Boral Limited
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V1

Marulan South Limestone Mine Continued Operations State Significant Development Application

ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Cement Limited | March 2019

Foreword

The judge presiding over the appeal of the NSW Land and Environment Court's refusal of the major project application by Warkworth Mining Limited for an open cut coal mine near Broke explained that, when grappling with the task of assessing a major project, we are dealing with a polycentric problem and stated:

"A polycentric problem such as determining whether to approve or disapprove a mining project, cannot be resolved by identifying each issue and sequentially resolving it; the resolution of one issue has repercussions on other issues."

With 17 environmental issues each requiring specialist consideration, the Project's planning and assessment team agreed from the beginning that this Project requires a polycentric approach to ensure that the mine planning, community and stakeholder engagement, technical studies and environmental impact assessment process is conducted in a truly integrated manner.

Two project definition and constraints workshops were attended by Boral's mining and planning teams, the technical study leads, the EIS delivery team and an independent 'challenger' (a mining approvals specialist appointed to challenge the Project team).

The Project team were introduced to Boral's objective of continuing mining limestone at the site then considered the key issues in their fields of expertise, and developed an environmental, social and economic values and constraints framework to inform development of the 30-year mine plan and associated infrastructure.

This allowed the implications of one decision, influenced by a certain issue to be considered by the other technical specialists, the challenger and Boral's mining and planning teams, to ascertain the impacts on the other issues. This facilitated in-depth discussion and consideration of why one issue should be attributed greater value than another issue.

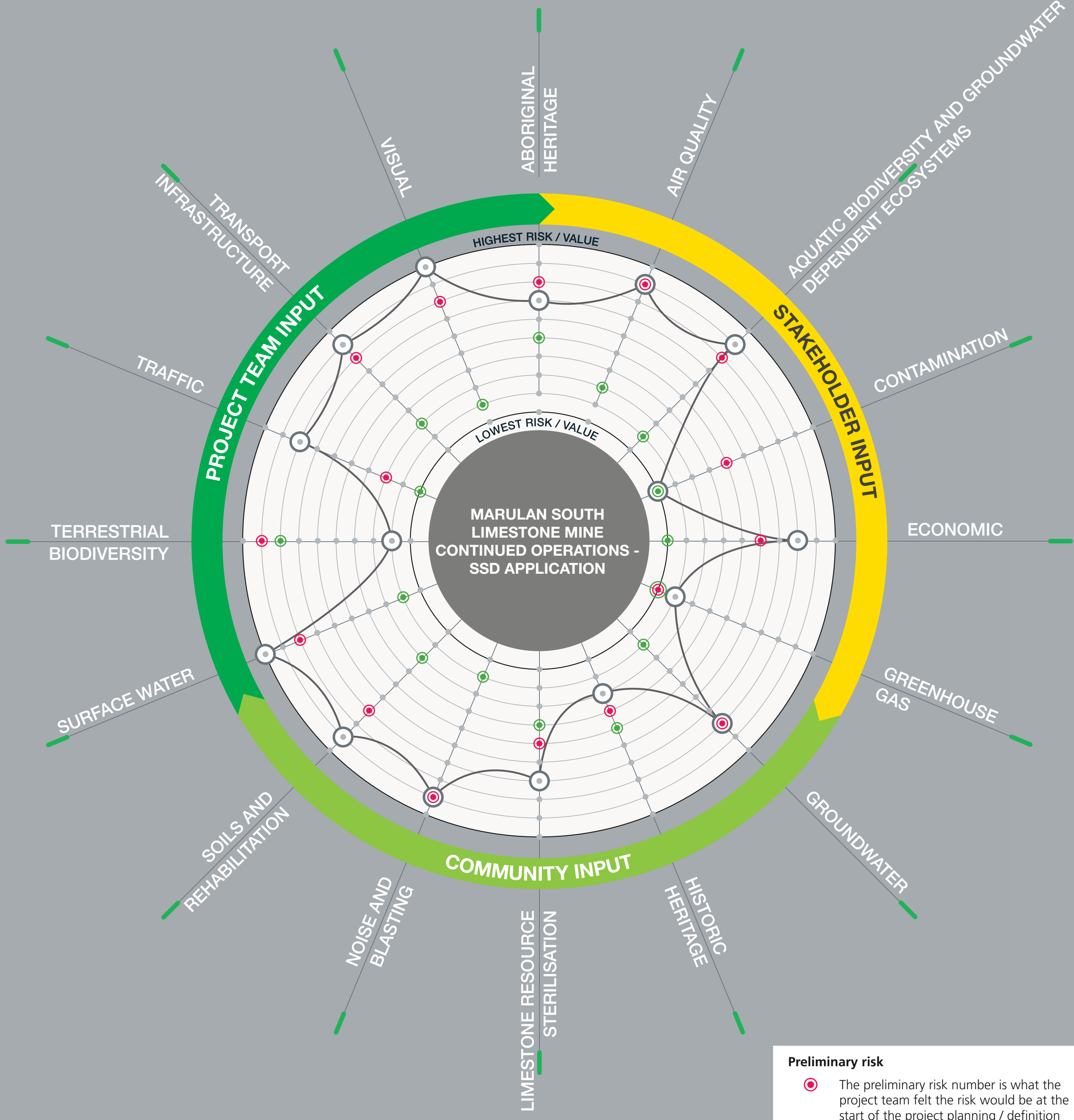
Stakeholder and local community input into the planning process for the continuation of a mine is essential to polycentric problem solving as they may identify additional or different issues to the Project team or attribute higher values to certain issues. Stakeholders and the community have been engaged over a four-year period and outcomes of this engagement have been carefully considered in developing the proposed 30-year mine plan and in deciding which issues should be attributed greater value than others.

Boral's mine planning and operations team and technical study leads have been regularly updated on outcomes from other technical studies and issues raised by stakeholders and the community. The weighting of values assigned to each issue identified in early project planning and consultation was revaluated and decisions made as to whether further changes should be made.

An example of this iterative process is the interaction between the visual and traffic specialists and mine planner. The visual specialist identified that the overburden emplacements would be barely visible from private and public viewpoints if they are below a certain height. The mine planner redesigned the emplacements to reduce their height and advised that extra emplacement areas would be required, which were found after negotiation with a neighbour. The extra emplacement area would require realignment of a section of Marulan South Road, which was assessed by traffic specialist who advised the realignment would have improved safety compared to the existing alignment.

By following this process, the 30-year mine plan and the avoidance, minimisation, mitigation and offsetting of environmental and social impacts outlined in this EIS are considered an optimum solution to a complex, polycentric problem.

Polycentric approach



Preliminary risk

The preliminary risk number is what the project team felt the risk would be at the start of the project planning / definition phase based on general knowledge of the site and supported by desktop investigations.

Residual risk

The residual risk number is the risk after all issues have been taken into account through the mine design process, have been assessed by technical specialists and avoidance, minimisation or mitigation applied. It does not account for offsetting in the case of biodiversity.

Value

The 'Value' is what attention / value the project team (particularly Boral and mine planner) gave to each issue in developing the mine plan.

CAMBIUM GROUP

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Marulan South Limestone Mine Continued Operations

STATE SIGNIFICANT DEVELOPMENT | ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Cement Limited
March 2019

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	Prepared by	Reviewed by
Name	Mark Roberts	Neville Hattingh
Company	Element Environment	Element Environment
Position	Senior Environmental Consultant	Director
Project Role	Lead EIS Author	Project Manager
Signature		
Date	20 March 2019	20 March 2019

DOCUMENT CONTROL

Revision	Date	Description	Prepared by	Reviewed by
0	30/11/2018	For Boral review	Element Environment	Boral Cement Limited
1	17 December 2018	For submission to DP&E for adequacy review	Element Environment	Boral Cement Limited
2	12 March 2019	For submission to DP&E addressing adequacy comments	Element Environment	Boral Cement Limited
3	20 March 2019	For submission to DP&E for exhibition	Element Environment	Boral Cement Limited

Environmental Impact Statement Certification

Submission of Environmental Impact Statement prepared under Part 4 of the *New South Wales Environmental Planning and Assessment Act 1979*.

Aspect	Details	
Name	Mark Roberts	Neville Hattingh
Position	Senior Environmental Consultant	Director
Project role	Lead EIS Author	Project Manager
Qualifications	B. Environmental Science	BSc (Hons) Environmental Science
Address	Element Environment Pty Ltd PO Box 1563, Warriewood, NSW, 2012	
In respect of	Marulan South Limestone Mine Continued Operations, State Significant Development – Environmental Impact Statement	
Applicant name	Boral Cement Limited	
Responsible person/applicant	Les Longhurst	
Responsible person/applicant address	Triniti 2, 39 Delhi Road North Ryde, NSW, 2113	
Proposed development	Marulan South Limestone Mine Continued Operations	
Land to be developed	The Project site at 1 Hume Street, NSW, 2579 covers an area of 846.4 ha. The existing pre SSD disturbance footprint associated with historical mining activities is 341.5 ha with 256.5 ha of new disturbance associated with the proposed 30-year mine plan. A land schedule for all land within the Project boundary is in **Appendix C**.	
Proposed development description	Continuation of mining extracting approximately 120 Mt of limestone at a rate of up to 4 Mtpa for a period of up to 30 years. Approximately 5 Mt of shale will be extracted at a rate of up to 200,000 tpa. The 30-year mine plan will generate approximately 108 Mt of overburden. Overburden will be emplaced within in-pit and out-of-pit overburden emplacements.	
Environmental assessment	This environmental impact statement addresses all matters in accordance with Part 4 of the NSW Environmental Planning & Assessment Act 1979.	
Preparation	This environmental impact statement (EIS) has been prepared by Element Environment Pty Ltd on behalf of Boral. In preparing the EIS, Element Environment has relied upon data, designs and plans and other information provided by Boral and other individuals and organisations referenced herein.	
Declaration	Pursuant to clause 6(f), Part 3, Schedule 2 of the Environmental Planning and Assessment Regulation 2000, I declare that this EIS: ▪ has been prepared in accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, Environmental Planning and Assessment Regulation 2000, and the Secretary's environmental assessment requirements (SSD-7009) dated 10 June 2015 and supplementary SEARs; ▪ contains all available information that is relevant to the environmental assessment of the proposed development to which the document relates; and ▪ is true in all material particulars and does not, by its presentation or omission of information, materially mislead.	
Signature		
Name	Mark Roberts	Neville Hattingh
Date	20 March 2019	20 March 2019

Executive Summary

Introduction

Boral Cement Limited (Boral) is seeking development consent for a State significant development (SSD 7009) to continue operations at its Marulan South Limestone Mine (the Project), an open cut limestone mine in the Southern Highlands of 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. Boral proposes to mine approximately 120 Mt over 30 years in an extension of the existing pit towards the west.

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 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 SEPP with consent.

Project overview

The proposed 30-year mine plan will access 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 million tonnes per annum for 30 years. 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.

Some of the existing infrastructure will be retained, however, the following changes are proposed:

- 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 is seeking to 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 will provide 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.

Two approvals are required for the Project:

- development consent for the Project (SSD 7009) under Part 4, Division 4.7 of the NSW *Environmental Planning and Assessment Act 1979* (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).

This environmental impact statement (EIS) has been 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 Environment and Energy.

Impact assessment

The judge presiding over the appeal of the NSW Land and Environment Court's refusal of the major project application by Warkworth Mining Limited for an open cut coal mine near Broke explained that, when grappling with the task of assessing a major project, we are dealing with a polycentric problem and stated:

> A polycentric problem such as determining whether to approve or disapprove a mining project, cannot be resolved by identifying each issue and sequentially resolving it; the resolution of one issue has repercussions on other issues.

