling.

3.3) General sampling procedures:

1. Record the condition, coordinates and elevation.

2. Record depth to standing groundwater level in the bore with a water level meter. Depth measurements will be referenced to an established datum or measuring point (e.g., top of bore casing).

3. Retrieve pressure logger (if present) within bore. Download data from pressure logger with correct cables and software with laptop.

4. Record the top of bore casing from ground level.

5. Decontaminate all reusable sampling equipment (i.e., pumps and cables) prior to use at each location.

6. Ensure that the water quality meter has been calibrated within the last 24 hours.

7. Compute water volume in the bore with standing water level, bore depth and bore diameter.

8. Lower the decontaminated pump or bailer into the bore. Ensure discharge outlet is placed at distances from bore when utilising a pump setup. Safe manual handling practices must be followed when lifting / carrying sampling equipment. Note any trip hazards prior to proceeding. If required; seek assisting when lifting heavy equipment and the position the field vehicle to minimise carry distance.

9. During purging, field water quality parameters such as pH, electrical conductivity, redox potential, temperature and sediment load will be recorded at regular intervals. Once sediment load is minimal, three bore volumes have been removed and field parameters are stable (within 10%, within 0.2°C for temperature), a groundwater sample can be collected.

10. Low yielding wells that do not yield three bore volumes in one visit should be purged dry and left to recover. Following recovery of groundwater levels, sampling can proceed as the recovered standing water should be representative of inflows from the screened hydrostratigraphic unit.

11. Scan the sample bottles with digital application provided by testing laboratory on tablet or mobile phone. If digital application is not available from testing laboratory, label sample bottles using a Xylene free permanent marker with details including bore name, sample round number, sampler name, date and time.

12. Record any other specific bottle filling instructions on the sample bottles before filling them. Note which samples need to be field filtered and/or contain preservatives such as acids.

13. Conduct filling of sample bottle with nitrile gloves.

14. For samples requiring field filtration, rinse and fill a new container with the water from the bore. Fill the syringe with water from the bore, attach the filter to the end of the syringe. Sit the filter over the sample bottle and push the water through from the syringe. Continue to do this until the sample bottle is full before screwing the cap on tightly.

15. Preserve samples in cooler boxes/eskies provided by testing laboratory that are chilled at or around 4ºC. The cooler boxes will be sealed, clearly labelled with the name and address of the testing laboratory.

16. Ensure preservation of samples in cooler boxes do not exceed the recommended sample holding times. The holding times will vary according to the NATA-certified method being used by the laboratory and will be clarified with the nominated laboratory.

17. Include chain of custody (COC) form detailing each sample sent to the laboratory. A COC form must be completed while in the field. When groundwater samples are relinquished, ensure that the receiving party have signed the form indicating the time and date. A copy of the signed form must be retained and filed as a record of samples sent and analyses requested. Where electronic COCs are used, all digital records and emails must be filed appropriately.

Care must be given to avoid loss or decay of sample labels during storage and handling. The sample label must be written on the cap of the sample bottle if the decay of sample label is unavoidable. The sample will then be sealed and recorded in a chain-of-custody form from the laboratory nominated for the analysis.

Standard Operating Procedure on

Quality Assurance Sampling

1) Purpose

The purpose of this procedure is to describe the approach to be taken for the collection of quality assurance samples during groundwater sampling.

2) Scope

This procedure applies when groundwater samples are collected.

3) Procedures

For the collection of the required field quality control (QC) samples refer to SOP on Field Documentation, Groundwater Level Gauging. Groundwater Sampling and Appropriate Storage and Handling Practices.

3.1) Quality assurance sampling

3.1.1) Field blind duplicates (Intra-laboratory duplicates)

Field blind duplicates are duplicate samples that are sent as independent samples to the same laboratory for analysis to assess the repeatability of the analytical results and the variation in analyte concentration between samples collected from the same sampling point. Field blind duplicates must be collected typically at a frequency of 1 in 20 samples (i.e., 5%).

Field blind duplicates must be taken simultaneously when the original sample is taken. Both the duplicate sample and the sample should be agitated as little as possible, preferably direct from the discharge line. The duplicates should be labelled without any indication of its original sampling point and sent for analysis as usual.

3.1.2) Field split duplicates (Inter-laboratory duplicates)

Field splits are duplicate samples that are sent to different laboratories for analysis to assess the analytical proficiency of the laboratories. Field split duplicates must be collected at a frequency of 1 in 20 samples (i.e. 5%). The combined blind and split frequency should be at least 10% of the total sample number. Field split duplicates are be collected using the same procedures as for field blind duplicates.

3.1.3) Field blanks

Field blanks monitor possible contamination that may be accidentally introduced when actually collecting the sample in the field. A sample container must be filled with deionised water in the field, sealed, labelled and sent for analysis as usual.

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Boral Cement Limited

5 Hume Street
Marulan South
NSW 2579

www.boral.com.au

APPENDIX B

Erosion and Sediment Control Checklist

Erosion and sediment control basins and water storage dams checklist

Inspection details			
Date:		Completed by:	

Sediment Basins and Water Storage Dams

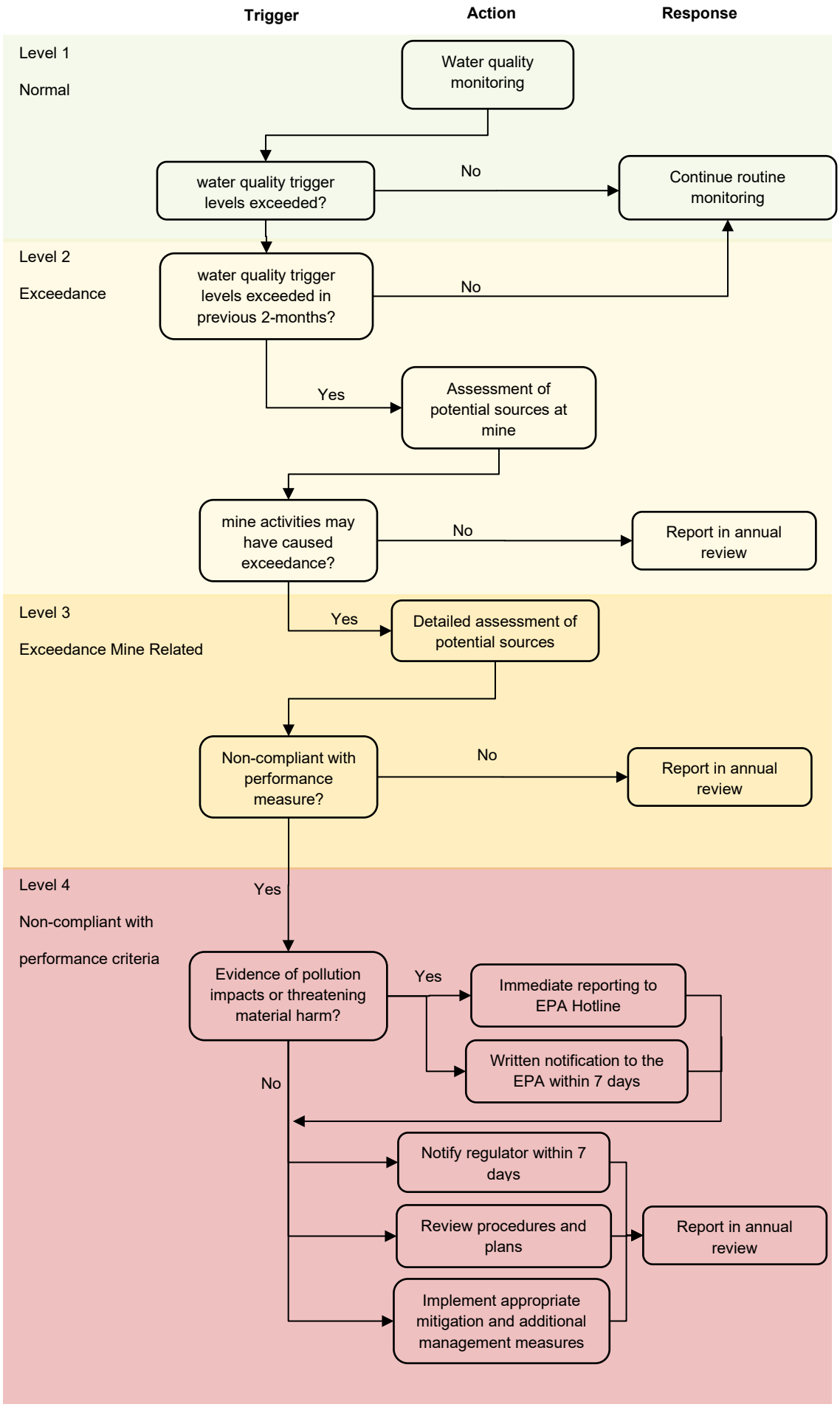
Sediment basin ID	Minimum Air Space (m)	Water level at time of inspection	Settlement capacity (ML)	Sediment storage capacity (ML)	Sediment basin/Dam embankment condition	Sediment basin/Dam spillway condition	Evidence of sediment basin/ dam overflow	General comments
Road Sales Stockpile Area*								
P1	1.7		1.3	0.8				
Northern Overburden Emplacement*								
N1	1.7		8.5	4.2				
N2	1.7		6.4	3.2				
Kiln Dam	N/A							
Western Overburden Emplacement								
W1	1.7		7.2	3.6				
W2	1.7		5.0	2.5				
Central Dam	N/A							
Southern Overburden Emplacement								
S1	1.7		3.8	1.2				
S2	1.7		2.7	1.4				
Pit								
North Pit Sump	N/A							
Southern Pit Sump	N/A							
Eastern Gully								
Eastern Gully Dam	N/A							

* Details from Peppertree Quarry Water Management Plan (Boral, 2021).

Drains – for example scouring, failures, sediment accumulation, failures

Area	Perimeter drain condition	Internal drainage condition	General notes
Road Sales Stockpile area			
Northern Overburden Emplacement			
Western Overburden Emplacement			
Southern Overburden Emplacement			
Pit			
Eastern Gully			

APPENDIX C
TARP

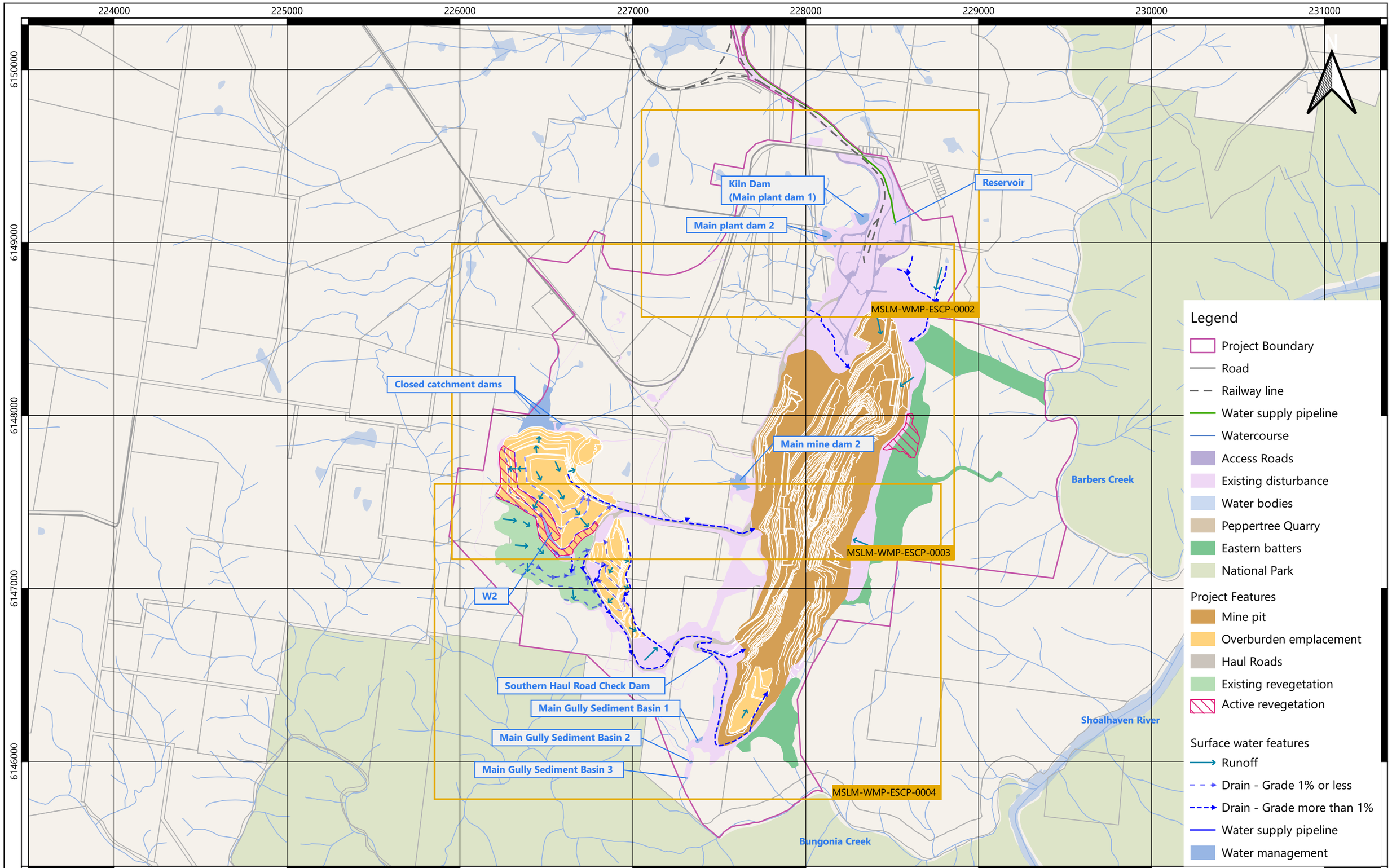

Trigger
Action
Response
Level 1
Normal
Water quality monitoring
water quality trigger levels exceeded?
No
Continue routine monitoring
Level 2
Exceedance
water quality trigger levels exceeded in previous 2-months?
No
Yes
Assessment of potential sources at mine
mine activities may have caused exceedance?
No
Report in annual review
Level 3
Exceedance Mine Related
Yes
Detailed assessment of potential sources
Non-compliant with performance measure?
No
Report in annual review
Level 4
Non-compliant with
performance criteria
Yes
Evidence of pollution impacts or threatening material harm?
Yes
Immediate reporting to EPA Hotline
Written notification to the EPA within 7 days
No
Notify regulator within 7 days
Review procedures and plans
Implement appropriate mitigation and additional management measures
Report in annual review