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Stakeholder and local community input into the planning process for the continuation of a mine is essential to polycentric problem solving as they may identify additional or different issues to the Project team or attribute higher values to certain issues. Stakeholders and the community have been engaged over a four-year period and outcomes of this engagement have been carefully considered in developing the proposed 30-year mine plan and in deciding which issues should be attributed greater value than others.

Boral's mine planning and operations team and technical study leads have been regularly updated on outcomes from other technical studies and issues raised by stakeholders and the community. The weighting of values assigned to each issue identified in early project planning and consultation was revaluated and decisions made as to whether further changes should be made.

An example of this iterative process is the interaction between the visual and traffic specialists and mine planner. The visual specialist identified that the overburden emplacements would be barely visible from private and public viewpoints if they are below a certain height. The mine planner redesigned the emplacements to reduce their height and advised that extra emplacement areas would be required, which were found after negotiation with a neighbour. The extra emplacement area would require realignment of a section of Marulan South Road, which was assessed by traffic specialist who advised the realignment would have improved safety compared to the existing alignment.

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Surface water and hydrology

Surface water is managed in accordance with the water management system and is based on segregating 'clean' and 'dirty' water and capturing stormwater runoff for use in the mine processes, dust suppression and environmental controls.

The main water source for the Project will be runoff, which will be collected in the sediment basins and mine water storage dams. Collected runoff will be supplemented primarily by Marulan Creek dam, with Tallong dam and the groundwater bore providing further supplementation early in the mine life. Groundwater inflow to the pits would not provide significant water supply as most of it will evaporate.

Marulan Creek dam will be maintained near full capacity except during the constant riparian release and transfers to the water management system. There would be a significant water supply shortfall without the dam, which could supply up to 182 ML/year.

The water balance model demonstrated that the range of existing and proposed water sources will meet operational water demands.

In terms of flooding, an average of 583 ML/year of runoff from the pit catchment and overflows from the water storage dams and sediment basins S1 and W2 will drain to a sump at the base of the pit. The average water level in the pit will be 0.5 m for most of the time which will increase up to 7.9 m during heavy rain, which will quickly seep into the pit floor.

Marulan Creek dam will not significantly increase flooding risks at the railway bridge approximately 1 km upstream of the proposed dam wall or on private property further upstream.

The Project will increase the Tangarang Creek catchment area and alter the Marulan Creek catchment with construction of Marulan Creek dam. The dam will alter flows along Marulan Creek, so a riparian flow of 0.3 ML/day will be maintained via seepage from the base of the dam.

There will be approximately 1.6 days of overflows from sediment basins to natural receiving waters per year, which is within the guidelines for sediment basins designed to capture fine or dispersive sediments in runoff from a 95th percentile rainfall event.

The principal surface water management measure is design and implementation of the water management system. However, operation of the Project (including Marulan Creek dam) will be subject to a MOP, which will include a water management plan. The plan will include protocols for monitoring discharges from sediment basins and quarterly monitoring in waterways adjacent to the Project site, and a trigger action response plan if monitoring indicates water quality values have been exceeded.

The Project is in the area of the Greater Metropolitan Region Unregulated Area Water Sharing Plan and Boral will apply for transfers and entitlements to account for Marulan Creek dam and groundwater return flows/recharge.

Groundwater

Groundwater sources in the Project site are shallow unconsolidated aquifers and deep consolidated aquifers. The main groundwater system in the Project site is the limestone targeted for mining. The predominantly north-south jointing/fracture pattern in the limestone is the main flow pathway in the limestone.

Groundwater storage and flow in the limestone body is influenced by fractures, jointing and solution-enhanced fissures. This results in rapid flow through fissures and solution cavities, while the limestone matrix itself is relatively impermeable.

The water table elevation up gradient from the mine is between 550 m and 600 m with a relatively low gradient. The hydraulic gradient of the water table steepens considerably closer to Bungonia and Barber's creeks with groundwater discharging into the gorge and 'daylighting' at springs on the northern face of the gorge. the recharge zone is likely to be the exposed limestone in the mine and outcrop, where higher permeability and exposure allows direct rainfall recharge.

There are 22 bores registered on the NSW Government's Pinneena database around the Project site, which are for domestic water supply and a few for industrial use. There is Shoalhaven Gorge Forest in the southern (into Bungonia Gorge) and eastern (into Barbers Creek) slopes of the Project site, which has high potential for groundwater interaction. There is also spring dependent flora of high ecological value along Barbers Creek and Bungonia Gorge.

A numerical model was developed which demonstrated the Project will result in up to a 1 m drawdown of groundwater, which will not extend to bores held by other groundwater users.

Therefore, ‘make good’ arrangements with surrounding land owners will not be necessary. Mining will result in a slight increase in groundwater inflows of 1 m^3/day over 30 years to the pits due to the increased groundwater gradient towards the pits. The increased pit inflows will result in a slight increase in spring flows down gradient.

The modelled level and extent of drawdown will be verified by groundwater monitoring, and changes will be investigated if drawdown is deeper or more extensive than predicted.

The Project will not change the current quality of groundwater as the current recharge pathways are not proposed to be altered. Changes to groundwater levels and quality will be investigated if monitoring results deviate from historical monitoring results.

Soils and land capability

Soils in the Project site were surveyed and mapped using 63 samples and observations made over 13 test pits and six archaeological test pits to identify suitable soil for use during rehabilitation and to determine the Project site’s land and soil capability.

There are a mix of texture contrast and shallow soils across the main Project site and Marulan Creek dam site. The duplex soils comprise Kurosols in lower sections and Sodosols on mid and upper sections. The shallow soils comprise Tenosols and Rudosols on steep slopes and ridges and there are narrow areas of Alluvial Rudosols along Barbers and Bungonia creeks.

There are land capability classes V to VIII in the Project site, which are moderate/low to extremely low capability land. Land uses in these land and soil capability classes are severely to extremely limited. There is no biophysical strategic agricultural land in the Project site.

Only the A1 horizon of the duplex soils is suitable for stripping, of which there will be 245,510 m^3 available for rehabilitation. Given the low pre-disturbance land capability classes (V, VII and VIII) of the land proposed to be disturbed, the Project will have minimal negative impact on the overall land capability. Further, there is only infrequent and temporary agricultural activity in the Project site, comprising occasional grazing associated with a lease over a section of the Project site.

Contamination

Existing and potential contamination from past and present land use was identified so that recommendations for future investigation, management and remediation to protect human health and the environment could be provided.

Eighteen potential sources of contamination were identified and three were assessed to have potential to impact human health and the environment, comprising petroleum hydrocarbons, asbestos and methylene blue active substances. It was determined the petroleum hydrocarbons and methylene blue active substances had negligible migration or human health risks.

There is a potential human health exposure pathway for asbestos at the former Marulan South township. One of the analysed fragments was friable and had potential to liberate asbestos fibres, which could occur during lawn mowing and landscaping. Implementation of management measures will prevent migration or human health risks from the asbestos.

Terrestrial biodiversity

Biodiversity impacts were assessed in accordance with the NSW Office of Environment and Heritage’s biodiversity assessment method (BAM) using the BAM Calculator. This comprised assessing the Project site’s landscape features, native vegetation and threatened species and populations, followed by an impact assessment considering avoidance and minimisation of impacts, impact and offset thresholds and offset requirements.

There are five native and one non-native plant community types in the Project site, with one threatened ecological community; Yellow Box Blakey’s Red Gum grassy woodland on the tablelands, South-eastern Highlands. This community is listed as an endangered ecological community (EEC) under the EPBC Act and a critically EEC under the EPBC Act.

The BAM Calculator predicted 31 threatened flora species could occur in the search radius, but it was determined only the *Solanum celatum* would occur, with one specimen recorded during the survey.

The BAM Calculator predicted 64 threatened fauna species could occur in the search radius, with 25 of these candidates for species credits (requiring offsetting if their habitat is present and/or habitat would be impacted). The list of candidate species was reduced to the Large-eared Pied Bat (*Chalinolobus dwyeri*) and Koala (*Phascolarctos cinereus*) after fieldwork. A further seven threatened species were recorded in or adjacent to the Project site.

The following direct impacts will result from the Project:

- clearing of native vegetation and associated habitat, conservatively estimated to be 182.4 ha, including 88.6 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC;
- clearing of associated species credit fauna habitat, comprising;
  - clearing of an estimated 132.4 ha of Koala habitat;
  - clearing of an estimated 140.3 ha of Large-eared Pied Bat habitat; and
- removal of one individual *Solanum celatum*.

The assessments of significance had the following conclusions:

- the removal of TEC and impact to Koala habitat will have a significant impact and triggers the need to offset the impacts under the EPBC Act;
- offsets will not be required for the Large-eared Pied Bat under the EPBC Act, but offsets will be required under the BC Act; and
- impacts on the other threatened and migratory species listed under the EPBC Act will not be significant and will not require offsetting.

A biodiversity offset strategy has been prepared to offset the impacts of the Project on biodiversity. A total of 3,093 ecosystem credits and the following species credits will need to be retired:

- Solanum celatum – 2;
- Koala – 2,941; and
- Large-eared Pied Bat – 4,567.

Boral has investigated offsetting opportunities in the Bungonia subregion and adjacent subregions and has purchased a 1,000 ha property and a 360 ha property in the Bungonia subregion for this purpose. The properties would satisfy most of the BC Act offset liability and all of the EPBC Act liability.

The remaining credit liability will be paid into the BCT Fund.

Aquatic biodiversity

Threatened species databases were searched and local streams were surveyed to assess the Project's potential impacts on aquatic biodiversity. Thirteen sites were surveyed upstream and downstream of the Project site along Barbers, Marulan and Bungonia creeks and the Shoalhaven River.

No threatened species were observed during the surveys. There were more macroinvertebrates at the downstream locations compared to the upstream locations in Bungonia Creek, which was likely due to the increased fine sediment and macrophytes in the downstream locations. There were no notable upstream/downstream differences in other waterways.

Barbers Creek had several pollution sensitive species present, indicating good stream health. Marulan Creek upstream of the Project site is in moderate health as there were several land use impacts on aquatic habitat, water quality and stream flow along the length of the waterway.

Fish communities differed between and within streams in the Project site. The introduced Mosquitofish (*Gambusia affinis*) was the only fish species observed in Marulan Creek. Barbers and Bungonia creeks showed longitudinal distribution of fish species, with Mountain Galaxias (*Galaxias olidus*) only observed upstream of the Project site in both systems.

Changes in flow regime will not adversely impact Tangarang Creek or Main Gully during or after mining and, therefore, there will be minimal impacts on aquatic habitat, flora, fauna or stream process.

The construction and operation of Marulan Creek dam is unlikely to have significant impacts as the system has already been altered by farm dams and water quality is relatively low from adjacent agricultural activities and low flows.

Except for the construction of Marulan Creek dam there is unlikely to be significant ecological impacts to these waterways resulting from the construction and operation of the Project. Impacts to Marulan Creek will not require offsetting as flows will be maintained after construction of Marulan Creek dam and the fish community in the creek mostly comprises introduced fish.

Stygofauna

Groundwater can contain many highly sensitive, specialised and highly localised, endemic flora and fauna that cannot be found elsewhere and have little tolerance to change.

Impacts to stygofauna were assessed by using NSW Office of Water's aquifer risk assessment process. Eight groundwater monitoring wells in the Project site and several control bores outside the Project site were sampled for stygofauna. The hyporheic zones (the zone below and within the porous sand and gravel substrate of a riverbed) of streams and springs were sampled in 15 locations.

No stygofauna were found in any of the groundwater monitoring wells in the Project site. One species of stygofauna was found in a groundwater bore outside the Project site. Fifty species of macroinvertebrates were found in the spring and riverine habitats of Bungonia and Barbers creeks. The species are generally tolerant of moderate levels of disturbance.

Fauna were most abundant in the epigean zone (confined to surface water/creeks/rivers), especially at the springs. These species do not enter far into the deeper zones as they are poorly adapted to the low light/oxygen environment.

The largest zone in and around the Project site is the hypogean ecosystem (true groundwater) or aquifers but only one species of stygofauna was found in this ecosystem in a groundwater bore outside the Project site.

Four groundwater dependent ecosystem types were identified in and adjacent to the Project site.

The aquifer risk assessment process was applied to each of the stygofauna survey sites to determine the risk of stygofauna across the Project site being adversely impacted by the Project. All the groundwater monitoring wells/bores and the Bungonia Creek Upper site had low ecological value, while the remaining spring sites had high ecological value given the abundance and diversity of species and the ecosystem health.

The ecological risk was low at all sites as it is predicted that the groundwater table is likely to only reduce by up to 1 m within approximately 290 m of the eastern edge of the current mine pit as a result of mining during the 30-year mine life, and flows/water quality will be maintained at the springs. Additionally, none of the GDEs will be directly impacted by mining as they are outside the disturbance area.

Overall, the assessment determined the Project poses a low risk to stygofauna.

Aboriginal heritage

Potential impacts of the Project on Aboriginal cultural heritage were assessed by searching OEH's Aboriginal Heritage Information Management System (AHIMS) for previous records of sites in and adjacent to the Project site, surveying the Project site for new sites and consulting Aboriginal parties. Some sites were also excavated to characterise sub-surface archaeological deposits.

According to AHIMS, there are 112 registered sites in a 10 by 10 km area around the Project site, 15 sites adjacent to the Project site and four items in the Project site.

The background environmental and cultural information was used to predict the following about the types of Aboriginal heritage items, and where they could occur, in the Project site:

- artefacts may be present as part of open camp sites or as isolated finds;
- rock shelters and art sites are not likely to be present due to the geology of the Project site;
- suitable landforms (eg elevated land, spurs and crests) next to reliable water will be of high archaeological potential; and
- culturally modified trees are rare but may be present where mature native trees remain.

The surveys targeted ground exposures on land near reliable watercourses; hill spurs and crests; and the relatively flat and undulating land near the proposed Marulan South Road realignment and the construction access road to the Marulan Creek Dam. All mature trees and rock outcrops along the survey transects were inspected for evidence of scars on trees and grinding grooves, rock pools or engravings on rocks.

Forty one new sites were recorded during the survey comprising 28 artefact scatters, 12 isolated finds and one potential scar tree. The potential scar on the tree was later determined not to be of Aboriginal origin.

The survey team counted 236 artefacts, comprising 224 in scatters and 12 isolated finds. Effective survey coverage was not reliable due to the amount of surface cover and the incidence of artefact discoveries did not accurately reflect the potential for artefacts to exist in the Project site, given the amount of sensitive landscapes in the area.

Test pits were excavated as the survey was not sufficiently accurate to verify the predictive model. There were 539 artefacts in 17 of the 25 test pits, which represent 17 new sites. The pits with the highest amounts of artefacts were on broad spurs next to Marulan Creek (86% of all artefacts). The remaining 73 artefacts were recovered from 10 test pits in the main Project site, with over half of these from one location.

The test excavations demonstrated that the most extensive assemblages exist along reliable watercourses and that some artefact materials, including grey silcrete, were brought in through trade or importation. Marulan Creek appears to have been a focus of long term, sustained habitation, with frequent visitations to create a rich and varied artefact assemblage.

Forty nine sites will be impacted by the Project, comprising 39 which will be totally lost and 10 that will be totally disturbed. One site which will be totally lost has high archaeological significance and 11 of the sites to be totally disturbed/lost have moderate significance.

Thirty two sites comprising surface artefact scatters and isolated finds in the disturbance footprint will be collected by an archaeologist and RAPs, prior to disturbance by the Project.

An area of high archaeological sensitivity in the Marulan Creek dam disturbance footprint and an area of moderate archaeological sensitivity in the main Project site will be salvaged as they are likely to contain relatively intact subsurface deposits which will assist in understanding the Aboriginal past in the Project site and will be totally lost during the Project. Sites close to the proposed Project disturbance footprint that will be avoided, will be protected by demarcation and signage.

Historic heritage

Potential impacts on items of historic heritage significance were assessed by searching State and Commonwealth heritage databases and surveying the Project site.

There are no registered heritage items in the Project site and the adjacent Bungonia State Recreation (Conservation) Area and nearby Glenrock Homestead and Outbuildings are listed under the LEP. Twelve items of local industrial, residential and road transport heritage significance were discovered in the Project site, all associated with historic mining. The Project will avoid five of the items and seven will be removed.

There is little opportunity to revise the proposed disturbance footprint to avoid impacts to heritage items due to the shape and orientation of the limestone resource. Therefore, it will not be possible to avoid impacts to items in the proposed disturbance footprint and alternative management measures will be required.

All items apart from one will be photographically archived and other measures such as archival recording, demarcation and signage will be applied to the other sites.

Air quality and greenhouse gases

Particulate matter, or dust, is the main air pollutant of concern from mining. Dust can be defined by the following sub-categories:

- total suspended particles (TSP), which comprises the total mass of all particles suspended in the air;
- particulate matter with an aerodynamic diameter of 10 µm or less (PM_{10});
- particulate matter with an aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$); and
- deposited dust, which is dust that has settled from the atmosphere onto surfaces.

Other air pollutants potentially associated with the Project are nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), which could be generated at the processing facilities, hydration plant and kiln.

Worst case pollutant generation scenarios over three of the mining stages were assessed (Stage 4 will have reduced operations and was not assessed) using emissions reduction factors, which assume the application of management measures.

The Project, in combination with other local emissions sources, will not result in exceedances of particulate matter and dust deposition criteria at any privately-owned sensitive receivers. The annual average PM_{10} criterion will be exceeded at a Boral owned receiver during Stage 1. Dust generated by the Project will not impact more than 25% of any privately owned property.

Stack emissions from the Project will be minimal and well below the criteria. When combined with background levels, cumulative levels will also be below the criteria.

Greenhouse gases will be generated by the following sources during construction and operation of the Project:

- fuel combustion by construction machinery and site vehicles;
- fuel combustion and electricity use during mining operations and lime production;
- lime production; and
- fuel combustion from transportation of the lime products off-site by road and rail.

The construction emissions of 14,179 tCO_2-e are substantially less than the operational emissions. Operational activities of the Project are estimated to generate 122,703 tCO_2-e per annum.

The Project's total construction GHG emissions of 14,179 tCO_2-e (0.014179 $MtCO_2$-e) will equate to 0.095% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

The Project's annual operational GHG emissions of 122,703 tCO_2-e (0.122703 $MtCO_2$-e) will equate to 0.83% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

Noise and blasting

There will be vehicle and plant noise, and blasting noise and vibration, associated with the Project which could impact sensitive receivers. Two worst case scenarios were assessed using the Environmental Noise Model:

- all fixed and mobile equipment operating 24 hours a day including four haul trucks transporting limestone to the crusher and two haul trucks transporting overburden; and
- all fixed and mobile equipment operating 24 hours a day including six haul trucks transporting overburden.

Noise trigger levels were determined in accordance with the *Noise Policy for Industry* and noise impacts assessed to determine if there were residual impacts. The significance of residual impacts were rated as negligible, marginal, moderate and significant. Negligible impacts are a less than or equal to 2 dBA difference between the predicted noise and trigger level and significant impacts are a greater than 5 dBA difference.

'Modifying factors' were also determined for noise sources in accordance with the *Noise Policy for Industry* to determine if low frequency noise will be generated.

Maximum noise level events were also considered as these could interrupt sleep.

As there will be minor increase in traffic associated with the Project, traffic noise was assessed in accordance with RMS's *Road Noise Policy*. Two scenarios were assessed; the worst case of houses 75 m from the road and typical case of houses 180 m from the road.

Construction noise was assessed in accordance with the *Interim Construction Noise Guidelines*, which included derivation of noise management levels which apply to standard construction hours.

Operational and maximum noise levels will be below the noise trigger levels, and low frequency noise will be below thresholds, at all sensitive receivers during all mine stages and time periods. Therefore, there will be no residual operational noise impacts.

Noise from vehicles associated with the Project travelling on Marulan South Road will increase by 2 dBA during the day and 1 dBA during the night for both scenarios, which complies with the traffic noise criterion.

Construction noise will comply with criteria during standard construction hours at all sensitive receivers.

Predicted blast vibration and overpressure levels are below the human annoyance and discomfort, and building damage criteria, at all sensitive receivers. The vibration from blasting would be below the structural damage criterion at all non-mine-owned infrastructure, including the Jemena gas pipeline that supplies the mine with gas.

Visual

The Project will have low overall visual exposure to its visual catchment. Of the 24 assessed viewpoints, only two will have medium impacts and the remainder will have low impacts. The viewpoints with medium impacts are Bungonia Lookdown Lookout and near Long Point Lookout.

Views from the affected viewpoints will improve over time as overburden emplacements are rehabilitated. Bungonia Lookdown Lookout has the most significant views to the mine, which will substantially reduce by Year 30 when the Southern Overburden Emplacement (SOE) is complete and being rehabilitated.

Traffic and transport

Impacts on traffic were assessed as the Project will include an increase in vehicle numbers over current levels, realignment of a section of Marulan South Road and construction of an intersection on Marulan South Road at the Road Sales Stockpile Area.

There will be an extra 34 truckloads (68 vehicle movements) on an average week day, and up to 58 truckloads (116 vehicle movements) on a worst case day along Marulan South Road. This will equate to up to three one-way trips in an average hour on an average day and up to five one-way trips in a worst case hour on a worst case day.

The additional traffic will have a relatively small impact on the level of service and average vehicle delay along Marulan South Road, and will not change average vehicle delays at the minor intersections along the road. Similarly, there will be a very small impact to traffic conditions on the Hume Highway.

Two intersection scenarios were assessed for the Road Sales Stockpile Area, with stop signs and with traffic signals. In both scenarios the level of service at the proposed intersection was A, which is the best possible intersection performance. The average vehicle delays were low, with a maximum of 13.5 seconds. The sight distances to and from the intersection will be longer than the guideline values.

Construction could result in up to 40 additional inbound and outbound vehicle trips (80 additional two-way trips) on some days. These will consist of light vehicle trips associated with additional construction workers, as well as heavy vehicle trips associated with the delivery of materials and equipment.

The Project is not expected to result in any negative impacts to other road users, including school buses, which use Marulan South Road in the morning and afternoon periods on school days. Upgrades to Marulan South Road will improve road safety and provide school bus stopping and turning facilities.

Waste management

The Project will not generate significant quantities of general solid, hazardous or liquid waste. Any waste that is generated will be managed in accordance with the waste hierarchy in the NSW *Waste Avoidance and Resource Recovery Act 2001*.

The Project will generate large quantities of overburden, which will all be managed onsite as described in the Project summary and rehabilitation sections.