APPENDIX D

Erosion and Sediment Control Plans

Table D-1 Erosion and Sediment Control Maps

Map	Title	Revision
MSLM-WMP-ESCP-0001	Overview - Current System	D
MSLM-WMP-ESCP-0002	Northern Overburden Emplacement – Current System	D
MSLM-WMP-ESCP-0003	Western Overburden Emplacement – Current System	D
MSLM-WMP-ESCP-0004	Southern Overburden Emplacement – Current System	D
MSLM-WMP-ESCP-0005	Overview – Stage 1	C
MSLM-WMP-ESCP-0006	Northern Overburden Emplacement – Stage 1	C
MSLM-WMP-ESCP-0007	Eastern Gully Dam – Stage 1	C
MSLM-WMP-ESCP-0008	North Pit Sump – Stage 1	C
MSLM-WMP-ESCP-0009	Western Overburden Emplacement – Stage 1	C
MSLM-WMP-ESCP-0010	Southern Overburden Emplacement – Stage 1	C
MSLM-WMP-ESCP-0011	Overview – Stage 2	C
MSLM-WMP-ESCP-0012	Northern Overburden Emplacement – Stage 2	C
MSLM-WMP-ESCP-0013	Eastern Gully Dam – Stage 2	C
MSLM-WMP-ESCP-0014	North Pit Sump – Stage 2	C
MSLM-WMP-ESCP-0015	Western Overburden Emplacement – Stage 2	C
MSLM-WMP-ESCP-0016	Southern Overburden Emplacement – Stage 2	C
MSLM-WMP-ESCP-0017	Standard Drawings 1 of 5	A
MSLM-WMP-ESCP-0018	Standard Drawings 2 of 5	A
MSLM-WMP-ESCP-0019	Standard Drawings 3 of 5	A
MSLM-WMP-ESCP-0020	Standard Drawings 4 of 5	A
MSLM-WMP-ESCP-0021	Standard Drawings 5 of 5	A



BORAL®

REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
D	Jun 2022	Updated drain classification	MB

0 200 400 600 800 1,000 m

SCALE 1:20000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Overview
Current System

DRAWING NO.
MSLM-WMP-ESCP-0001

REV.
D

227500 228000 228500 229000

6149500

6149000

N

Water supply pipeline
from Tallong Weir

Kiln Dam
(Main plant dam 1)

Reservoir

Main plant dam 2

Legend

- Project Boundary
- Cadastre
- Road
- Railway line
- Water supply pipeline
- Watercourse
- Access roads
- Existing disturbance
- Water bodies
- Peppertree Quarry
- Eastern batters
- National Park

Project Features

- Mine pit
- Overburden emplacement
- Haul roads
- Existing revegetation
- Active revegetation

Surface water features

- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water supply pipeline
- Water management

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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
D	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:5000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Northern Overburden Emplacement
Current System

DRAWING NO.
MSLM-WMP-ESCP-0002

REV.
D

226000 226500 227000 227500 228000 228500

6149000 6148500 6148000 6147500

N

Closed catchment dams

W2

Main Mine Dam 2

Legend

- Project Boundary
- Road
- Railway line
- Water supply pipeline
- Watercourse
- Access Roads
- Existing disturbance
- Water bodies
- Peppertree Quarry
- Eastern batters
- National Park

Project Features

- Mine pit
- Overburden emplacement
- Haul Roads
- Existing revegetation
- Active revegetation

Surface water features

- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water supply pipeline
- Water management

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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
D	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:7500

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
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PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Western Overburden Emplacement
Current System

DRAWING NO.
MSLM-WMP-ESCP-0003

REV.
D

226000 226500 227000 227500 228000 228500

6147500 6147000 6146500 6146000

N

W2

Main Mine Dam 2

Drain on haul road
reports to Mine Pit

Southern Haul Road Check Dam

Main Gully Sediment Basin 1

Main Gully Sediment Basin 2

Main Gully Sediment Basin 3

Legend

- Project Boundary
- Road
- Railway line
- Water supply pipeline
- Watercourse
- Access Roads
- Existing disturbance
- Water bodies
- Peppertree Quarry
- Eastern batters
- National Park

Project Features

- Mine pit
- Overburden emplacement
- Haul Roads
- Existing revegetation
- Active revegetation

Surface water features

- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water supply pipeline
- Water management

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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
D	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:7500

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

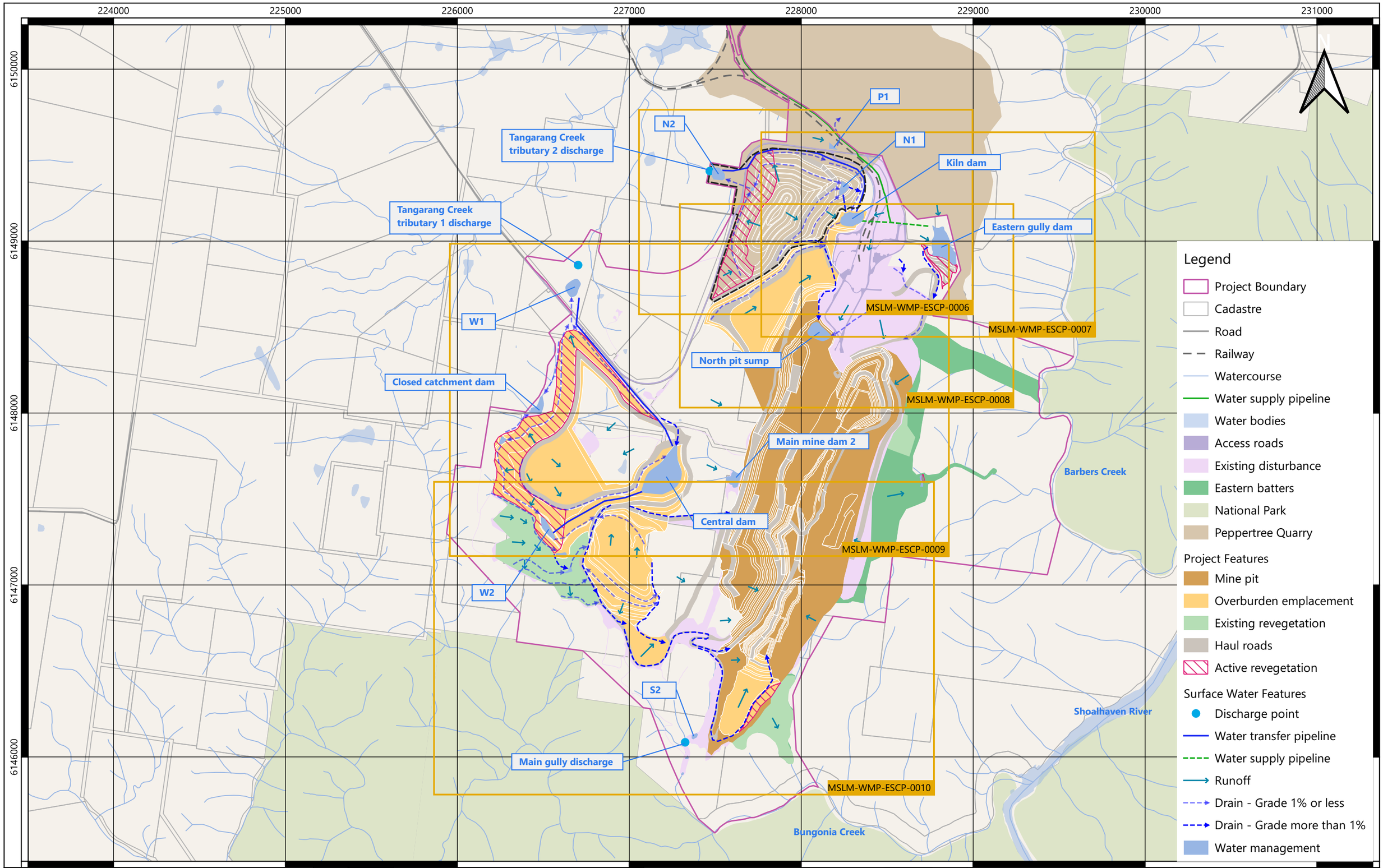
CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Southern Overburden Emplacement
Current System

DRAWING NO.
MSLM-WMP-ESCP-0004

REV.
D



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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 200 400 600 800 1,000 m

SCALE 1:20000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Overview
Stage 1

DRAWING NO.
MSLM-WMP-ESCP-0005

REV.
C

227500 228000 228500 229000

6149500

6149000

N

Overflow from road sales stockpile
Sediment Basin P1 to Peppertree Quarry
Water Management System

P1

Transfer pipeline from
Sediment Basin N2 to Kiln Dam

N2

Water supply pipeline
from Tallong Weir

Tangarang Creek
tributary 2 discharge

N1

Transfer pipeline from Kiln Dam
to Eastern Gully Dam

Overflow from N1
to Kiln Dam

Erosion and sediment control of Northern Overburden Emplacement described in Peppertree Quarry Water Management Plan (Boral, 2021)

Transfer pipeline from
N1 to Kiln Dam

Kiln dam

Overflow from Kiln Dam
to Northern Pit Sump

Legend

- Project Boundary
- Cadastre
- Road
- Railway
- Watercourse
- Water supply pipeline
- Water bodies
- Access roads
- Existing disturbance
- Eastern batters
- National Park
- Peppertree Quarry

Project Features

- Mine pit
- Overburden emplacement
- Existing revegetation
- Haul roads
- Active revegetation

Surface Water Features

- Discharge point
- Water transfer pipeline
- Water supply pipeline
- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water management

BORAL®

REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:5000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Northern Overburden Emplacement
Stage 1

DRAWING NO.
MSLM-WMP-ESCP-0006

REV.
C

228000
228500
229000
229500
6149500
6149000
6148500
N
P1
N2
Kiln dam
Eastern gully dam
North pit sump
Transfer pipeline from Kiln dam to Eastern gully dam
Overflow from Eastern gully dam to Mine Pit

Legend

- Project Boundary
- Cadastre
- Road
- Railway
- Watercourse
- Water supply pipeline
- Water bodies
- Access roads
- Existing disturbance
- Eastern batters
- National Park
- Peppertree Quarry

Project Features

- Mine pit
- Overburden emplacement
- Existing revegetation
- Haul roads
- Active revegetation

Surface Water Features

- Discharge point
- Water transfer pipeline
- Water supply pipeline
- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water management

BORAL®

REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:5000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Eastern Gully Dam
Stage 1

DRAWING NO.
MSLM-WMP-ESCP-0007

REV.
C

227500
228000
228500
229000
6149000
6148500
N
Kiln dam
Eastern gully dam
Overflow from Kiln dam
North pit sump
North Pit Sump overflows to Mine Pit

Legend

- Project Boundary
- Cadastre
- Road
- Railway
- Watercourse
- Water supply pipeline
- Water bodies
- Access roads
- Existing disturbance
- Eastern batters
- National Park
- Peppertree Quarry

Project Features

- Mine pit
- Overburden emplacement
- Existing revegetation
- Haul roads
- Active revegetation

Surface Water Features

- Discharge point
- Water transfer pipeline
- Water supply pipeline
- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water management

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C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:5000

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DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

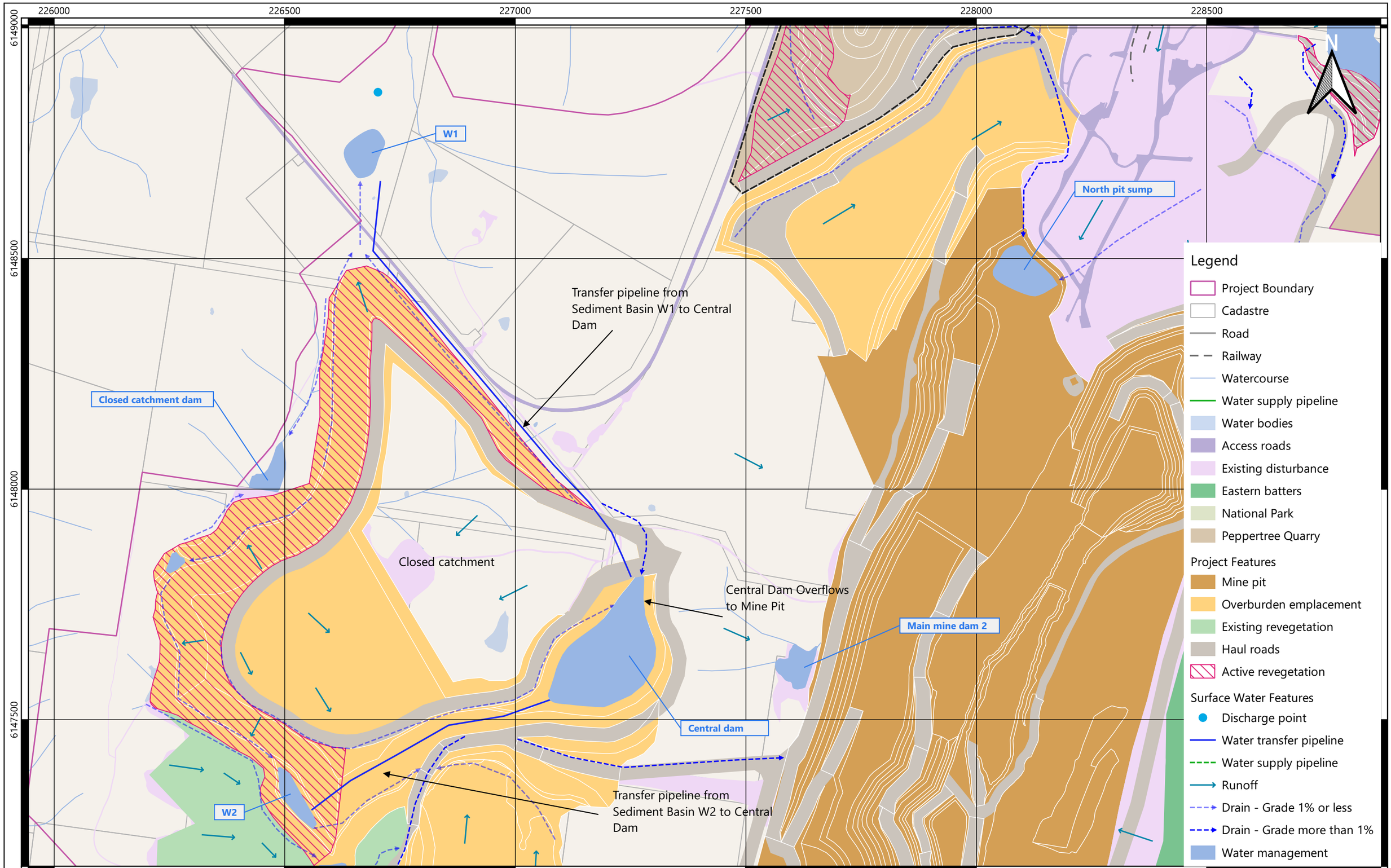
CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
North Pit Sump
Stage 1

DRAWING NO.
MSLM-WMP-ESCP-0008

REV.
C



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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:7500

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

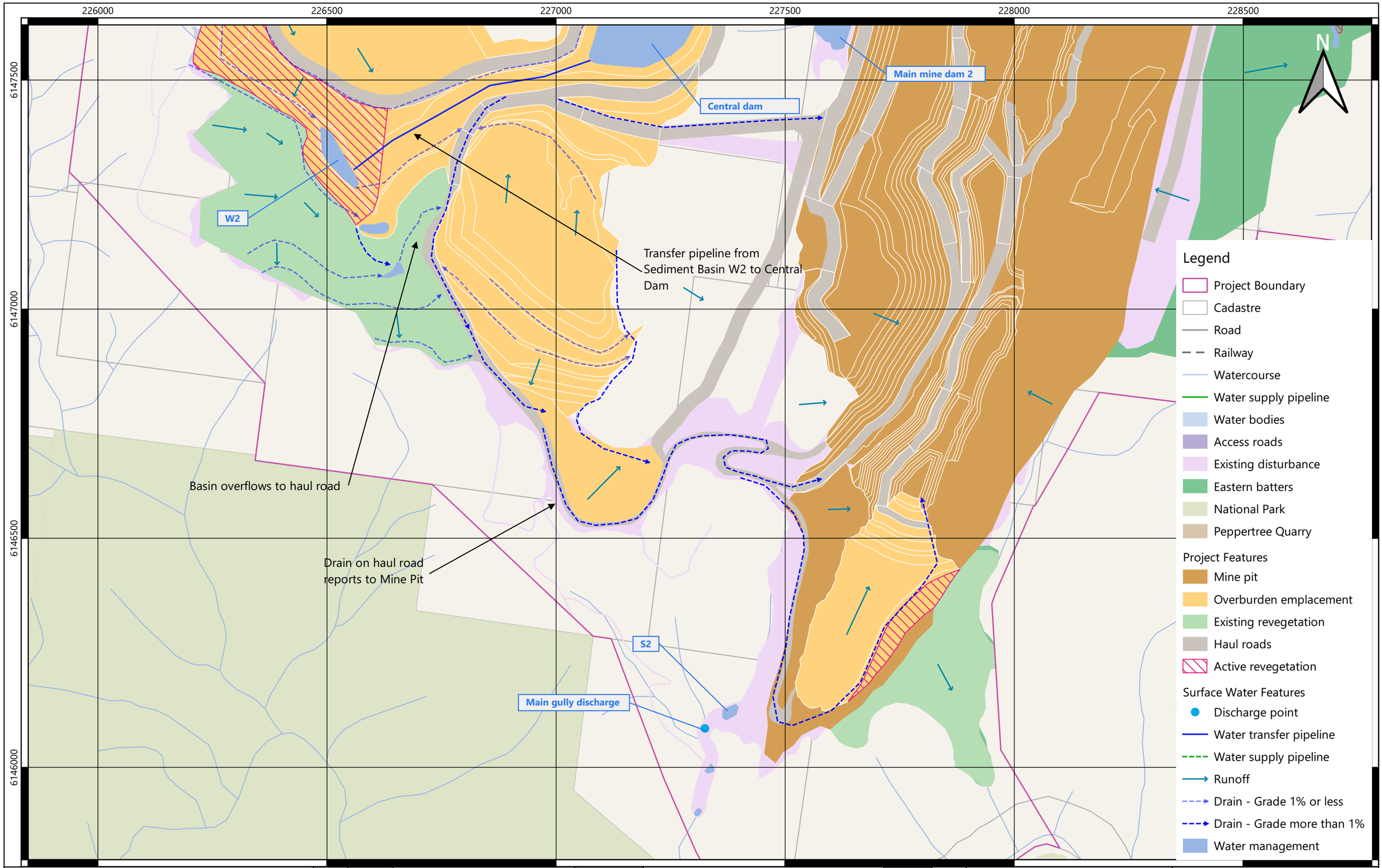
CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Western Overburden Emplacement
Stage 1

DRAWING NO.
MSLM-WMP-ESCP-0009

REV.
C



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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:7500

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

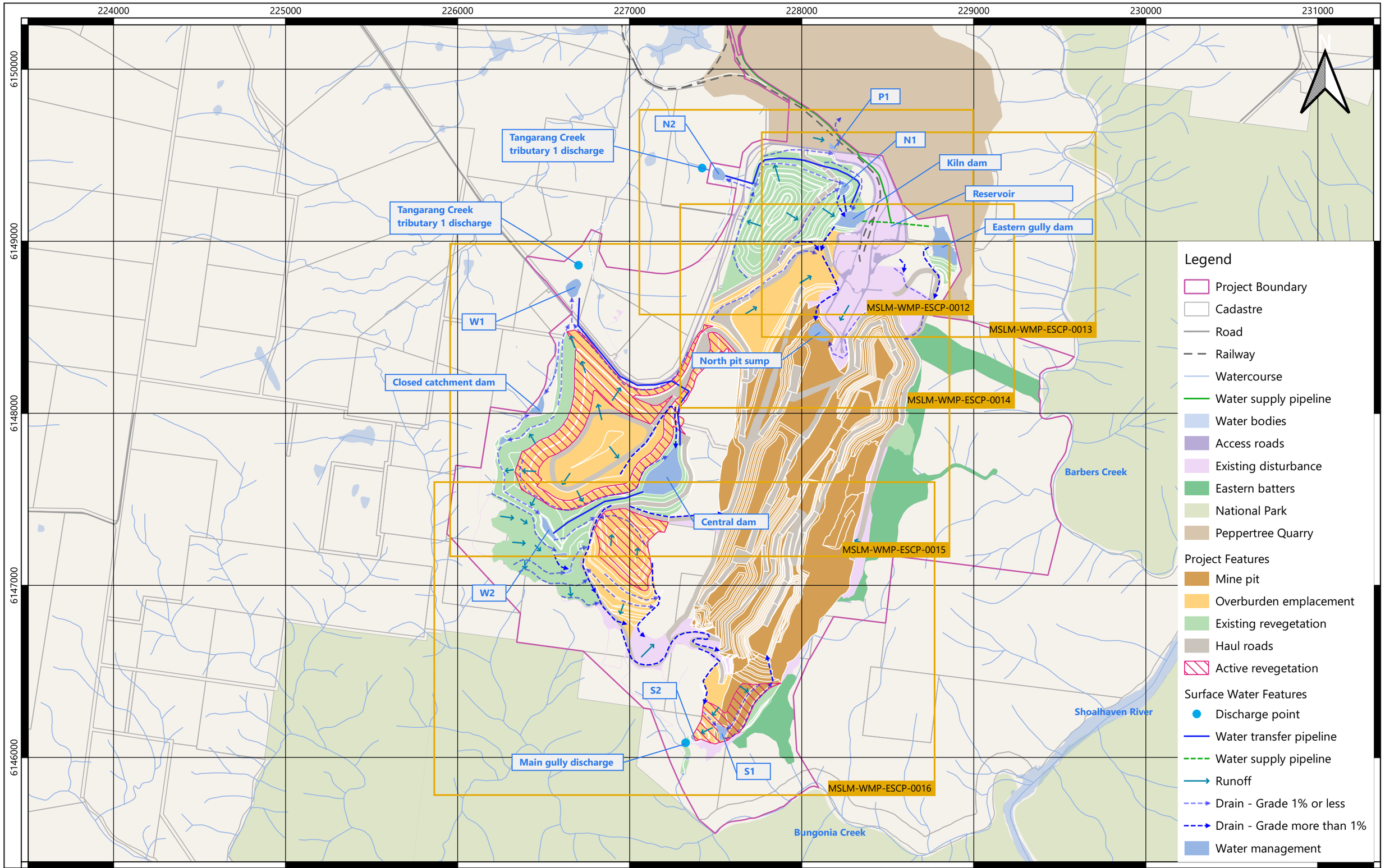
CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Southern Overburden Emplacement
Stage 1

DRAWING NO.
MSLM-WMP-ESCP-0010

REV.
C



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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 200 400 600 800 1,000 m

SCALE 1:20000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

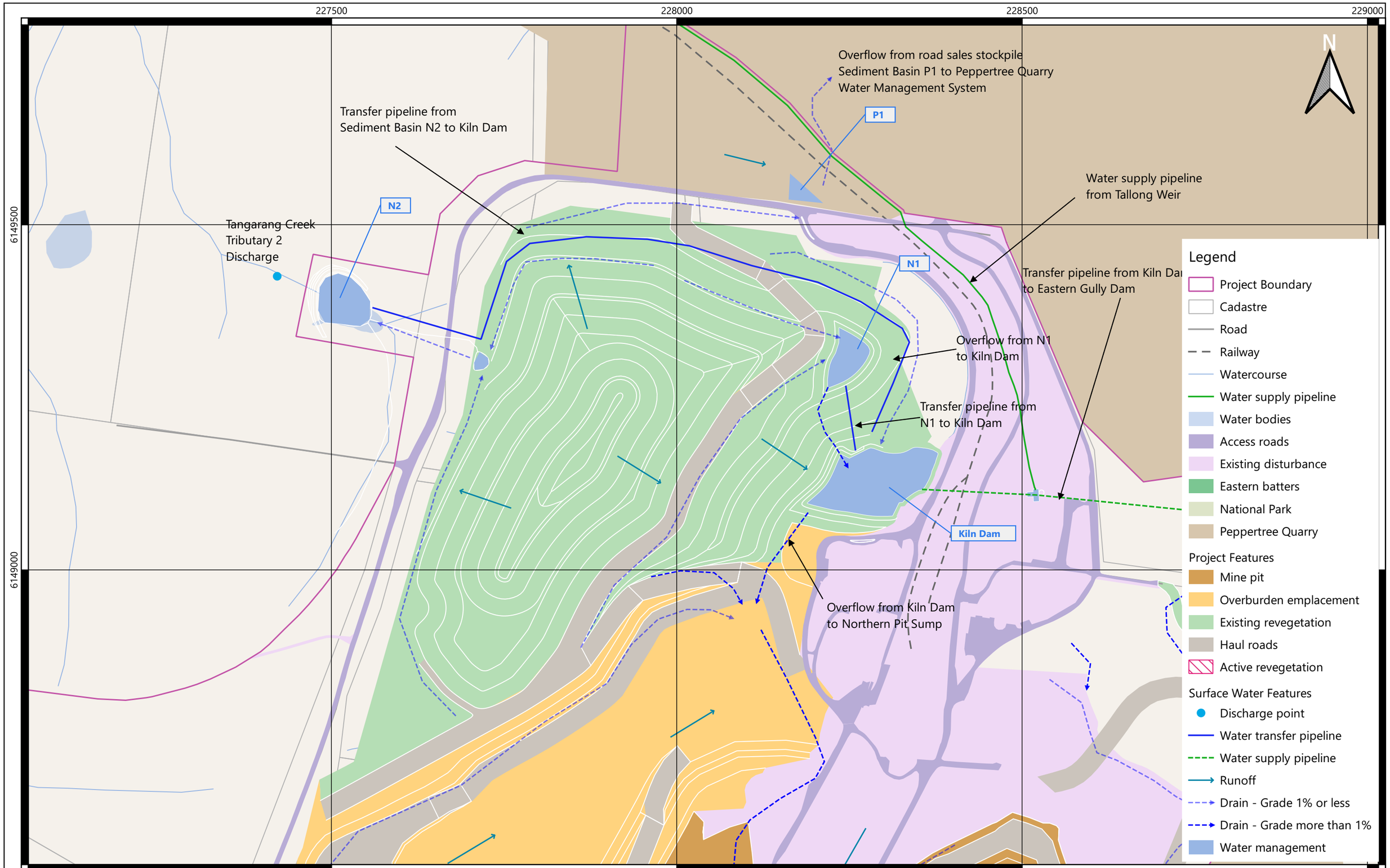
CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Overview
Stage 2