Hazards and risks

Hazardous substances to be used at the Project were screened against the thresholds in DPE's (2011) *Applying SEPP 33* to determine if the Project will be hazardous or offensive development under State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33). The quantities of dangerous goods proposed to be stored and handled at the Project will be below the thresholds in *Applying SEPP 33*. Therefore, the Project will not be a hazardous development.

The Project could be an offensive development under SEPP 33 if in the absence of safeguards and controls, the mine could 'emit a polluting discharge that could cause a significant level of offence'. However, if the EPA were to issue a licence for the pollution, then it is demonstrated that the pollution will not be significant and can be controlled via mitigation and management measures. It is expected the existing environmental protection license will continue for the Project (including updates associated with the Project). Therefore, it is unlikely the Project will be offensive development.

Boral will update the existing emergency and bushfire management plans to reflect the Project, which will continue to be implemented at the mine to reduce hazards and risk associated with the continuation of mining operations.

Economics

Cost benefit analysis (CBA) and two forms of local effects analysis were used to assess the potential economic impacts of the Project in refence to the Project not being approved and the mine closing.

CBA is concerned with whether the incremental benefits of the Project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the Project compared to 'without' it. The CBA compared the production and environmental costs with the production benefits, such as the value of the limestone and residual land values at the end of the Project.

The CBA determined the Project will have net social benefits to Australia of $643 million (M) and to NSW of $321 M including employment benefits and a 7% discount rate. Any unquantified residual impacts of the Project after mitigation, offset and compensation would need to be valued at greater than these amounts for the Project to be questionable from a national and NSW economic efficiency perspective.

The local effects analysis determined the Project is likely to have the following net local (LGA) benefits:

- 42 full time equivalent jobs;
- $3.1 M disposable wages per year; and
- $7.1 M of other non-labour expenditure.

The supplementary local effects analysis used an input-output (IO) table to identify the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of indicators of economic activity – output, income, value-added and employment. The IO analysis determined the Project will make the following contributions to the region:

- $82 M in annual direct and indirect regional output or business turnover;
- $48 M in annual direct and indirect regional value added;
- $14 M in annual direct and indirect household income; and
- 198 direct and indirect jobs.

The IO analysis determined the Project will make the following contributions to NSW:

- $137 M in annual direct and indirect regional output or business turnover;
- $74 M in annual direct and indirect regional value added;
- $27 M in annual direct and indirect household income; and
- 364 direct and indirect jobs.

Social impacts

Social impacts were assessed in the context of the Project's potential changes to people's way of life; community; access to and use of infrastructure, services and facilities; culture; health and wellbeing; surroundings; personal and property rights; decision making systems; and fears and aspirations.

The community was extensively consulted in 2015, 2016 and 2018 via correspondence, meetings, the media and social media to understand attitudes towards the mine and Project and issues of most importance to the community. Issues of concern to the community were noise, visual and dust impacts; access to property; road safety and traffic impacts; and livelihood concerns such as property values, employment opportunities and raw material supplied to business.

A social impact scoping exercise determined that some of these potential impacts required detailed assessment of impacts without management measures in the form of consultation with residents (noise, visual and dust impacts), visual impacts assessment, ethnographic content analysis (ECA – dust and traffic impacts), health impact assessment (HIA – road safety and livelihood impacts) and interviews with stakeholders (access to property and traffic impacts).

The following positive impacts were predicted:

- Way of life – local and regional employment and business opportunities.
- Personal and property rights – driveway access improvements along Marulan South Road.
- Access to and use of infrastructure, services and facilities – widening and upgrade of Marulan South Road.

The following negative impacts were predicted:

- Access to and use of infrastructure, services and facilities – cumulative and perceived risk of increased traffic volumes and impact to pavement condition along Marulan South Road.
- Health and wellbeing – perceived low frequency (cumulative noise) and disturbance from airbrakes.
- Surrounds – headlight spill into properties from re-aligned Marulan South Road.
- Personal and property rights – dust fallout causing damage to property asset (shed).

Impacts to property values and business revenue were discounted after detailed economic assessment and further engagement respectively. Other than environmental management controls to avoid other identified negative impacts, no mitigation is required to minimise impacts on property values. However, Boral will meet with the neighbour that raised this concern and will talk them through the results of the economics assessment, other technical studies and proposed mitigation measures. Boral met with the business owner concerned about the supply of raw materials was assured that their supply would not diminish.

Physical impacts to roads and road safety will be mitigated as described in the project description and transport sections of the EIS, and perceived traffic and safety impacts will be addressed by further consultation with stakeholders, including provision of the EIS.

Noise impacts will be managed as described in the noise section of the EIS, including provision of monitoring results to concerned stakeholders. The resident concerned about low frequency noise will continue to be consulted and sources investigated if necessary, which changes to mining operations implemented where reasonable and feasible.

Light spill onto private property will be addressed at the detailed design phase of the road re-alignment, with options including adjustments to the vertical alignment of the road and/or construction of earth bunds and planting of screening vegetation.

Dust impacts will be addressed as described in the air quality section of the EIS and ongoing consultation with concerned stakeholders, including provision of monitoring results.

Rehabilitation strategy

The mine will be progressively rehabilitated to achieve a final landform based on the following objectives:

- Rehabilitated land will be geotechnically stable and will not present a greater safety hazard than surrounding land to land-users, public, livestock and native fauna accessing or transiting the post-mining area.

- Land capability will, as far as possible, be returned to a class similar to that existing prior to Project commencement (class V, VII or VIII).
- Except for the mine void, mined land will be visually compatible with the surrounding natural landscape.
- Rehabilitated landforms will be designed to shed water without causing excessive erosion or increasing downstream pollution.
- Rehabilitated landforms will not negatively impact visual amenity for nearby residents and users of conservation reserves.

To achieve these objectives the site was divided into primary and secondary domains. The primary domains were operationally based e.g. overburden emplacements/infrastructure area, and the secondary domains were based on post-mining land use objective e.g. woodland.

The domains will be rehabilitated by reshaping and stabilising post-mining landforms, topdressing reshaped landforms and establishing and maintaining native woodland communities over the following phases.

- decommissioning;
- landform establishment;
- growth medium development;
- ecosystem and land use establishment;
- ecosystem and land use sustainability; and
- relinquishment.

The domains will be rehabilitated in the above phases to achieve the domain specific objectives described in the 2018–2023 MOP. Rehabilitation will be complete once the completion criteria for each rehabilitation element (landform stability, topsoil, vegetation, fauna, water quality and safety) are satisfied.

There will be 215,510 m^3 of stripped topsoil available for rehabilitation, which will not be sufficient to cover all rehabilitation areas. Therefore, topsoil will be prioritised for rehabilitation of the high and moderate erosion risk areas on overburden emplacement slopes and alternative growth media will be used on lower slopes and flats.

Decomposed granite from the Peppertree Quarry and weathered shale from the mine has been used as a growth medium in previous rehabilitation at the mine. The weathered shales have resulted in good tree germination rates, and the decomposed granite was useful in establishing ground cover vegetation.

Justification and conclusion

The mine is a strategically important asset for Boral, as it supplies the main ingredient for the manufacture of cement at Boral’s Berrima Cement Works. This is also a strategically important operation for Sydney based consumers of these products as this represents around 60% of the cement sold in NSW and feeds into more than 30% of concrete sold in Sydney. Major projects previously or currently supplied include Sydney Opera House, Barangaroo, Sydney Metro, and Pacific Highway upgrades.

The continued operations at the mine will provide the following key benefits:

- uninterrupted supply of essential construction materials to local and regional development projects at cost-effective prices;
- continued employment of 191 full time employees and truck/transportation drivers, with further jobs created through flow-on effects;
- optimal use of a regionally-significant resource; and
- economic benefits to the local community through the purchase of goods and services and local expenditure both directly and indirectly through employee wages.

As the mine contains a limestone deposit significance enough to support ongoing operations until the end of this century, it is critical to Boral to ensure continued operations at the site.

All potential amenity impacts from the Project on sensitive receivers, comprising noise, air quality and visual impacts, will be below relevant criteria or have low residual impacts. The Project will not have significant impacts on some biophysical aspects such as surface and ground water, and aquatic and stygofauna biodiversity. However, the Project will have residual impacts on terrestrial biodiversity, which will be compensated through the proposed biodiversity offset strategy.

The Project will also have residual impacts on Aboriginal and historic heritage. Areas of medium to high Aboriginal archaeological sensitivity will be salvaged and items of historic heritage significance to be impacted will be archivally recorded.

The Project will have significant economic and social benefits and is in the public interest.

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Chapter 1

Introduction

VOLUME 1

1 INTRODUCTION

1.1 Brief history of limestone mining at Marulan South

Limestone mining north of Bungonia Gorge began soon after the limestone deposit was discovered in 1830 with the stone used for the production of marble. A contract was awarded for provision of material for flux to the Fitzroy Falls Iron Works and the first commercial lime was produced in 1875. Major developments emerged in the 1920s to supply limestone for cement manufacturing and steel making.

The limestone mine at Marulan South 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.

Marulan South was originally considered an isolated location and as the business grew, a village was established to house personnel. The village was subsequently closed in 1999.

In 1974 a formal merger of the two mining companies at Marulan South took place. The northern mine pit was mined by Southern Portland Cement which was owned by BHP and used the limestone in its steel works and cement plant at Berrima. The southern mine pit was mined by Metropolitan Portland Cement, which supplied limestone to its cement plant at Maldon. During the 1960s Metropolitan Portland Cement was absorbed into the Australian Portland Cement Manufacturers of Australia, which was formed by the Blue Circle (UK) company following the purchase of Commonwealth Portland Cement, Standard Portland Cement and Metropolitan Portland Cement.

In 1974 Blue Circle and BHP agreed to merge their operations to form Blue Circle Southern Cement Ltd (BCSC) with both parties retaining equal ownership. In 1987 Boral Limited purchased BCSC and continues to retain ownership of the company as a wholly owned subsidiary. As at 1st August 2010, BCSC changed the company name to Boral Cement Limited.

A pictorial timeline of the history of limestone mining at Marulan South is presented in **Figure 1.1**.

1.2 Project need and justification

Boral Cement Limited (Boral) owns and operates the Marulan South Limestone Mine (the mine). This long standing open cut mine produces up to 3.38 million tonnes (Mt) of limestone based products per year for the cement, steel, agricultural, construction and commercial markets.

The mine is a strategically important asset for Boral, as it supplies the main ingredient for the manufacture of cement at Boral's Berrima Cement Works. This is also a strategically important operation for Sydney based consumers of these products as this represents around 60% of the cement sold in NSW and feeds into more than 30% of concrete sold in Sydney. Major projects previously or currently supplied include Sydney Opera House, Barangaroo, Sydney Metro, and Pacific Highway upgrades.

Boral's operations provide substantial economic benefits at Federal, State and local levels while being committed to maintaining a good working relationship with the local community and implementing sound environmental management across the site.

The continued operations at the mine will provide the following key benefits:

- uninterrupted supply of essential construction materials to local and regional development projects at cost-effective prices;

- continued employment of 191 full time employees and truck/transportation drivers, with further jobs created through flow-on effects;
- optimal use of a regionally-significant resource; and
- economic benefits to the local community through the purchase of goods and services and local expenditure both directly and indirectly through employee wages.

The mine operates under Consolidated Mining Lease No. 16 (CML 16), Mining Lease No. 1716, Environment Protection Licence (EPL) 944 and a combination of development consents issued by Goulburn Mulwaree Council (Council) and continuing use rights.