DRAWING NO.
MSLM-WMP-ESCP-0011

REV.
C



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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Incorporate client comments	MB

0 50 100 150 200 250 m

SCALE 1:5000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Northern Overburden Emplacement
Stage 2

DRAWING NO.
MSLM-WMP-ESCP-0012

REV.
C

228000 228500 229000 229500

6149500 6149000 6148500

N

P1

N2

Kiln dam

Eastern gully dam

North pit sump

Transfer pipeline from Kiln dam to Eastern gully dam

Overflow from Eastern gully dam to Mine Pit

Legend

- Project Boundary
- Cadastre
- Road
- Railway
- Watercourse
- Water supply pipeline
- Water bodies
- Access roads
- Existing disturbance
- Eastern batters
- National Park
- Peppertree Quarry

Project Features

- Mine pit
- Overburden emplacement
- Existing revegetation
- Haul roads
- Active revegetation

Surface Water Features

- Discharge point
- Water transfer pipeline
- Water supply pipeline
- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water management

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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:5000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Eastern Gully Dam
Stage 2

DRAWING NO.
MSLM-WMP-ESCP-0013

REV.
C

227500 228000 228500 229000

6149000

6148500

N

Kiln dam

Eastern gully dam

Overflow from Kiln dam

North pit sump

North Pit Sump overflows
to Mine Pit

Legend

- Project Boundary
- Cadastre
- Road
- Railway
- Watercourse
- Water supply pipeline
- Water bodies
- Access roads
- Existing disturbance
- Eastern batters
- National Park
- Peppertree Quarry

Project Features

- Mine pit
- Overburden emplacement
- Existing revegetation
- Haul roads
- Active revegetation

Surface Water Features

- Discharge point
- Water transfer pipeline
- Water supply pipeline
- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water management

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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:5000

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

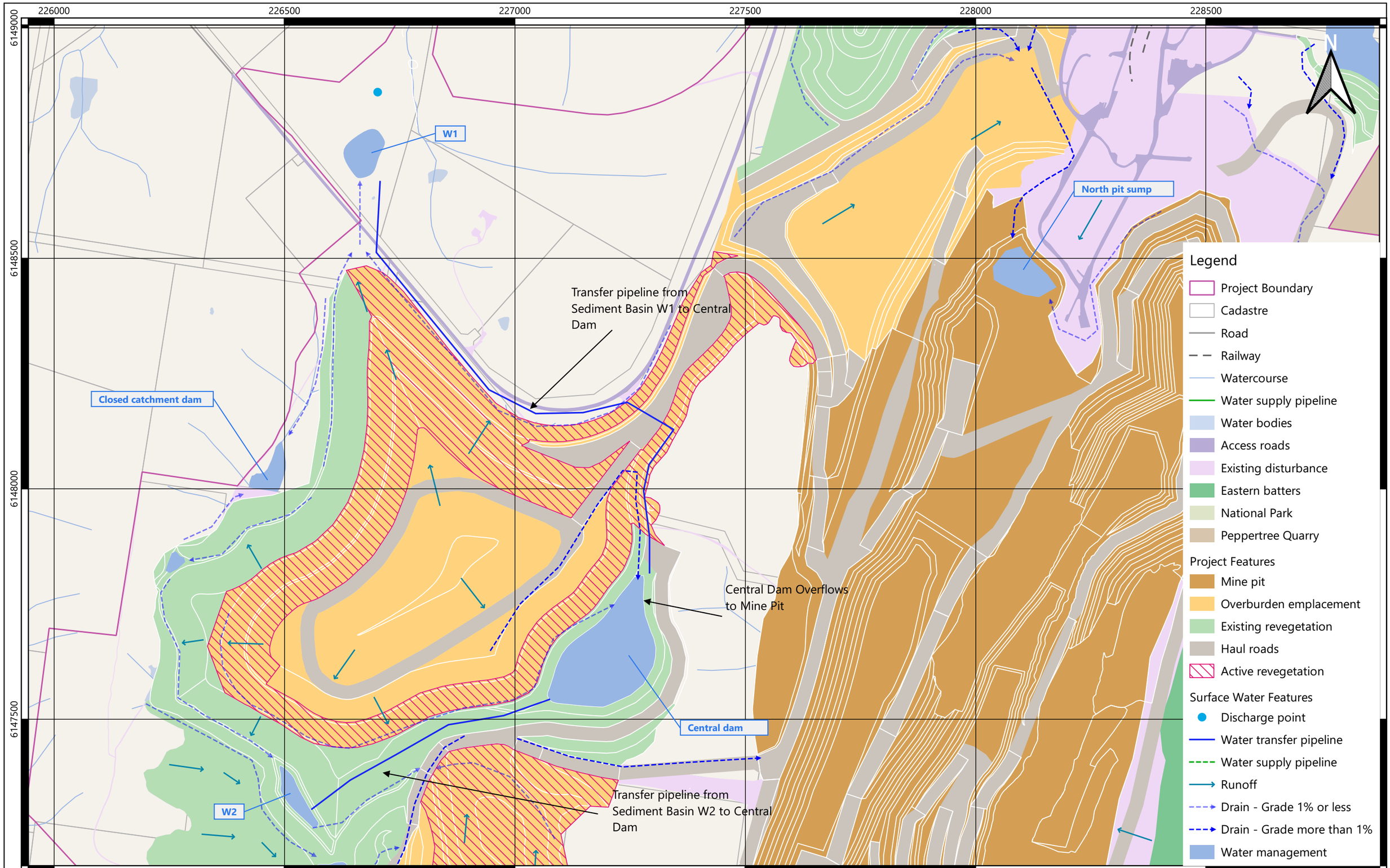
CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
North Pit Sump
Stage 2

DRAWING NO.
MSLM-WMP-ESCP-0014

REV.
C



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REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:7500

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
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DATUM	MGA94
ZONE	56

CLIENT
Boral

PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Western Overburden Emplacement
Stage 2

DRAWING NO.
MSLM-WMP-ESCP-0015

REV.
C

226000 226500 227000 227500 228000 228500

6147500 6147000 6146500 6146000

N

Central dam

W2

Transfer pipeline from Sediment Basin W2 to Central Dam

Basin overflows to haul road

Drain on haul road reports to Mine Pit

S2

Main gully discharge

S1

Legend

- Project Boundary
- Cadastre
- Road
- Railway
- Watercourse
- Water supply pipeline
- Water bodies
- Access roads
- Existing disturbance
- Eastern batters
- National Park
- Peppertree Quarry

Project Features

- Mine pit
- Overburden emplacement
- Existing revegetation
- Haul roads
- Active revegetation

Surface Water Features

- Discharge point
- Water transfer pipeline
- Water supply pipeline
- Runoff
- Drain - Grade 1% or less
- Drain - Grade more than 1%
- Water management

BORAL®

REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
C	Jun 2022	Updated drain classification	MB

0 50 100 150 200 250 m

SCALE 1:7500

A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	MGA94
ZONE	56

CLIENT
Boral

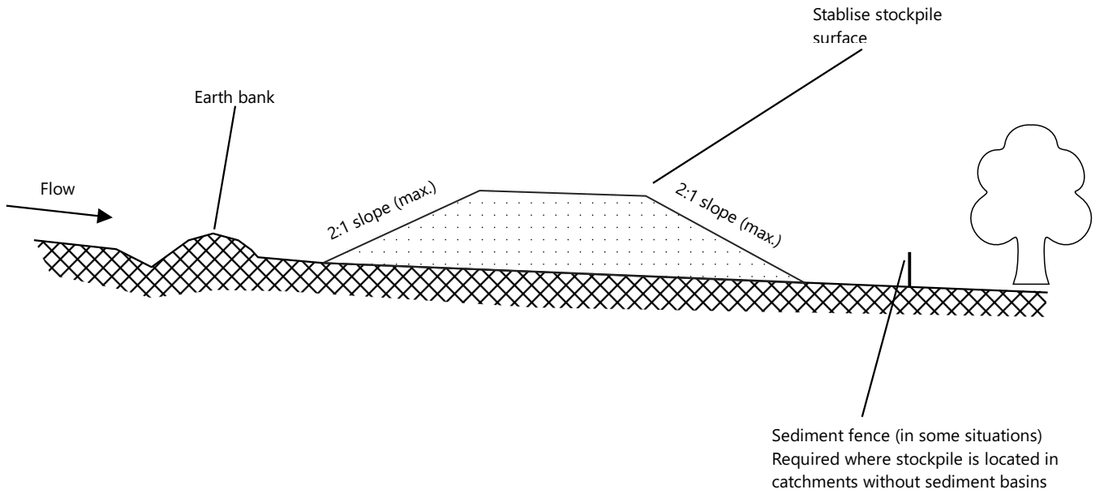
PROJECT
Marulan South Limestone Mine

TITLE
Erosion and Sediment Control Plan
Southern Overburden Emplacement
Stage 2

DRAWING NO.
MSLM-WMP-ESCP-0016

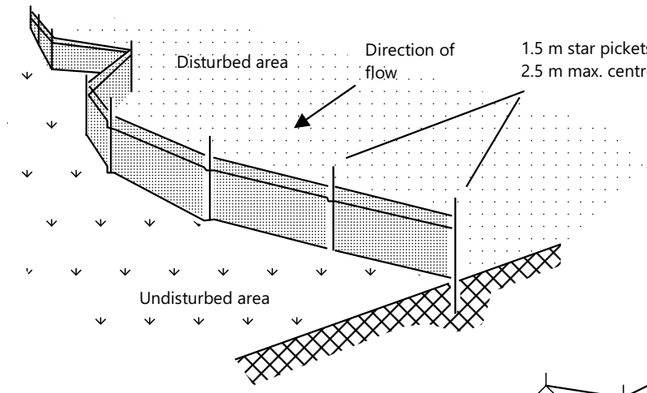
REV.
C

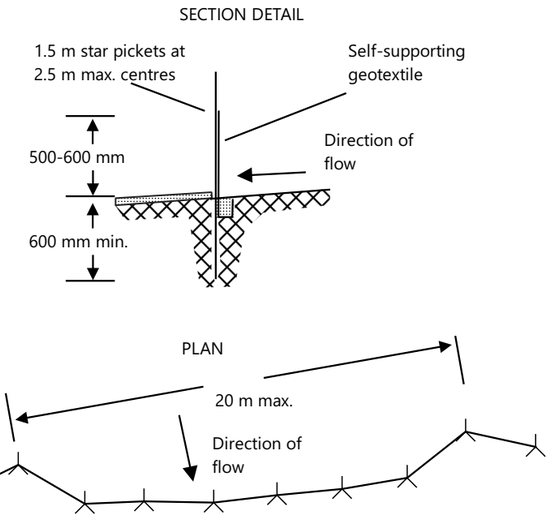
TOPSOIL STOCKPILE (SD 4-1)



Stockpile Construction and Management
(Recommended approach from EIS Appendix I - Appendix 5)
1. The proposed stockpile pad should be stripped, cleared of surface rocks and vegetation, and isolated from local drainage, with nearby weed infestations treated, if required.
2. As a general rule, a maximum stockpile depth of 3 m will be maintained.
3. Seed stockpiles as soon as possible with a sterile annual cover crop species (e.g. oats or millet). A rapid growing and healthy annual crop sward provides sufficient competition to minimize the emergence of undesirable weed species.
4. Topsoil will be block tipped. Under no circumstances will topsoil be tipped over a tip head or a second lift of block tip be used.
5. Stockpiles should be trimmed and graded to ensure they shed water, to avoid pooling or waterlogging.
6. Stockpile surfaces should be left coarsely textured to minimise erosion until vegetation is established, and avoid surface compaction and surface sealing.
7. Every effort will be made to avoid equipment trafficking over topsoil stockpiles. Stockpiles should be isolated from adjacent operations and accidental vehicle access (by berm, ditch, substantial fence, bollards, old electricity poles, etc), and clearly identified by a sign to reduce the likelihood of interference.
8. Following construction, stockpiles will be surveyed and recorded on mine plans. This information will be recorded on the topsoil stockpile register, along with other relevant data pertaining to each stockpile.
9. Prior to re-spreading stockpiled material onto reshaped overburden emplacements (particularly onto designated tree seeding areas), an assessment of weed infestation on stockpiles should be undertaken to determine if individual stockpiles require herbicide application and / or "scalping" of weed species prior to spreading.

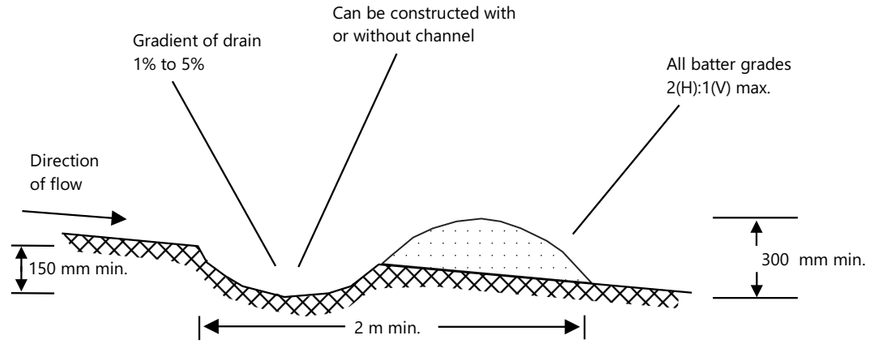
SEDIMENT FENCE (SD 6-8)





Sediment Fence Conctruction Notes:
1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 L/s in the design storm event (1 in 10-year).
2. Cut a 150 mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 m long star pickets into the ground at maximum 2.5 m intervals at the downstream edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing.
5. Join sections of fabric at a star picket with 150 mm overlap
6. Backfill the trench over the base of the fabric and compact it thoroughly

LOW FLOW EARTH BANK (SD 5-5)



Low Flow Earth Bank Conctruction Notes:
1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible – work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

Source:
Reproduced from Managing Urban Stormwater - Soils and Construction Standard Drawing SD 4-1, 6-8 & 5-5 (Landcom, 2004)

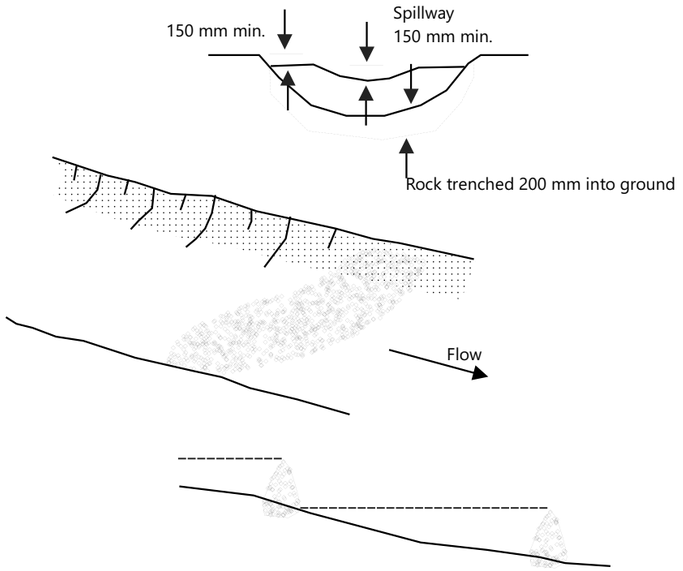
REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
A	Jun 2022	For review	MB

A3 NOT TO SCALE
THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	
ZONE	

CLIENT: Boral
PROJECT: Marulan South Limestone Mine
TITLE: Erosion and Sediment Control Plan Standard Drawings 1 of 5
DRAWING NO.: MSLM-WMP-ESCP-0017
REV.: A

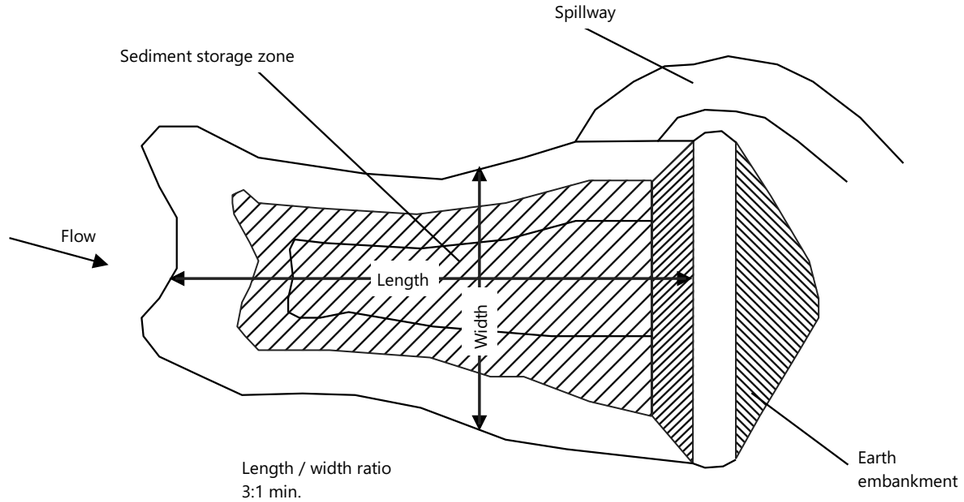
ROCK CHECK DAM (SD 5-4)

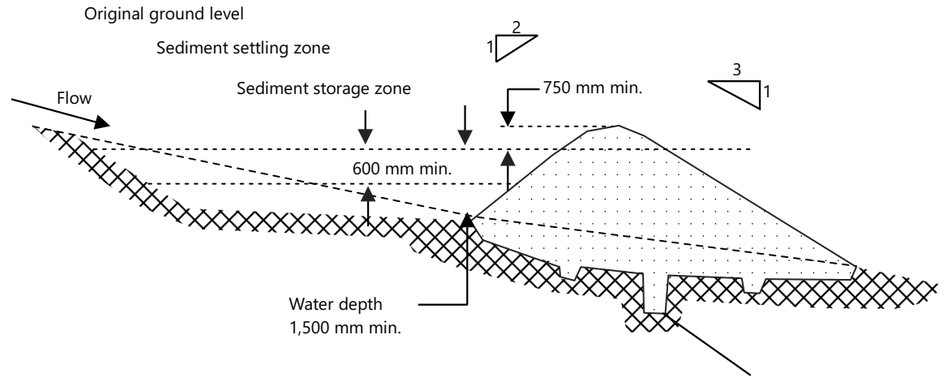


Conctruction notes
1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

Grade	Check Dam Spacing
2.5%	20 m
5%	10 m
10%	5 m

EARTH BASIN - WET (SD 6-4)





Conctruction notes
1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment to 95 per cent Standard Proctor Density.
4. Select fill that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content.

Source:
Reproduced from Managing Urban Stormwater - Soils and Construction Standard Drawing SD 5-4 & 6-4 (Landcom, 2004)

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[1.0]	[date 2]	[add description 2]	[initial 2]
A	Jun 2022	For review	MB

A3 NOT TO SCALE
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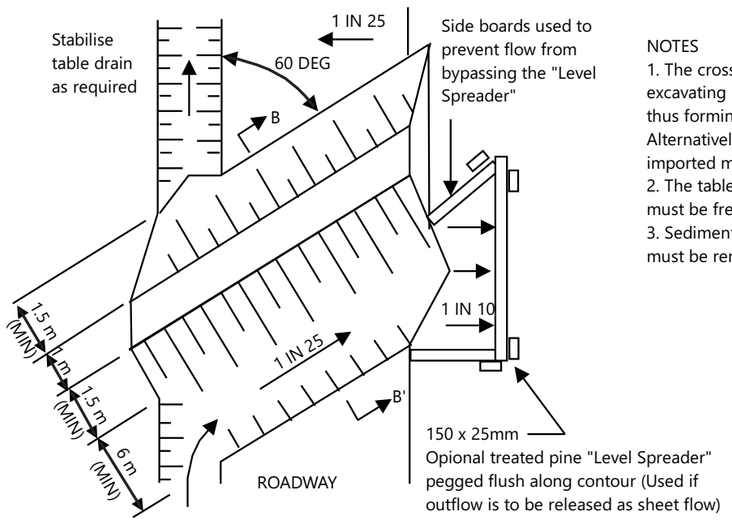
DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	
ZONE	

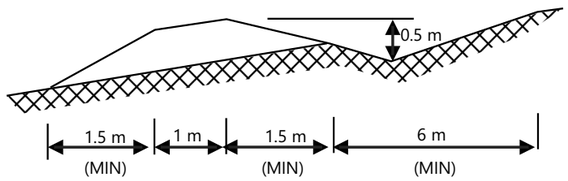
CLIENT: Boral
PROJECT: Marulan South Limestone Mine
TITLE: Erosion and Sediment Control Plan Standard Drawings 2 of 5
DRAWING NO.: MSLM-WMP-ESCP-0018
REV.: A

OUTFALL CROSS-BANK FOR LOW SPEED TRACKS (CR-01a)



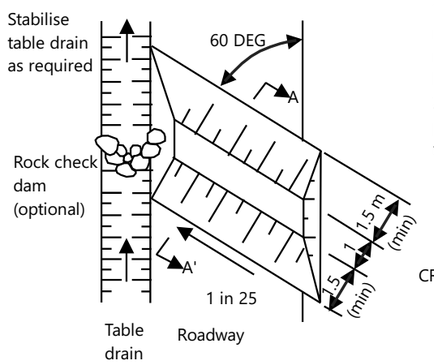
NOTES
1. The cross bank shown is formed by excavating road material upslope of the bank, thus forming an upslope cross drain. Alternatively, the bank could be formed of imported material.
2. The table drain upslope of the cross bank must be free draining.
3. Sediment depositied within the cross drain must be removed on a regular basis

CROSS BANK PROFILE (B-B')



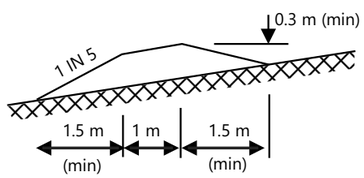
INFALL CROSS-BANK FOR LOW SPEED TRACKS (CR-01b)

INFALL CROSS BANK (PLAN VIEW)

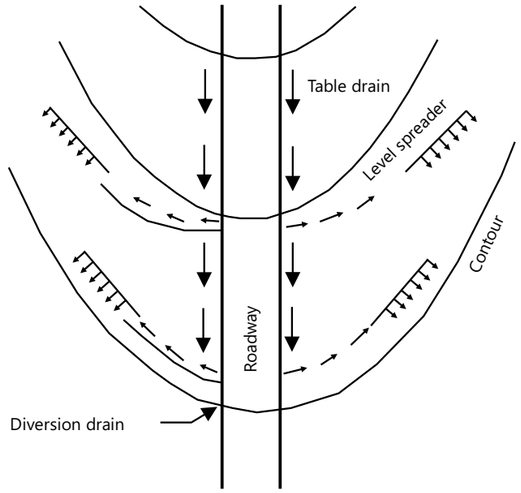


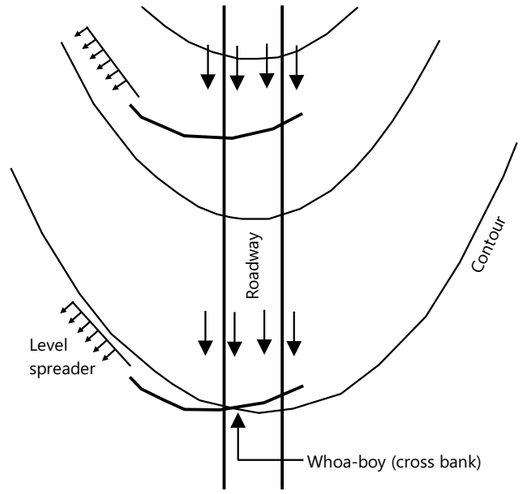
Notes
1. The cross bank shown is formed usign imported material and does not require and excavation into teh road upslope of the bank. Alternatively, the bank can be formed using insitu material.
2. Rock check dams or other stabilisation measures placed in the table drain must not cause ponding on the road.