As the mine contains significant limestone deposit it can support ongoing operations until after the end of this century. Therefore, it is critical that Boral ensures continued operations at the site. However, due to changes in the NSW *Mining Act 1992* (Mining Act) and the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act), a development consent under the EP&A Act will need to be in place when mining moves beyond the area covered by the mining operations plan (MOP) (Boral Cement Limited, 2017). Therefore, Boral is seeking development consent for continued operations at the site through a development application for a State significant development (SSD) including a 30-year mine plan, associated overburden emplacement areas and a mine water supply dam (hereafter referred to as 'the Project').

Figure 1.1
Brief history of limestone mining at Marulan South

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

By March 1826 it was clear that the deposits of limestone in the Marulan South area were recognised and it was recommended that these areas were not included in settlers grants. Workings of the limestone began 'soon after' 1930, with the stone used for the production of marble.

1826

The area of Marulan South was bought by Mr Fuljames who purchased the land for its limestone deposits in the early nineteenth century. By 1869 the limestone quarries were worked by three parties. In 1875, the first commercial lime was produced from our site.

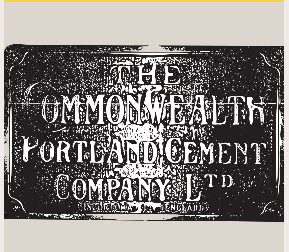
1869

Limestone mining north of Bungonia Gorge began in 1869 with major developments emerging in the 1920s to supply limestone for cement manufacturing and steel making.

1920

The area was then held under adjoining leases by Weenga Lime Limited, Hoskins Iron and Steel Limited and Southern Portland Cement prior to 1928 when the area was consolidated and worked by Southern Portland Cement.

1928



There was dispute between Metropolitan Products Ltd and the Commonwealth Portland Cement Company for access to build a dam, aerial ropeway and pipeline. Timber was cleared in preparation for the installation of an aerial ropeway sometime before October 1936.

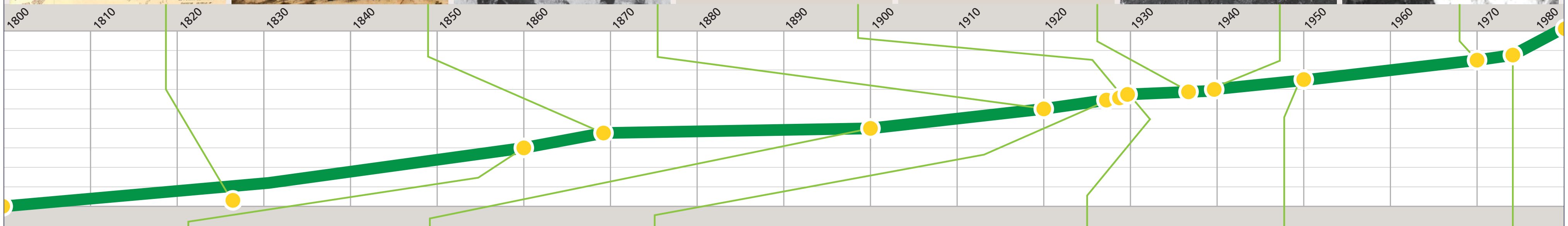
1936

Although disputes over access continued into 1939, the aerial ropeway was operating to the west of the mine. Problems with a bend in the alignment resulted in the rope breaking on a regular basis and stopping works.

1939

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.

1970



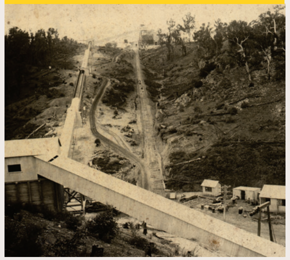
1860

When mining limestone at Marulan was first undertaken by James Hogg in the 1860s it was completed by hand with picks and shovels and hand–loaded into horse drawn wagons.

1900

By the early 1900s, the rock was carted from the pits by approximately 25 horses, while mining was completed with steam shovels.

1927



The rail line from the Great Southern Railway to Marulan South was built between 1927 and 1928 and opened in 1928.

1929

The limestone mine was opened in 1929 to supply limestone for cement, manufacturing and steel making.

Marulan South was originally considered an isolated location and as the business grew, a village was established to house personnel. The earliest permanent resident of the now empty village at Marulan South was Les Cooper who arrived in 1929 to build his home.

1950

In the 1950s and 1960s Southern Portland Cement assisted in the creation of a local oval, community hall and tennis courts to further increase the facilities present for recreation. The community hall held a number of debutant balls as well as touring entertainers.

1974

In 1974 Blue Circle and BHP merged their operations to form Blue Circle Southern Cement Ltd (BCSC). In 1987 Boral Limited purchased BCSC and retains ownership of the company as a wholly owned subsidiary. In 2010, BCSC changed the company name to Boral Cement Limited.

CAMBIUM GROUP

Source: Boral Cement Limited (2018), EMM (2018), Cambium Group (2019).

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1.3 Project overview

The Project is summarised in **Table 1.1** and described in detail in **Chapter 4**.

Table 1.1: Project summary

Project component	Summary of the Project
Mining method	Overburden including clay shale is removed using excavators and front-end loaders. Limestone is extracted using open-cut drill and blast techniques. Limestone is loaded using excavators and front-end loaders and hauled either to stockpiles or the primary processing plant using haul trucks. Oversized material is stockpiled and reduced in size using a hydraulic hammer attached to an excavator, before being introduced to the processing plant.
Resource	The proposed 30-year mine plan accesses approximately 120 Mt of limestone down to a depth of 335 m Australian Height Datum (AHD). The mine footprint focuses on an expansion of the North Pit westwards to mine the Middle Limestone and to mine deeper into the Eastern Limestone. As the Middle Limestone lies approximately 70 m to 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.
Project site and disturbance area	The Project site covers an area of approximately 846.4 hectares (ha). The area of disturbance within the Project site associated with the existing mine operations is approximately 341.5 ha. The Project would result in an additional disturbance footprint of approximately 256.5 ha.
Annual production	Limestone will be extracted at a rate of up to 4 million tonnes per annum (Mtpa) for a period of 30 years. Clay shale will also continue to be extracted at a rate of up to 200,000 tonnes per annum (tpa).
Mine life	Project life 30 years.
Total Resource recovered	Up to 120 Mt of limestone and up to 5 Mt of shale resource extracted over 30 years.
Beneficiation	Processing of 4 Mtpa of limestone to create various limestone and lime products including limestone aggregates and sand, hydrated lime and quick lime.
Management of mining waste (overburden)	The proposed 30-year mine plan will generate approximately 108 Mt of overburden. Overburden will be emplaced both within ‘in-pit’ and ‘out-of-pit’ overburden emplacements.
General infrastructure	The existing mine includes access and haul roads, limestone handling and processing equipment, limestone product stockpiling and reclaim areas, conveyor network, lime production and processing plant, limestone sand plant, rail loading and despatch infrastructure, administration offices and visitor/employee car parking facilities, electricity supply and distribution, utility infrastructure, workshop, stores and ablution buildings, underground diesel storage, heavy vehicle servicing, parking and washdown facilities. The Project will require the following key infrastructure 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; and ▪ development of a shared Road Sales Stockpile Area including a weighbridge and wheel wash to service both the mine and Peppertree Quarry.
Product transport	The majority of limestone products will continue to be transported to customers by rail for cement, steel, commercial and agricultural uses. Boral seeks to maintain the approved rail transportation limit of six trains departing the mine per day. Manufactured sand will continue to be transported by truck along a dedicated internal road, across Marulan South Road and into Peppertree Quarry for

Project component	Summary of the Project
	blending and dispatch by rail. The mine currently produces approximately 500,000 tpa for Peppertree Quarry and proposes to increase production of manufactured sand to approximately 1 Mtpa. Agricultural lime, quick lime and fine limestone products will continue to be transported by powder tanker, bulk bags on trucks or open tipper trucks along Marulan South Road. Shale, limestone aggregates, sand and tertiary crushed products will be transported by predominantly truck and dog along Marulan South Road. The adjoining Peppertree Quarry is currently approved to transport all products by rail. Boral will seek to transport approximately 150,000 tpa of Peppertree Quarry's products from the mine to customers via Marulan South Road. This could be achieved by back loading to the new shared road sales product stockpile area by the trucks carrying the limestone sand to Peppertree Quarry. In total, Boral is seeking to 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, which is approximately 1 km west along Marulan South Road.
Water management	Water supply for the Project, including dust suppression, processing activities and some non-potable amenities will be from existing and new on-site dams and a proposed new 118 megalitre (ML) water storage dam on Marulan Creek. This dam will be on Boral owned land north of Peppertree Quarry and will use Boral's adjoining Tallong water pipeline to transfer water to the mine. This dam will require the purchase of water entitlements. Mine water demand in the earlier stages of the 30-year mine operations will also be supplemented by Tallong dam via the Tallong water pipeline and the groundwater production wells (WP16 and 17) north of the pit. Surface water runoff from active mining areas will drain to a network of sediment basins. Water captured in sediment basins will be pumped to the water storage dams to service the mine's water demand and to restore capacity in the sediment basins.
Operational workforce	Approximately 191 full time personnel are currently employed by Boral in connection with the mine, including lime manufacturing, administration and logistics. This includes 118 personnel on-site (excluding contractor personnel) and another 73 that are employed at other locations e.g. Berrima and Maldon Cement Works and North Ryde that would otherwise not be employed if it weren't for the mine. The Project will provide continued direct employment for 118 people on the mine site and 73 offsite.
Hours of operation	24-hours per day, 7 days per week. Blasting will continue during daylight hours on weekdays, excluding public holidays.
Blasting frequency	Blasting will continue at a frequency of up to one blast per day on weekdays, excluding public holidays, totalling five blasts per week.
Key environmental impacts and mitigation measures	The following key environmental impacts have been assessed through specialist technical assessments: ▪ surface water and hydrology; ▪ groundwater; ▪ air quality; ▪ noise and blasting; ▪ soils and rehabilitation; ▪ aboriginal heritage; ▪ historic heritage ▪ biodiversity; ▪ traffic; ▪ visual amenity; ▪ economics; ▪ social; and ▪ contamination. These technical specialist assessments have identified environmental management and mitigation measures which are to be implemented during construction and operational phases of the Project, to minimise environmental, social and economic impacts associated with the Project.

Project component	Summary of the Project
Capital investment value	$111 million.

Figure 1.2
Project overview

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

233 million tonnes

Expansion of mine void to extract 120 million tonnes of limestone, 5 million tonnes of shale and 108 million tonnes of overburden. Mining of eastern limestone, upper, middle and lower limestone members.

4.5 hectares (Road sales stockpile area)

Road sales stockpile area to store and despatch finished product by truck.

4 million tonnes

Produce up to 4 million tonnes of limestone and extraction of up to 200,000 tonnes of clay/shale per annum.

24/7

Operates 24 hours per day, 7 days a week.

720,000 tonnes by road per annum

600,000 tonnes per annum by road via Marulan South Road to the Hume Highway and 120,000 tonnes per annum to the agricultural lime manufacturing facility immediately west of the mine.

6 up to six trains departing the mine per day

Continued reliance on rail for the majority of finished product transport (up to six trains departing the mine per day).

108 million tonnes

New overburden emplacement areas to store up to 108 million tonnes of overburden.

$165 million

Net social benefits to Australia of $485 to 640 million over 30 years.

Net social benefits to NSW of $165 to 320 million over 30 years.

1.4 kilometre realignment

Proposed realignment of a section of Marulan South Road. Deregistration of Marulan South Road east of the Agricultural lime manufacturing facility.

118 megalitres

Proposed water supply dam on Marulan Creek (north of Peppertree Quarry).

1 million tonnes

1 million tonnes per annum of manufactured limestone sand transported across the road to Peppertree Quarry.

80 kilometres per hour

Upgrade of Marulan South Road.

Filling of south pit and rehabilitation to partially screen mine void from the Bungonia Lookdown.

1.4 kilometres

Realignment of high voltage powerlines.

256.5 hectares

256.5 hectares of new disturbance associated with the proposed 30 year mine plan.

191 full time staff

Continue to employ 191 full time personnel in connection with the mine. 118 on site and 73 off-site.

CAMBIUM GROUP

Source: Boral (2018), Cambium Group (2019).

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1.4 Project objectives

The Project has the following main objectives:

1. enable the continuation of limestone mining at Australia's oldest and largest limestone mine in an environmentally, socially and economically sustainable and ethical manner;
2. ensure the continued supply of around 60% of the cement sold in NSW and more than 30% of concrete sold in Sydney, which is critical to the delivery of over $22.5 billion in major infrastructure projects in Sydney and NSW; and
3. continue the direct and indirect employment of over 421 people (191 direct Boral employees, 90 contractors and 140 transport related personnel).

1.5 The applicant

Boral Cement Limited is a wholly owned subsidiary of Boral Limited and is the applicant for the Project. Boral Limited is an international building and construction materials group, headquartered in North Sydney, Australia. Boral's competitive position is underpinned by being a market leader in cement and construction materials in Australasia, Plasterboard and interior linings in Australia and Asia and a building product and flyash business in the USA.

The Boral Australia division has over 5,000 employees in its quarry, concrete, asphalt, concrete placing and cement operations. The business is a major supplier of products to the housing industry, commercial construction, and roads and engineering markets.

The Boral business operates over 110 quarries, sand pits and gravel operations, producing products such as concrete aggregates, crushed rock, asphalt and sealing aggregates, road base materials, sand and gravels for the Australian construction materials industry.

1.6 Document purpose

The Project is SSD pursuant to Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). Accordingly, approval is required under Part 4, Division 4.7 of the EP&A Act for the mine and associated facilities. This EIS has been prepared by Element Environment Pty Limited (Element) on behalf of Boral to support the SSD application for development consent under Section 4.12(8) of the EP&A Act. It has been prepared in accordance with the form and content requirements specified in clauses 6 and 7 of Schedule 2 of the NSW Environmental Planning and Assessment Regulation 2000 (EP&A Regulation). The schedule of lands to which this EIS applies is in **Appendix C**.

The primary objective of this EIS is to inform the public, government authorities and other stakeholders about the Project and the measures that will be implemented to mitigate, manage and/or monitor potential impacts, together with a description of the remaining social, economic and environmental impacts. It addresses the specific requirements provided in the Secretary's environmental assessment requirements (SEARs) issued by the Department of Planning and Environment (DPE) on 10 June 2015. The SEARs are provided in **Appendix A** along with a table identifying where each requirement has been addressed in the EIS. The EIS has also been prepared with input from several technical specialists

1.7 Secretary's Environmental Assessment Requirements (SEARs)

The SEARs and references to the relevant chapter and/or section of the EIS where they have been addressed are listed in Table 1.2. The requirements relevant to each environmental aspect are also provided at the introduction of each chapter for ease of reference. The SEARs (including government agency requirements) are reproduced in full in **Appendix A**.

Additionally, in accordance with the *Bilateral Agreement between the Commonwealth of Australia and the State of New South Wales relating to Environmental Assessment* (February 2015), the Commonwealth Department of the Environment and Energy (DoEE) has accredited the NSW SSD assessment process for the Project. Accordingly, the DoEE has provided its assessment requirements and these have been attached to the SEARs (**Appendix A**).

Provided the assessment requirements have been adequately addressed in this EIS, DPE are able to assess the Project and its level of impact on matters of national environmental significance (MNES) and determine the Project pursuant to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), on behalf of the Commonwealth Minister for Environment.

Table 1.2: Project SEARs

Secretary's Environmental Assessment Requirement (SEAR)	EIS Reference/Section
GENERAL The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*. In addition, the EIS must include:	Section 6.3.6
▪ A full description of the development, including: 1. the resource to be extracted, demonstrating efficient resource recovery within environmental constraints;	Chapter 4
2. the mine layout and scheduling;	Section 4.5
3. minerals processing;	Section 4.4.1
4. surface infrastructure and facilities;	Section 4.4
5. a waste (overburden, tailings, etc.) management strategy, having regard to the EPA's requirements (see Attachment 2);	Section 3.1.14, Section 4.5, Chapter 22, Chapter 26
6. a water management strategy, having regard to the EPA's, NSW Office of Water's and Water NSW's requirements; and	Section 3.1.8, Section 3.1.13, Section 4.4.2, Section 4.5, Section 4.9.2, Section 8.3
7. a rehabilitation strategy, having regard to DRE's requirements;	Chapter 26
▪ A list of any approvals that must be obtained before the development may commence;	Section 6.5
▪ An assessment of the likely impacts of the development on the environment, focussing on the specific issues identified below, including:	Chapters 8-26
a. a description of the existing environment likely to be affected by the development, using sufficient baseline data;	Chapter 2
b. an assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice;	Chapters 8-26
c. a description of the measures that would be implemented to mitigate and/or offset the potential impacts of the development, and an assessment of: - whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented;	Chapters 8-26, Chapter 29
- the likely effectiveness of these measures; and	As above
- whether contingency plans would be necessary to manage any residual risks;	As above

Secretary's Environmental Assessment Requirement (SEAR)	EIS Reference/Section
d. a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved;	Section 29.3, Section 29.4
- A consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS;	Chapter 29
- Consideration of the development against all relevant environmental planning instruments (including Part 3 of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007); and	Chapter 6
- The reasons why the development should be approved having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development.	Section 1.2, Section 6.3.5, chapters 8-26
While not exhaustive, Attachment 1 of the DP&E SEARS contains a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development. In addition to the matters set out in Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*, the development application must be accompanied by a signed report from a suitably qualified expert that includes an accurate estimate of the: ▪ Capital investment value (as defined in Clause 3 of the Environmental Planning and Assessment Regulation 2000) of the development, including details of all the assumptions and components from which the capital investment value calculation is derived; and	Appendix A
▪ Jobs that would be created during each stage of the development.	Appendix B
SOILS (LAND) AND REHABILITATION ▪ An assessment of the likely impacts of the development on the soils, land capability, and landforms (topography) of the site;	Chapter 10
▪ An assessment of the likely agricultural impacts of the development; and	Section 10.3.2
▪ An assessment of the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements in Clause 12 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.	Section 6.4.1
WATER ▪ An assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the EPA's, NSW Office of Water's and Water NSW's requirements and the NSW Aquifer Interference Policy;	Section 8.2.2, Section 9.3.2, Section 9.3.5
▪ An assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users;	Section 8.2.2, Section 9.3.1, Section 9.3.2
▪ A detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;	Section 8.2.1
▪ Demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan;	Section 6.3.10, Section 8.3.4
▪ A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant Water Sharing Plan or water source embargo; and	Section 6.3.10, Section 8.3.4

Secretary's Environmental Assessment Requirement (SEAR)	EIS Reference/Section
▪ A detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.	Section 3.1.8, Section 4.4.2, Section 4.5, Section 8.3.2, Section 9.4
AIR QUALITY	
▪ An assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW and the EPA's additional requirements, and having regard to the NSW Government's Voluntary Land Acquisition and Mitigation Policy: For State Significant Mining, Petroleum and Extractive Industry Developments; and	Section 17.2
▪ An assessment of the likely greenhouse gas impacts of the development, having regard to the EPA's requirements.	Chapter 17
NOISE AND BLASTING	
▪ An assessment of the likely operational noise impacts of the development (including construction noise) under the NSW Industrial Noise Policy, including the obligations in chapters 8 and 9 of the policy,	Section 19.3
▪ If a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the Interim Construction Noise Guideline;	Section 19.2.3, Section 19.3.2
▪ An assessment of the likely road noise impacts of the development under the NSW Road Noise Policy;	Section 19.3.3
▪ An assessment of the likely rail noise impacts of the development under the Rail Infrastructure Noise Guideline; and	Section 19.3.4
▪ An assessment of the likely blasting impacts of the development on people, livestock, buildings, infrastructure, and significant natural features, having regard to the relevant ANZECC guidelines.	Section 19.3.5
BIODIVERSITY	
▪ An assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the NSW Biodiversity Offsets Policy for Major Projects and the requirements of OEH;	Section 12.3
▪ Measures taken to avoid, reduce or mitigate impacts on biodiversity;	Section 12.4
▪ Accurate estimates of proposed vegetation clearing; and	Section 12.3
▪ A comprehensive offset strategy to ensure the development maintains or improves biodiversity values of the region in the medium to long term.	Section 12.5.1
HERITAGE	
▪ An Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must: ▪ Demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; and	Chapter 15, Section 5.3
a. Outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures), having regard to OEH's requirements.	Section 15.5
▪ A Historic heritage assessment (including archaeology) which must: a. Include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items; and	Section 16.3

Secretary's Environmental Assessment Requirement (SEAR)	EIS Reference/Section
b. Outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures), having regard to the Heritage Branch of NSW's requirements.	Section 16.4
VISUAL ▪ An assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to the temporary and permanent modification of the landscape during the various stages of the project (overburden dumps, bunds, etc.), and minimising the lighting impacts of the development.	Chapter 20
TRAFFIC AND TRANSPORT ▪ Accurate predictions of the road and rail traffic generated by the development;	Section 22.2.2, Section 22.2.9
▪ An assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the local and State road and rail network; and	Section 21.2
▪ A detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the development, having regard to Transport NSW's and Goulburn Mulwaree Council's requirements.	Section 21.3
HAZARDS ▪ An assessment of the likely risks to public safety, paying particular attention to the handling, transport and use of dangerous goods and potential bushfire risks, and in accordance with State Environmental Planning Policy No. 33 – Hazardous and Offensive Development.	Chapter 23
SOCIAL AND ECONOMICAL ▪ An assessment of the likely social impacts of the development; and	Chapter 25
▪ An assessment of the likely economic impacts of the development, paying particular attention to:	Chapter 24
a. The significance of the resource;	Section 24.5.1
b. Economic benefits of the project for the State and region; and	Section 24.5.2
c. The demand for the provision of local infrastructure and services.	Section 24.5.3
STAKEHOLDER CONSULTATION During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners. The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	Chapter 5, Chapter 25

1.8 Document Structure

This EIS includes the main report that describes the Project in the context of the existing environment, the planning framework, key environmental issues, potential impacts, proposed mitigation measures and residual impacts. It is informed by the technical assessments contained in the appendices and provides a concise summary of these specialist assessments.

The structure of the EIS is summarised in **Table 1.3**.