CROSS BANK PROFILE (SECTION A-A')

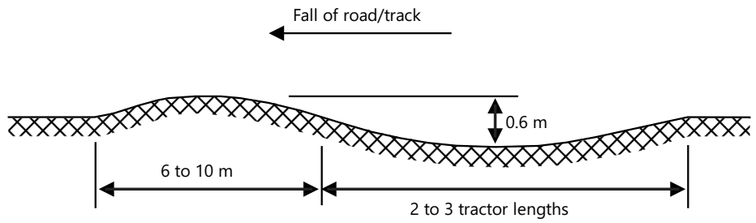


DRAINAGE OPTIONS FOR RIDGE TRACKS (CR-01c/d)





TYPICAL CROSS BANK PROFILE FOR LOW SPEED TRACKS (CR-01e)



General Notes
1. Drainage details are applicable to unsealed roads and tracks.
2. Design details vary with traffic volume and speeds.
3. Typical spacing of cross banks on unsealed roads is
   - 120 m for road grades less than 2%
   - 60 m for road grades of 2 to 4%
   - 30 m for road grades of 4 to 8%
   - 15 m for road grades greater than 8%

Source:
Reproduced from Best Practice Erosion and Sediment Control Book 6 - Standard Drawing CR-01 (IECA, 2008)

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A	Jun 2022	For review	MB

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A3 THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	
ZONE	

CLIENT: Boral

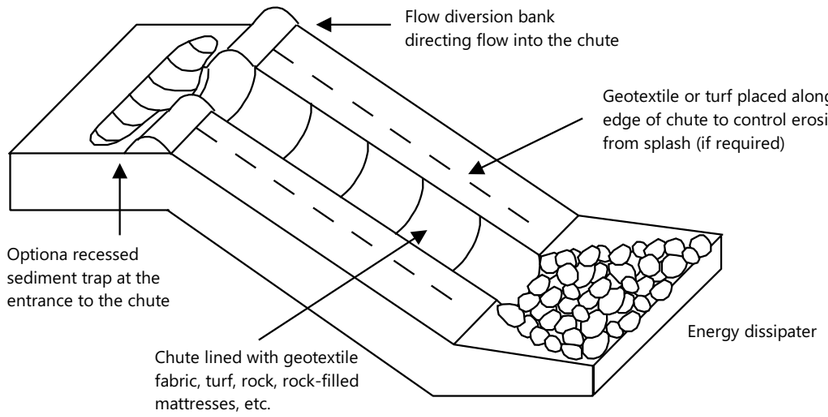
PROJECT: Marulan South Limestone Mine

TITLE: Erosion and Sediment Control Plan
Standard Drawings 3 of 5

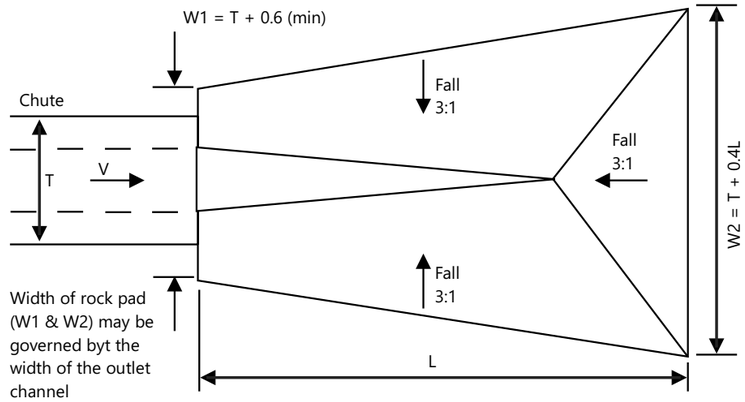
DRAWING NO.: MSLM-WMP-ESCP-0019

REV. A

TEMPORARY DRAINAGE CHUTE WITH ROCK PAD OUTLET STRUCTURE (CH-01a)

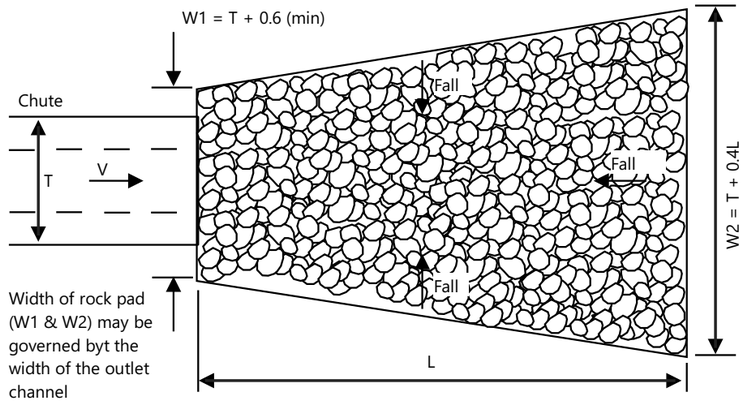


TYPICAL LAYOUT OF AN ENERGY DISSIPATER FOR A DRAINAGE CHUTE (CH-01b)

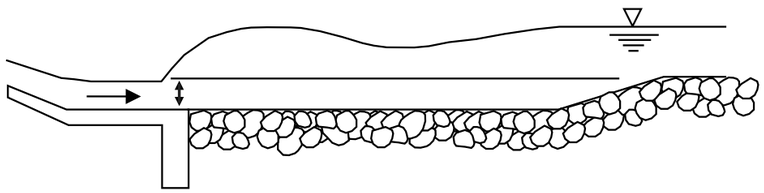


T = Maximum top width of flow at the base of chute

TYPICAL LAYOUT OF A ROCK PAD OULET STRUCTURE FOR A DRAINAGE CHUTE (CH-01c)



TYPICAL PROFILE OF A ROCK PAD OUTLET STRUCTURE FOR A DRAINAGE CHUTE (CH-01d)



Notes:
1. Drawings applicable to temporary drainage chutes, not basin spillways.
2. A rock pad outlet structure if just one option for the design of the outlet energy dissipater.

Source:
Reproduced from Best Practice Erosion and Sediment Control
Book 6 - Standard Drawing CH-01 (IECA, 2008)

BORAL®

REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
A	Jun 2022	For review	MB

A3 NOT TO SCALE
THE SCALE SHOWN IS THE ORIGINAL DRAWING SCALE

DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	
ZONE	

CLIENT: Boral

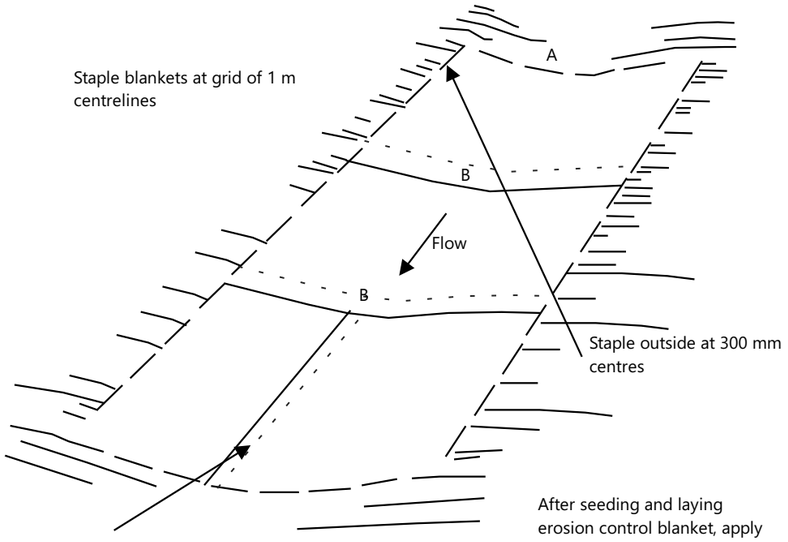
PROJECT: Marulan South Limestone Mine

TITLE: Erosion and Sediment Control Plan
Standard Drawings 4 of 5

DRAWING NO.: MSLM-WMP-ESCP-0020

REV.: A

RECP: CONCENTRATED FLOW (SD 5-7)



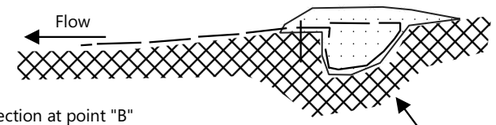
Staple blankets at grid of 1 m centrelines

After seeding and laying erosion control blanket, apply a soil binder in areas of high erosion hazard.

Overlap blankets 150 mm where two or more widths are required and staple joins at 300 mm centres.

Centreline section at point "A"

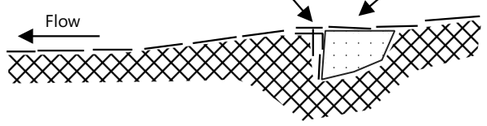
Bury the top of the blanket in a trenchg 300 mm or more in depth and staple at 150 mm centres



Centreline section at point "B"

Overlap - bury upper and lower blanket in "A". Overlap end of top blanket 300 mm and staple at 150 mm centres.

Fill the trench with soil and compact



Staples: 8 gauge (4mm) wire

Notes:
1. Remove and rocks, clods, sticks or grass from the surface before matting.
2. Ensure that topsoil is at least 75 mm deep

Source:
Reproduced from Managing Urban Stormwater - Soils and Construction
Standard Drawing SD 5-7

REV.	DATE	REVISION DETAILS	APPROVED
[1.0]	[date 2]	[add description 2]	[initial 2]
A	Jun 2022	For review	MB

A3 NOT TO SCALE
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DRAWN	MB
DESIGNER	MB
APROVED	MB
DATE	JUN 22
DATUM	
ZONE	

CLIENT: Boral

PROJECT: Marulan South Limestone Mine

TITLE: Erosion and Sediment Control Plan
Standard Drawings 5 of 5

DRAWING NO.: MSLM-WMP-ESCP-0021

REV.: A

APPENDIX E

Agency Consultation

Table E-2 Agency Consultation

Agency	Section	Consideration	Comment
Water NSW	3.4	WaterNSW would disagree with the statement that the small or slight declines in water quality in Barbers, Bungonia Creek and the Shoalhaven River upstream and downstream of the mine are due to broader land use. The decrease in the water quality in the River is similar to that in the creeks appears to indicate that the mine may be the cause of the decrease.	Noted
	5.1.3	The location of all on-site wastewater systems, including the effluent management areas, should be shown on a plan of the site.	Additional figure (Figure 5.2) included
	5.3.3	Dot point 1 • the main measure for sediment and erosion control is given as rock check dams at regular intervals. As the "Blue Book" states that intervals between rock check dams varies with respect to grade then a table of intervals between rock check dams at various grades should be included in the WMP • the various standard measures to be applied to drains with grades over 1% should be included as there will be grades over 1%. Those drains with grades over 1% should be identified on the maps	Additional details included for rock check dams in MSLM-WMP-ESCP-0015 & 16 Drains with grades greater than 1% indicated on drawings MSLM-WMP-ESCP-0001 to 16
		Dot point 5 - there is a reference to Blue Book SD 4-1. SD 4-1 should be included in the document, along with other applicable Standard Drawings.	Applicable standard drawings in MSLM-WMP-ESCP-0017 to 19
		Dot point 8 - Sediment basins "to be operated so the required "air space" (Settlement zone) is restored within five days of the end of a rainfall event. There is no information or figures given to the required air space (settlement zone). Also, this requirement is not included in the checklist.	Air space requirement added to Table 5.4 and 5.5. Required air space added to checklist
	5.3.4	Dot point 2 - Inspections for erosion to occur after a rainfall event greater than 50mm in 24 hours. This is a large event that would generate a lot of runoff. It is suggested that the inspections for erosion on newly constructed drains or recently cleared areas should be done after a rainfall event that generated runoff. This interval could be changed to large rain events as the system stabilises (ie no visible signs of erosion)	Additional dot point included in 5.3.4

Agency	Section	Consideration	Comment
		Access Roads - mitre drains and scour protection are given as measures. Examples or Standard Drawings should be included. For mitre drains and interval table with respect to grade should also be included	Standard drawings included in Appendix D
		Drainage network • Sediment fences - the Standard Drawing for sediment fences should be included • Some examples of more “robust drain liners” should be included • Examples of energy dissipation structures should be included	Sediment fence details shown in MSLM-WMP-ESCP-0017 Drain liner shown in MSLM-WMP-ESCP-0021 Energy dissipater shown in MSLM-WMP-ESCP-0020
		Overburden Emplacement Measures - Examples of additional measures should be included	Standard drawings contain details of examples
		Temporary Stockpiles - refer to SD 4-1	Reference to standard drawing (MSLM-WMP-ESCP-0017) included
		Overburden stripping areas - examples of additional measures should be included	Standard drawings show details of examples, with reference to the drawings included in the introduction.
	5.3.5	Table 5.5 should include required Sediment Storage volume and Settling zone. The individual dam designs should include RLs for those zones	Air space requirement included in Table 5.5
	6.2.1	Section states that monitoring may cease in Barbers Creek and Shoalhaven River once NOE and WOE rehabilitation has been established. Monitoring should cease when the monitoring shows that those areas have stabilised	Adjusted sentence to include additional requirement.
	Table 6.2, 6.5 and 6.6	a reference to a map showing these locations should be included	Monitoring sites (Table 6.2) is shown in Figure 3.1. Dam and pipeline locations are shown in MSLM-WMP-ESCP-0005
	7.2	specific time frames for actions should be given rather than “at earliest opportunity”	Changed to “as soon as practical”. Specifying specific timeframes is problematic as adaptive management measures will depend on the issue identified.

Agency	Section	Consideration	Comment
	9.1	specific time frames for actions should be given	Incident reporting is described as immediately
	Appendix B	Contains requirements for water level, settlement capacity, sediment storage capacity but no information on what these items actually are. Specific design information for each sediment dam should be included	Details included for dams with design requirements
		Drains checklist should include the parameters that need to be inspected or checked (eg scouring, failure, sediment accumulation)	Examples included in checklist
		No checklist for Groundwater Performance measures	Not considered appropriate for groundwater measures
EPA	Discharges to waters	According to Section 4.2.2 of the WMP, an EPL license variation application is proposed for a licensed discharge point for the management of surface water. Currently the EPL does not have a licensed surface water discharge point. The Protection of the Environment Operations Act 1997 (the Act) provides the statutory framework for managing water pollution in NSW. Considering the environmental values of water and the practical measures that can be taken to restore or maintain those values is a consideration that is specific to water pollution and applies when the EPA exercises its licencing functions. Under Section 45 of the Act, the EPA must consider the pollution caused or likely to be caused by a licensed discharge or a unlicensed discharge, and the likely impact of that pollutant on the environment. Further, the EPA must consider the practical measures that could be taken to prevent, control or abate that pollution, and, protect the environment from harm as a result of that pollution. In relation to licensed discharge points to waters, the EPA must also consider the environmental values of the receiving environment, and the practical measures that could be taken to restore or maintain those values. In this regard, the EPA advises that should the licensee wish to pursue seeking approval for a licenced discharge point, a water quality objective (WQO) assessment must be undertaken and submitted to the EPA which assesses the potential impact the discharge may have on the environment, an assessment of all reasonable and feasible options to prevent a discharge to the environment, and an assessment of any practical mitigation measures	The water management system includes sediment basins that have been designed in accordance with the “Blue Book”. The sediment basins are expected to overflow when rainfall exceeds the design event. Discharge is expected to occur when rainfall exceeds the design event or to re-establish the required air space (settlement zone) when there is insufficient space in the mine water dams to allow transfer. Assessment of the potential impacts to water quality were assessed in the EIS (see below) including consideration of these releases to water.