Table 1.3: EIS structure

Chapter	Description
Main report	
Preliminary	▪ EIS certification; ▪ Executive summary;
Chapter 1: Introduction	▪ Discusses the background to the Project; ▪ Introduces the Project and the applicant; ▪ Discusses the justification for the Project; ▪ Provides the document structure; and ▪ Provides an overview of the approval process and SEARs issued for the Project.
Chapter 2: Site description	▪ Provides an outline and description of the existing site status, location, land use and a description of the surrounding environment.
Chapter 3: Existing operations	▪ Provides a description of the historical mine ownership, planning approval history, existing mine operations and current environmental management system.
Chapter 4: The proposed Project	▪ Describes the Project including construction and operational parameters.
Chapter 5: Stakeholder engagement	▪ Discusses the engagement strategies of the Project; and ▪ Details how consultation has been addressed in the EIS.
Chapter 6: Planning framework	▪ Identifies the applicable local and regional environmental planning instruments, the relevant State and Commonwealth environment and planning legislation and regulations and discusses other approvals and permits that may be applicable to the Project.
Chapter 7: Environmental assessment approach	▪ Introduces the approach taken by the project team to identify key environmental, social and economic issues associated with the Project and how these issues were considered in the polycentric decision making approach to developing the preferred 30-year mine plan.
Chapter 8 - 26: Environmental impact assessment	▪ These chapters assess key environmental issues, and the potential impact of the Project; and ▪ Describe the management measures proposed to mitigate and reduce potential adverse environmental risk of the Project and/or offset any unavoidable impacts.
Chapter 27: Revised environmental risk analysis	▪ Re-presents the preliminary risk ratings from the start of the Project and assigns a revised risk rating to all key environmental factors assessed in this EIS after mine design reiterations, avoidance, minimisation, mitigation and offsetting has been considered.
Chapter 28: Project alternatives	▪ Describes how the mine plan and do-nothing alternatives were evaluated.
Chapter 29: Environmental management, monitoring & reporting	▪ Provides a consolidated summary of all recommended management and mitigation measures identified by the EIS, and outlines Boral's approach to responsible environmental management, monitoring and reporting of the Project.
Chapter 30: Conclusion	▪ Draws conclusions based on the overall impacts and benefits of the Project.
Chapter 31: References	▪ Contains references used throughout this EIS.
Chapter 32: Abbreviations	▪ Abbreviations.
Appendices	
Appendix A Stakeholder Consultation	▪ Secretary's Environmental Assessment Requirements June 2015 including Government Agency response letters to the PEA and SEARs.
Appendix B Quantity Surveyor's Report	▪ QS report on capital investment value of the Project; and ▪ Boral statement on job creation.

Chapter	Description
Appendix C Schedule of Lands	▪ Map of all properties within the Project boundary; and ▪ Spreadsheet of all properties within the Project Boundary including Lot and DP numbers.
Appendix D Geological Report	▪ Geological report prepared to address the Department of Resources and Geoscience's SEARs (GeoRes, 2018).
Appendix E Geotechnical Assessment	▪ Geotechnical assessment report on the proposed 30-year mine plan.
Appendix F Marulan Creek dam Concept Design Report	▪ Concept design report on the proposed Marulan Creek dam including alternative locations.
Appendix G Surface Water Assessment	▪ Surface Water Assessment, (Advisian, 2019).
Appendix H Groundwater Assessment	▪ Groundwater Technical Study, (Australasian Groundwater and Environmental Consultants, 2019).
Appendix I Soil, Land Resources and Rehabilitation Assessment	▪ Soil, Land Resources and Rehabilitation Assessment, (LAMAC, 2018). ▪ Soil and land resources identification and mapping, land capability assessment, agricultural impact assessment (including assessment of Biophysical Strategic Agricultural Land (BSAL) and Site Verification Certificate)), topsoil resource identification and rehabilitation and mine closure strategy.
Appendix J Phase 1 and 2 Environmental Site Assessment	▪ Phase 1 and 2 Environmental Site Assessment, (ZOIC, 2018).
Appendix K Biodiversity Development Assessment Report	▪ Biodiversity Development Assessment Report, (Niche Environment and Heritage, 2019a).
Appendix L Aquatic Ecology Assessment	▪ Aquatic Ecology Assessment, (Niche Environment and Heritage, 2018b).
Appendix M Stygofauna and Groundwater Dependent Ecosystem Assessment	▪ Stygofauna and Groundwater Dependent Ecosystem Assessment, (Niche Environment and Heritage, 2018c).
Appendix N Aboriginal Cultural Heritage Assessment	▪ Aboriginal Cultural Heritage Assessment, (EMM Consulting, 2018a).
Appendix O Historic Heritage Assessment	▪ Historic Heritage Assessment, (EMM Consulting, 2018b).
Appendix P Air Quality Assessment	▪ Air Quality Impact Assessment, (Todoroski Air Sciences, 2019).
Appendix Q Greenhouse Gas Assessment	▪ Greenhouse Gas Emissions Assessment, (Edge Environment, 2018).
Appendix R Noise and Blasting Assessment	▪ Noise and Blasting Assessment, (Wilkinson Murray, 2019).
Appendix S Visual Assessment	▪ Visual Impact Assessment, (Richard Lamb and Associates , 2018).
Appendix T Traffic Assessment	▪ Traffic Impact Assessment, (Transport and Urban Planning, 2019).
Appendix U Economic Assessment	▪ Economic Assessment, (Gillespie Economics, 2019).
Appendix V Social Impact Assessment	▪ Social Impact Assessment, (Element Environment, 2019).

Chapter 2

Site description

VOLUME 1

2 SITE DESCRIPTION

2.1 Site location and character

2.1.1 Location

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) in the Southern Tablelands of NSW and the South Eastern Highlands Bioregion, which covers approximately 6% of the state (**Figure 1.2**). The Project site covers approximately 0.01% of the bioregion and separates extensively cleared agricultural and commercial land uses to the west from the protected areas of Morton National Park (NP) to the east and Bungonia NP and Bungonia State Conservation Area (SCA) to the south.

The mine is separated from the Bungonia NP and SCA to the south by Bungonia Creek and is separated from the Shoalhaven River and Morton NP to the east by Barbers Creek.

2.1.2 Zoning

The majority 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. Permissibility of the Project under the LEP is described in **Section 6.3.3**.

Figure 2.3 shows LEP zoning boundaries as they apply to the Project site.

2.1.3 Access and road network

Access is via Marulan South Road, which connects the mine and Peppertree Quarry with the Hume Highway approximately 9 km to the north-west (**Figure 2.1**). Boral's private rail line connects the mine and Peppertree Quarry with the Main Southern Railway approximately 6 km to the north (**Figure 2.2**).

Marulan South Road, a two-lane rural road is predominantly 80 km/h except at/near the Hume Highway intersection and at the mine where it is 60 km/h.

The main intersections along Marulan South Road are:

- Hume Highway grade separated interchange intersection which provides access to Marulan South Road and Jerrara Road, as well as to Holcim's Lynwood Quarry, which is north of the Hume Highway.
- Marulan Creek Road/Tangarang Road, which are unsealed gravel roads and form a minor cross section intersection with Marulan South Road under priority control.
- The agricultural lime manufacturing facility access road forms a channelised T junction intersection under priority control.

The Hume Highway is a high standard four lane divided road with dual carriageways. It is the main road between Sydney, Canberra and Melbourne, and services towns in south-western NSW, and the ACT.

In the Marulan area the Hume Highway provides two through lanes in each direction plus additional turning and/or diverging/merging lanes at intersections for vehicles entering or leaving the Highway.

The speed limit on this section of the Hume Highway is 110 km/h.

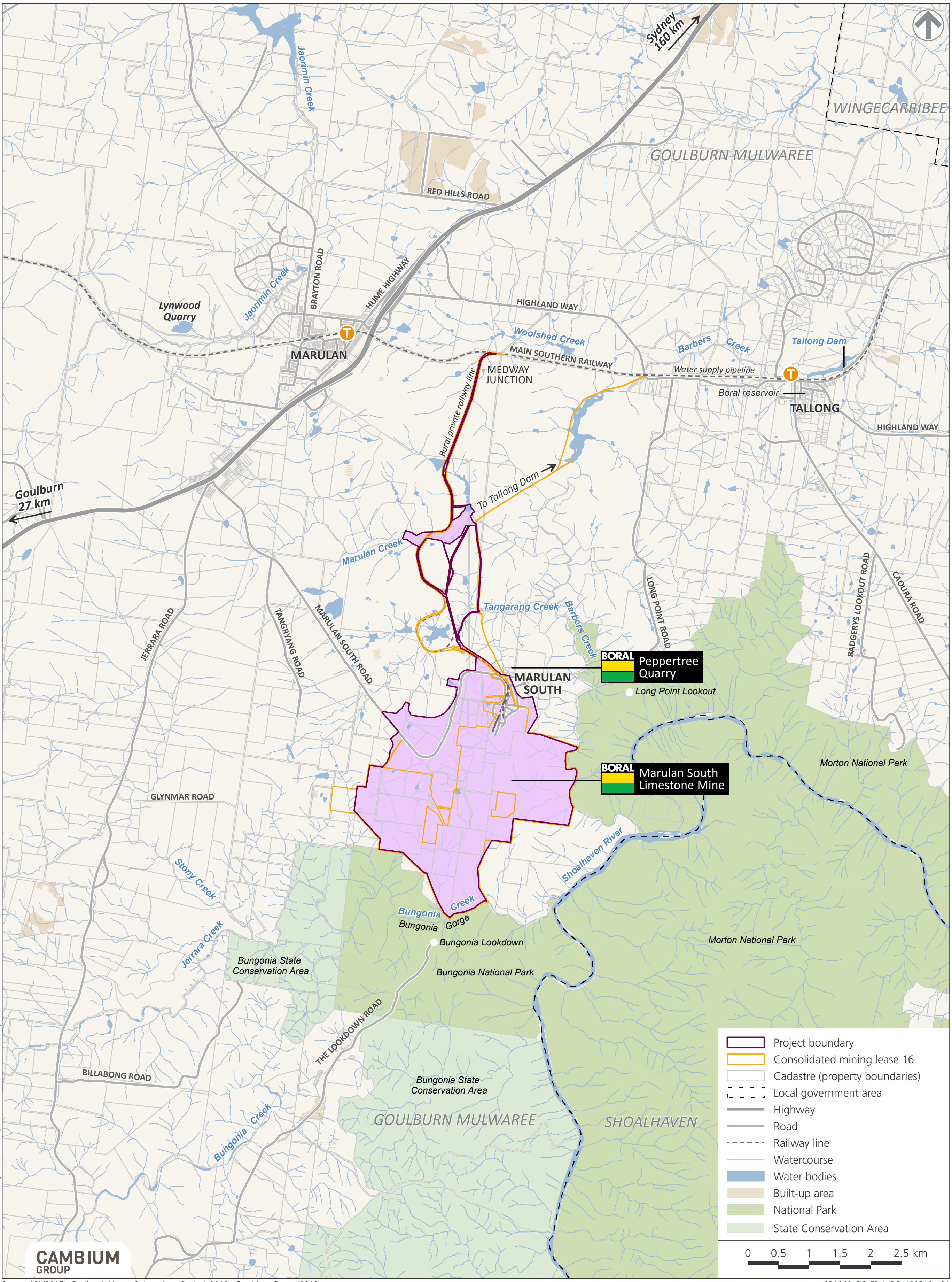
The principal intersections along the Hume Highway between Marulan and Marulan South are:

- A grade separated interchange at the northern end of Marulan that provides the main access to/from the township including access to George Street.
- A grade separated interchange at Old Marulan that provides access to Marulan South Road and Jerrara Road as well as to Holcim’s Lynwood Quarry. This interchange includes a roundabout at the southbound ramps and a conventional cross junction intersection at the northbound ramps.