Agency	Section	Consideration	Comment
		to achieve an appropriate licenced discharge quality. Please contact the EPA should you require further advice on a WQO assessment. The EPA further advises that that the design, installation, operation and maintenance of pollution controls (such as erosion and sediment controls) on the licensed premises must be undertaken to protect waters and comply with section 120 of the Act (prohibits pollution of waters).	
	Surface Water Quality Guidelines:	Section 4.3 of the WMP advises that water quality criteria as outlined in Table 4.3 has been derived from the Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC). Under ANZECC Table 3.3.2-3.3.3 Upland Streams are classified as those at >150m altitude, while alpine streams are those at altitudes >1500m. A desktop altitude assessment of the project boundary (as derived in Figure No 6.4 of the WMP) identifies that the receiving waters exceed >150m but are <1500m in altitude. As a result, the EPA advises that Upland Streams water quality criteria be applied, including consideration of these revised values against the trigger values in Table 4.3 of the WMP. The EPA advises that the draft WMP must reconsider its proposed pollution controls to ensure that any discharges from the premises protects upland streams water quality criteria. The licensee is also advised to ensure pollution controls are designed to protect the higher environmental values that should be afforded to discharge receiving environments such as Bungonia National Park.	Water quality assessment was completed in the Environmental Impact Statement in accordance with ANZECC Water Quality Guidelines. Water quality impacts are summarised in Section 8.2.2. Site specific trigger values were developed for the project following ANZECC Water Quality Guidelines. Values are presented in Table 8.6. Further details are presented in Surface Water Assessment (Appendix G of the EIS). Section 5 summarises baseline conditions (with data provided in Annexure C). Potential impacts to water quality are described in Section 9.5. Proposed Water Quality Trigger Vales for Bungonia and Barbers Creek (Table 11.3) were developed in accordance with the ANZECC Water Quality Guidelines.
	TARP	Condition 7.1 of the WMP outlines that when assessing a difference in water quality parameters between upstream and downstream locations of the mine, an investigation into potential impacts from the mine will only occur after three (3) consecutive months of water quality results showing exceedances of trigger values. The EPA advises that in any occurrence, where evidence arises indicating potential pollution impacts from a licensed	Update TARP to include reference to immediate reporting of pollution potential

Agency	Section	Consideration	Comment
		premise, this may be a reportable incident under the EPL and may require immediate investigation to determine if a pollution incident has occurred. The EPA advises the licensee to ensure that any TARP fully considers the requirements of the Act in terms meeting their obligations under section 120, and that the TARP is robust enough to quickly identify emerging issues to prevent pollution of waters.	
	Flocculants	Section 5 of the WMP states that where a potential discharge is required, a flocculant is to be added. The EPA advises that the licensee must ensure that the use of a flocculant must be fully considered to ensure that it does not result in a breach of the Act and cause environmental harm. Should licensee wish to use a flocculant, you will be required to undertake an assessment. Attachment A to this letter outlines details of the assessment including discharge characterisation and ecotoxicological testing.	Include additional Appendix F
DPE Water	1.0 Groundwater Hydraulic Parameterisation	1.1 Recommendation The formation hydraulic parameter characterisation of Mt Frome Middle Limestone is undertaken immediately following the installation of the proposed monitoring bore MW8 (replacement to MW2). Explanation This information is necessary for the update of the model within 3 years of approval and is consistent with a recommendation included in the Department's response to the Supplementary Response to Submissions document (July 2020).	Refer to Table 2.2 in Appendix A
	2.0 Groundwater Monitoring	2.1 Recommendation The proposed quarterly inspections of stream and vegetation health (GWMP Section 6.4.3 and WMP Section 6.5) should include a survey and description of the status of springs/seepages. Any changes observed from quarterly inspections must be reported in the Annual Review. Explanation Springs and seepages are potentially present adjacent to the Mine, particularly in the vicinity of Bungonia and Barbers Creeks. Table 4 in the Development consent requires the proponent to demonstrate negligible	Refer to Table 2.2 in Appendix A

Agency	Section	Consideration	Comment
		impacts (beyond those previously predicted by modelling) to groundwater springs as a result of the development.	
		2.2 Recommendation Monitoring bore MW4D be either repaired or replaced so that pH and Electrical Conductivity measurements can continue to be collected. Explanation Continued groundwater quality monitoring at the site of MW4D is critical to enable the results to be checked against the performance measures and control thresholds as detailed by the Trigger Action Response Plan (TARP).	Refer to Table 2.2 in Appendix A
		2.3 Recommendation The Groundwater Management Plan (GWMP) include a commitment to the monitoring of seepage from overburden emplacements. Explanation The request for monitoring of seepage from overburden emplacements is to provide an early indicator of potential risk to the groundwater source and is consistent with a recommendation included in the Department's response to the Supplementary Response to Submissions document (July 2020).	Refer to Table 2.2 in Appendix A
	3.0 Groundwater Trigger Action Response Plan	3.1 Recommendation The GWMP include a commitment to immediate implementation of the TARP (outlined in Section 9.1) if any of the performance indicators have been exceeded. Explanation Section 8.1 of the GWMP does not clearly state what the proposed duration of exceedance is to be for the performance measures listed in Table 8.1. The performance measures referred to in Table 8.1 are equivalent to the Aquifer Interference Policy guidelines, therefore it is required that the GWMP commit to immediate initiation of the TARP (outlined in Section 9.1) if any of the performance indicators have been exceeded.	Refer to Table 2.2 in Appendix A
		3.2 Recommendation Section 13.1 of the GWMP include a definition of unauthorised groundwater impacts as any breach of GWMP performance measures or control thresholds.	Refer to Table 2.2 in Appendix A

Agency	Section	Consideration	Comment
		Explanation Section 13.1 does not clearly define what the term 'unauthorised groundwater impacts' means. In this context unauthorised groundwater impacts is understood to mean any breach of performance measures or control thresholds set by the GWMP as defined by the conditions of consent.	
	4.0 Geomorphic Condition Monitoring	4.1 Recommendation A suite of channel form indicators for geomorphic monitoring of channel types and condition should be applied. This should be consistent with the NSW River Styles dataset for Marulan Creek, Barbers Creek and Bungonia Creek. This must include details of riparian vegetation condition and channel form and condition in accordance with the River Styles framework www.riverstyles.com Explanation The geomorphic monitoring requirements is to address the requirements of Consent Conditions B43 and B45(iii) that relate to reporting on change in channel form and riparian health.	Additional detail provided in Section 6.5.1, with geomorphic indicators consistent with the River Styles Framework relevant to the River Style included in Table 6.7
		4.2 Recommendation The monitoring indicators for Marulan Creek should address the points set out in Consent Condition B43 (Table 4) and B45(iv). Prior to construction of Marulan Creek Dam, any alteration of channel form involving abnormal sediment transport downstream along Marulan Creek must be noted and any necessary response actions presented. Explanation Whilst it is understood Marulan Creek dam is not included within Stages 1 and 2 which are being addressed by this WMP, it is recommended baseline data collection be initiated immediately to understand and monitor channel conditions to aid in the development of future management requirements. Baseline data collection of watercourse stability and riparian health is also a requirement of Consent Condition B45(iii).	Baseline monitoring of stream and riparian health, including additional detail regarding geomorphology is described in section 6.5.1.
	5.0 Geomorphic Condition Trigger Action Response Plan	5.1 Recommendation Remediation actions for geomorphic condition need to be specified in a response action in the TARP. This should address specific impact	Specific TARP to address geomorphic condition added in Section 7.1, in

Agency	Section	Consideration	Comment
		mechanisms, such as bed gravel sediment clogging, and response actions to alleviate and prevent such impacts occurring. Photographic records need to be enhanced with monitoring of channel form indicators against performance criteria with trigger levels to be of value in identifying and responding to change. Explanation The Trigger Action Response Plan has not included the structural features of watercourses to aid in addressing the requirements of Consent Conditions B43 (Table 4) and B45(iii) to manage impacts on channel stability.	addition to details that are now included in Section 6.5.1
		5.2 Recommendation The remediation and rehabilitation strategy for areas of Marulan Creek both above and below the dam up to the entry to the Barber's Creek gorge, be prepared in consideration of the guideline, "A Rehabilitation Manual for Australian Streams (Land and Water Resources Research and Development Corporation, 2000). This strategy needs to be prepared by a suitably qualified and experienced fluvial geomorphologist.	Included in the rehabilitation strategy

From: Jim Caddey <James.Caddey@waternsw.com.au>
Sent: Tuesday, 31 May 2022 9:25 AM
To: Neville Hattingh <neville@elementenvironment.com.au>
Cc: PR163 <PR163@elementenvironment.com.au>
Subject: RE: Marulan South Limestone Mine SSD 7009 (RMS ref: STH13/00010) - Water Management Plan for comment

Neville

Apologies for the delay. Thank you for the opportunity to review the Marulan South Limestone Mine Water Management Plan (revision 0 dated 11 April 2022) (WMP). Water NSW comments follow:

- S3.4 – WaterNSW would disagree with the statement that the small or slight declines in water quality in Barbers, Bungonia Creek and the Shoalhaven River upstream and downstream of the mine are due to broader land use. The decrease in the water quality in the River is similar to that in the creeks appears to indicate that the mine may be the cause of the decrease.
- S5.1.3 - The location of all on-site wastewater systems, including the effluent management areas, should be shown on a plan of the site.
- S5.3.3 –
    - Dot point 1
        - the main measure for sediment and erosion control is given as rock check dams at regular intervals. As the "Blue Book" states that intervals between rock check dams varies with respect to grade then a table of intervals between rock check dams at various grades should be included in the WMP
        - the various standard measures to be applied to drains with grades over 1% should be included as there will be grades over 1%. Those drains with grades over 1% should be identified on the maps
    - Dot point 5 - there is a reference to Blue Book SD 4-1. SD 4-1 should be included in the document, along with other applicable Standard Drawings
    - Dot point 8 - Sediment basins "to be operated so the required "air space" (Settlement zone) is restored within five days of the end of a rainfall event. There is no information or figures given to the required air space (settlement zone). Also, this requirement is not included in the checklist
- S5.3.4 –
    - 2nd dot point - inspections for erosion to occur after a rainfall event greater than 50mm in 24 hours. This is a large event that would generate a lot of runoff. It is suggested that the inspections for erosion on newly constructed drains or recently cleared areas should be done after a rainfall event that generated runoff. This interval could be changed to large rain events as the system stabilises (ie no visible signs of erosion)
    - Access Roads – mitre drains and scour protection are given as measures. Examples or Standard Drawings should be included. For mitre drains and interval table with respect to grade should also be included
    - Drainage network –
        - Sediment fences - the Standard Drawing for sediment fences should be included
        - Some examples of more "robust drain liners" should be included
        - Examples of energy dissipation structures should be included
    - Sediment Basins –

        - Include the information for the required capacity of the sediment basins – both settling zone and sediment storage zones
        - Reference to what is appropriate stabilisation required
        - Discharge – information as to the required clarity for discharge is required (eg Table 4.3 – turbidity). Also, information of how to determine turbidity in the field should be included
    - Overburden Emplacement Measures – examples of additional measures should be included
    - Temporary Stockpiles – refer to SD 4-1
    - Overburden stripping areas – examples of additional measures should be included
- S5.3.5 – Table 5.5 should include required Sediment Storage volume and Settling zone. The individual dam designs should include RLs for those zones
- S6.2.1 – states that monitoring may cease in Barbers Creek and Shoalhaven River once NOE and WOE rehabilitation has been established. Monitoring should cease when the monitoring shows that those areas have stabilised
- Table 6.2, 6.5 and 6.6 – a reference to a map showing these locations should be included
- S7.2 – specific time frames for actions should be given rather that "at earliest opportunity"

Groundwater Management Plan

- S9.1 – specific time frames for actions should be given

Appendix B _ ESC checklist

- Contains requirements for water level, settlement capacity, sediment storage capacity but no information on what these items actually are. Specific design information for each sediment dam should be included
- Drains checklist should include the parameters that need to be inspected or checked (eg scouring, failure, sediment accumulation)
- No checklist for Groundwater Performance measures

If you have any questions, please contact me

Regards

Jim Caddey

For noting: *I am currently working remotely.*
Please reach me via email or 0408 605 316

Catchment Assessments Officer (Goulburn)
1st Floor Goulburn State Office Block
159 Auburn Street Goulburn
Phone: 02 4824 3401

Department of Planning and Environment

Our ref: OUT22/4934

Neville Hattingh

Email: neville@elementenvironment.com.au

24 May 2022

Subject: Marulan South Limestone Mine Water Management Plan

Dear Neville

I refer to your email on 22 April 2022 providing the Department of Planning and Environment (DPE) Water an opportunity to comment on the above matter.

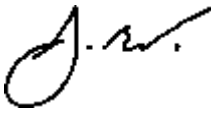
The Department of Planning and Environment- Water (DPE Water) has reviewed the report and has the following key comments.

- Additional groundwater monitoring and groundwater model parameterisation be included, and further clarity be provided of groundwater trigger exceedances.
- Additional geomorphic condition monitoring be included and reflected in the Trigger Action Response Plan.
- It is noted Stages 1 and 2 addressed in this WMP include a number of additions and modifications to water storages. It is recommended the Licensing and Approvals unit of DPE Water be consulted directly via the major projects portal to ensure the works are consistent with the regulatory framework.

Please see attachment A for further detail on the above comments.

Should you have any further queries in relation to this submission please do not hesitate to contact DPE Water Assessments at water.assessments@dpie.nsw.gov.au, or Tim Baker, Water Assessments at Tim.Baker@dpie.nsw.gov.au or 0428162097

Yours sincerely,



Luke McIver
Acting Manager, Assessments, Knowledge Division
Department of Planning and Environment: Water

Attachment A

Detailed advice regarding the Marulan South Limestone Mine Water Management Plan

1.0 Groundwater Hydraulic Parameterisation

1.1 Recommendation

The formation hydraulic parameter characterisation of Mt Frome Middle Limestone is undertaken immediately following the installation of the proposed monitoring bore MW8 (replacement to MW2).

Explanation

This information is necessary for the update of the model within 3 years of approval and is consistent with a recommendation included in the Department's response to the Supplementary Response to Submissions document (July 2020).

2.0 Groundwater Monitoring

2.1 Recommendation

The proposed quarterly inspections of stream and vegetation health (GWMP Section 6.4.3 and WMP Section 6.5) should include a survey and description of the status of springs/seepages. Any changes observed from quarterly inspections must be reported in the Annual Review.

Explanation

Springs and seepages are potentially present adjacent to the Mine, particularly in the vicinity of Bungonia and Barbers Creeks. Table 4 in the Development consent requires the proponent to demonstrate negligible impacts (beyond those previously predicted by modelling) to groundwater springs as a result of the development.

2.2 Recommendation

Monitoring bore MW4D be either repaired or replaced so that pH and Electrical Conductivity measurements can continue to be collected.

Explanation

Continued groundwater quality monitoring at the site of MW4D is critical to enable the results to be checked against the performance measures and control thresholds as detailed by the Trigger Action Response Plan (TARP).

2.3 Recommendation

The Groundwater Management Plan (GWMP) include a commitment to the monitoring of seepage from overburden emplacements.

Explanation

The request for monitoring of seepage from overburden emplacements is to provide an early indicator of potential risk to the groundwater source and is consistent with a recommendation included in the Department's response to the Supplementary Response to Submissions document (July 2020).

3.0 Groundwater Trigger Action Response Plan

3.1 Recommendation

The GWMP include a commitment to immediate implementation of the TARP (outlined in Section 9.1) if any of the performance indicators have been exceeded.

Explanation

Section 8.1 of the GWMP does not clearly state what the proposed duration of exceedance is to be for the performance measures listed in Table 8.1. The performance measures referred to in Table 8.1 are equivalent to the Aquifer Interference Policy guidelines, therefore it is required that the GWMP commit to immediate initiation of the TARP (outlined in Section 9.1) if any of the performance indicators have been exceeded.

3.2 Recommendation

Section 13.1 of the GWMP include a definition of unauthorised groundwater impacts as any breach of GWMP performance measures or control thresholds.

Explanation

Section 13.1 does not clearly define what the term ‘unauthorised groundwater impacts’ means. In this context unauthorised groundwater impacts is understood to mean any breach of performance measures or control thresholds set by the GWMP as defined by the conditions of consent.

4.0 Geomorphic Condition Monitoring

4.1 Recommendation

A suite of channel form indicators for geomorphic monitoring of channel types and condition should be applied. This should be consistent with the NSW River Styles dataset for Marulan Creek, Barbers Creek and Bungonia Creek. This must include details of riparian vegetation condition and channel form and condition in accordance with the River Styles framework www.riverstyles.com

Explanation

The geomorphic monitoring requirements is to address the requirements of Consent Conditions B43 and B45(iii) that relate to reporting on change in channel form and riparian health.

4.2 Recommendation

The monitoring indicators for Marulan Creek should address the points set out in Consent Condition B43 (Table 4) and B45(iv). Prior to construction of Marulan Creek Dam, any alteration of channel form involving abnormal sediment transport downstream along Marulan Creek must be noted and any necessary response actions presented.

Explanation

Whilst it is understood Marulan Creek dam is not included within Stages 1 and 2 which are being addressed by this WMP, it is recommended baseline data collection be initiated immediately to understand and monitor channel conditions to aid in the development of future management requirements. Baseline data collection of watercourse stability and riparian health is also a requirement of Consent Condition B45(iii).

5.0 Geomorphic Condition Trigger Action Response Plan

5.1 Recommendation

Remediation actions for geomorphic condition need to be specified in a response action in the TARP. This should address specific impact mechanisms, such as bed gravel sediment clogging, and response actions to alleviate and prevent such impacts occurring. Photographic records need to be enhanced with monitoring of channel form indicators against performance criteria with trigger levels to be of value in identifying and responding to change.

Explanation

The Trigger Action Response Plan has not included the structural features of watercourses to aid in addressing the requirements of Consent Conditions B43 (Table 4) and B45(iii) to manage impacts on channel stability.

5.2 Recommendation

The remediation and rehabilitation strategy for areas of Marulan Creek both above and below the dam up to the entry to the Barber's Creek gorge, be prepared in consideration of the guideline, "*A Rehabilitation Manual for Australian Streams* (Land and Water Resources Research and Development Corporation, 2000). This strategy needs to be prepared by a suitably qualified and experienced fluvial geomorphologist.

End Attachment A

From: Carla Ganassin <carla.ganassin@dpi.nsw.gov.au>
Sent: Tuesday, 21 June 2022 11:09 AM
To: Mark Ryan <mark@elementenvironment.com.au>; Neville Hattingh <neville@elementenvironment.com.au>
Cc: PR163 <PR163@elementenvironment.com.au>; les.longhurst@boral.com.au
Subject: RE: PR163: Marulan South Limestone Mine - Water Management Plan

Hi Mark,

DPI Fisheries has reviewed the *Marulan South Limestone Mine | SSD 7009 | Water Management Plan* (dated 11 April 2022).

The Department has no suggested changes to make on this plan and considers it sufficient in terms of minimising impacts on aquatic habitat.

Please use this email for your reporting to Planning. Noting that Fisheries did not receive this plan this via the Planning Portal to provide comment on.

Regards,
Carla Ganassin | Senior Fisheries Manager - South | Coastal Systems
NSW Department of Primary Industries | Fisheries
Block E Level 3, 84 Crown Street (PO Box 5106), Wollongong NSW 2520
T: (02) 4222 8342 | M: 0447 644 357 | E: carla.ganassin@dpi.nsw.gov.au

DOC22/382235

Boral Cement Limited
PO Box 6041
NORTH RYDE NSW 2113
Attn: Les Longhurst

Marulan South Limestone Mine and Lime Plant (EPL 944)
Draft Water Management Plan

Dear Mr Longhurst,

Boral Cement Limited (**the licensee**) is the holder of Environment Protection License 944 (**the EPL**) for the undertaking of scheduled activities 'Cement and lime production' and 'Mining for minerals' at 'Marulan South Limestone Mine and Lime Plant' at Hume Street, MARULAN SOUTH NSW. The licensee has an approved State Significant Development (**SSD**) consent (SSD 7009) (**the consent**) to extend mining operations beyond the current operational footprint.

Condition B45 of the consent requires a Water Management Plan (**WMP**) be developed. The licensee has developed a draft WMP and provided this to EPA on 22 April 2022 for review and comment. Although EPA does not review or endorse management plans, EPA is taking the opportunity to provide advice for consideration by the licensee.

Discharges to waters
According to Section 4.2.2 of the WMP, an EPL license variation application is proposed for a licensed discharge point for the management of surface water. Currently the EPL does not have a licensed surface water discharge point.

The *Protection of the Environment Operations Act 1997* (the Act) provides the statutory framework for managing water pollution in NSW. Considering the environmental values of water and the practical measures that can be taken to restore or maintain those values is a consideration that is specific to water pollution and applies when the EPA exercises its licencing functions.

Under Section 45 of the Act, the EPA must consider the pollution caused or likely to be caused by a licensed discharge or a unlicensed discharge, and the likely impact of that pollutant on the environment. Further, the EPA must consider the practical measures that could be taken to prevent, control or abate that pollution, and, protect the environment from harm as a result of that pollution. In relation to licensed discharge points to waters, the EPA must also consider the environmental values of the receiving environment, and the practical measures that could be taken to restore or maintain those values.

In this regard, the EPA advises that should the licensee wish to pursue seeking approval for a licenced discharge point, a water quality objective (WQO) assessment must be undertaken and submitted to the EPA which assesses the potential impact the discharge may have on the environment, an assessment of all reasonable and feasible options to prevent a discharge to the environment, and an assessment of any practical mitigation measures to achieve an appropriate licenced discharge quality. Please contact the EPA should you require further advice on a WQO assessment.

Phone 131 555
Phone +61 2 9995 5555 (from outside NSW)
TTY 133 677
ABN 43 692 285 758
Locked Bag 5022 Parramatta NSW 2124 Australia
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info@epa.nsw.gov.au
www.epa.nsw.gov.au

The EPA further advises that that the design, installation, operation and maintence of pollution controls (such as erosion and sediment controls) on the licensed premises must be undertaken to protect waters and comply with section 120 of the Act (prohibits pollution of waters).

Surface Water Quality Guidelines:
Section 4.3 of the WMP advises that water quality criteria as outlined in Table 4.3 has been derived from the Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC). Under ANZECC Table 3.3.2-3.3.3 Upland Streams are classified as those at >150m altitude, while alpine streams are those at altitudes >1500m.

A desktop altitude assessment of the project boundary (as derived in Figure No 6.4 of the WMP) identifies that the receiving waters exceed >150m but are <1500m in altitude. As a result, the EPA advises that Upland Streams water quality criteria be applied, including consideration of these revised values against the trigger values in Table 4.3 of the WMP.

The EPA advises that the draft WMP must reconsider its proposed pollution controls to ensure that any discharges from the premises protects upland streams water quality criteria. The licensee is also advised to ensure pollution controls are designed to protect the higher environmental values that should be afforded to discharge receiving environments such as Bungonia National Park.

TARP:
Condition 7.1 of the WMP outlines that when assessing a difference in water quality parameters between upstream and downstream locations of the mine, an investigation into potential impacts from the mine will only occur after three (3) consecutive months of water quality results showing exceedances of trigger values. The EPA advises that in any occurrence, where evidence arises indicating potential pollution impacts from a licensed premise, this may be a reportable incident under the EPL and may require immediate investigation to determine if a pollution incident has occurred.

The EPA advises the licensee to ensure that any TARP fully considers the requirements of the Act in terms meeting their obligations under section 120, and that the TARP is robust enough to quickly identify emerging issues to prevent pollution of waters.

Flocculants:
Section 5 of the WMP states that where a potential discharge is required, a flocculant is to be added. The EPA advises that the licensee must ensure that the use of a flocculant must be fully considered to ensure that it does not result in a breach of the Act and cause environmental harm.

Should licensee wish to use a flocculant, you will be required to undertake an assessment. Attachment A to this letter outlines details of the assessment including discharge characterisation and ecotoxicological testing.

If you require any further information regarding this letter, or would like to meet to discuss further, please contact Dane Graham on (02) 6229 7002 or by email to EPA.southopsregional@epa.nsw.gov.au .

Yours sincerely,

17/05/2022

JANINE GOODWIN
Unit Head
Regulatory Operations Regional

Attachment A

Discharge characterisation

- The dose concentration of the flocculant used on site. The dose calculation should detail any potential for variance and resulting impact on the quality of the discharge;
- A characterisation of the expected quality of the discharge in terms of all pollutants present that pose a risk of non-trivial harm to the environment;
- An assessment of the potential impact of discharges on the environmental values of the receiving waterway with reference to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality guideline values (the Water Quality Guidelines);
- The degradation rate of the flocculant and the potential for accumulation in bed sediments of the receiving waterway.

Ecotoxicology testing

- Ecotoxicology testing of the flocculant and the treated discharge, by a NATA accredited lab;
- The ecotoxicology testing should contain representative test species across a range of taxonomic groups in order to provide data on the potential environmental risk;
- The current minimum number of species for toxicity data is at least five that belong to at least four taxonomic groups, as recommended by the Water Quality Guidelines.

APPENDIX F
Flocculant Assessment

In some situations, the use of flocculants will assist in the settling of fine suspended solids in runoff captured in sediment basins. The use of flocculants and other settling agents needs to be fully considered to ensure that there are no unintended impacts on downstream waters and/or environmental harm. Prior to the use of a flocculant or other settling agent, discharge characterisation and ecotoxicology will be assessed as follows.

Discharge characterisation

- The dose concentration of the flocculant used on site. The dose calculation should detail any potential for variance and resulting impact on the quality of the discharge;
- A characterisation of the expected quality of the discharge in terms of all pollutants present that pose a risk of non-trivial harm to the environment;
- An assessment of the potential impact of discharges on the environmental values of the receiving waterway with reference to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality guideline values (the Water Quality Guidelines);
- The degradation rate of the flocculant and the potential for accumulation in bed sediments of the receiving waterway.

Ecotoxicology testing

- Ecotoxicology testing of the flocculant and the treated discharge, by a NATA accredited lab;
- The ecotoxicology testing should contain representative test species across a range of taxonomic groups in order to provide data on the potential environmental risk;
- The current minimum number of species for toxicity data is at least five that belong to at least four taxonomic groups, as recommended by the Water Quality Guidelines.

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Boral Cement Limited

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NSW 2579

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