The speed limit at these intersections is 60 km/h.

Figure 2.1
Regional context

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



CAMBIUM GROUP

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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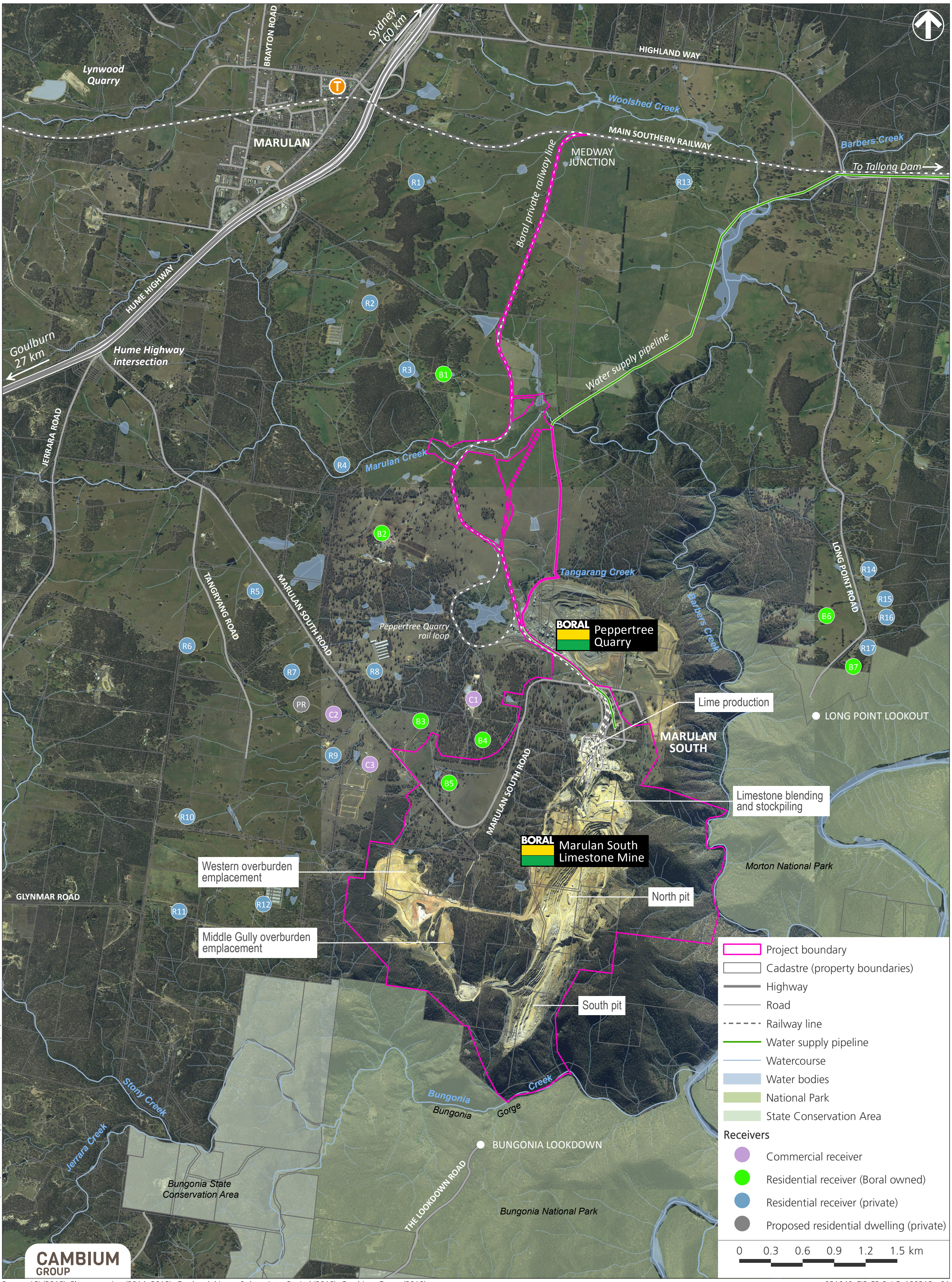
Figure 2.2
Local context

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



Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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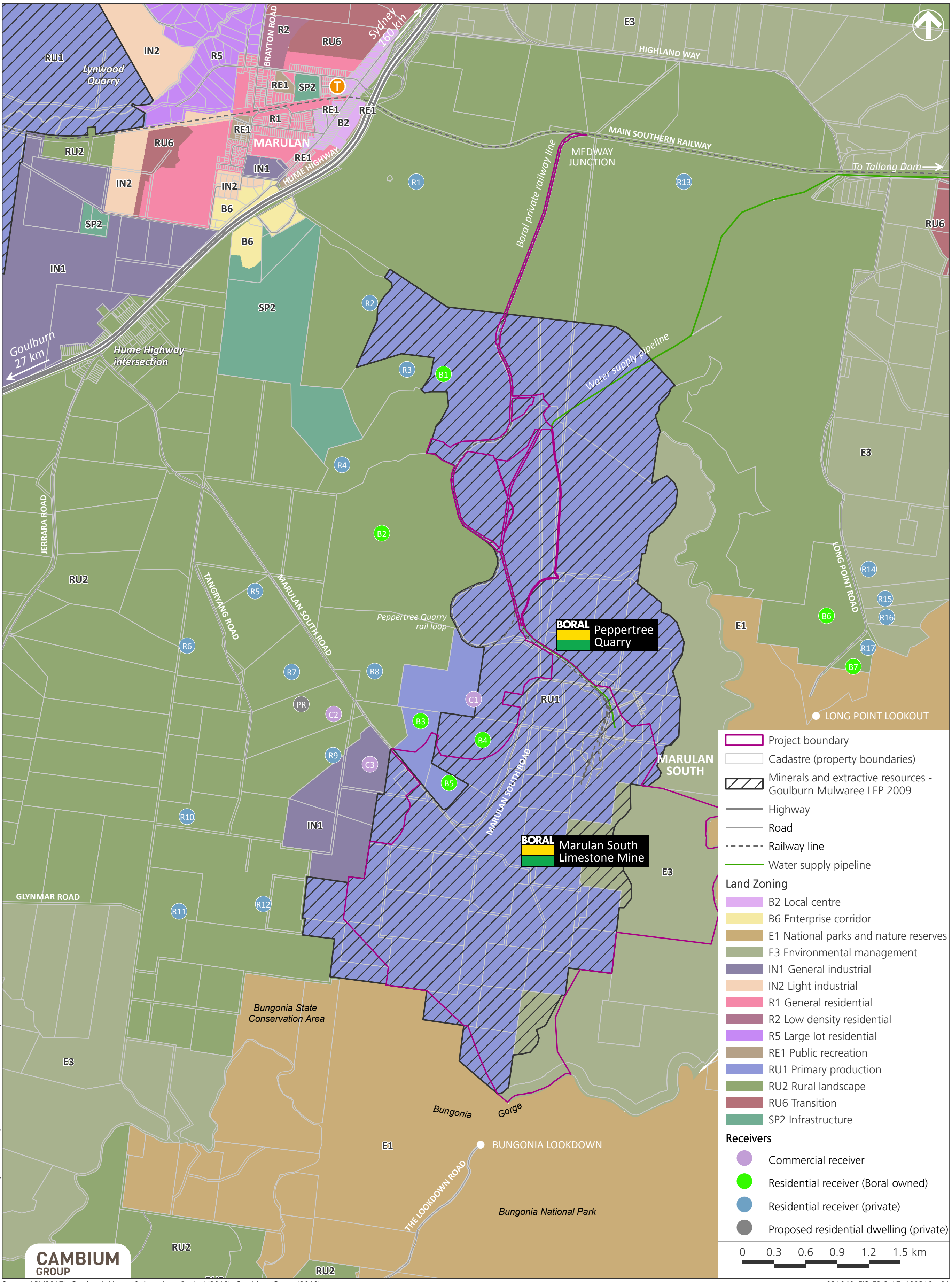
Figure 2.3
Land zoning

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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2.2 Biophysical factors

2.2.1 Baseline monitoring overview

Overview

Boral has established a surface water, groundwater, meteorological and air quality monitoring network to gain an understanding of the biophysical properties of the Project site and surrounds. Baseline monitoring locations are shown on **Figure 2.4**.

Surface water monitoring

Surface water in the mine has been monitored at the Main Gully Sample Point irregularly up to 2014 and continuously since 2014. Samples were taken monthly and quarterly to 2017 then quarterly after 2017. There is also an auto sampler in Main Gully which commences sampling when there is sufficient water velocity. Key analytes are summarised in **Table 2.1**.

Table 2.1: Key analytes at Main Gully

Analyte	Unit	Statistics	Main Gully Sample Point	Main Gully Auto Sampler	ANZECC default*
pH	pH value	Count	21	87	6.5 – 7.5
		20th %ile	8.0	8.1	
		Median	8.1	8.2	
		80th %ile	8.2	8.3	
Electrical conductivity (EC) @ 25˚C	µS/cm	Count	21	87	350**
		20th %ile	590	400	
		Median	610	484	
		80th %ile	630	570	
Total dissolved solids (TDS)	mg/L	Count	21	33	N/A
		20th %ile	356	313	
		Median	369	350	
		80th %ile	390	400	
Suspended solids	mg/L	Count	15	119	N/A
		20th %ile	1.8	78.2	
		Median	8.1	166	
		80th %ile	9.2	620	

* Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000) (ANZECC) guidelines for slightly to moderately disturbed ecosystems.
** 80th %ile EC default value in ANZECC guideline.

The following observations can be made on the above data:

- pH is slightly alkaline, which is consistent with the pH range in Bungonia Creek;
- salinity at the sampling points is above the ANZECC guideline but the Main Gully Sample Point is consistent with the salinity range in Bungonia Creek and the Main Gully Auto Sampler is less than median salinity in the creek; and
- suspended solids at the Main Gully Sample Point is consistent with the median value for Bungonia Creek (<5 mg/L) but is much higher at the Main Gully Auto Sampler.

The Main Gully Sample Point data shows the quality of water discharges is consistent with the quality of receiving waters.

Surface water quality is monitored around the mine and Peppertree Quarry at the water monitoring sites below and with the frequencies summarised in **Table 2.2**.

- U1 – Tangarang Creek upstream of Peppertree Quarry dam 1 (Tangarang dam);
- T1 – Tangarang Creek downstream of Peppertree Quarry dam 1;
- Marulan Up – Marulan Creek upstream of the mine's proposed Marulan Creek dam;
- Marulan Dn – Marulan Creek downstream of the Marulan Creek dam;
- Barbers Up – Barbers Creek upstream of the mine;
- Barbers Dn – Barbers Creek downstream of the mine;
- Bungonia Up – Bungonia Creek upstream of Main Gully tributary confluence;
- Bungonia Dn – Bungonia Creek downstream of Main Gully tributary confluence; and
- SR1/2/3 – Shoalhaven River sites 1 (upstream of Bungonia Creek confluence), 2 (between the Bungonia and Barbers Creek confluences) and 3 (downstream of the Barbers Creek confluence).

The analytes in **Table 2.2** are compared to the trigger values in the ANZECC guidelines for South East Australia, slightly to moderately disturbed ecosystems, upland rivers.

Key analytes from WaterNSW water quality monitoring at Fossickers Flat on the Shoalhaven River are summarised in **Table 2.3** for comparison.

The monitoring results for waterways near the Project site show the following:

- Shoalhaven River – water quality declines slightly between the upstream monitoring point (SR1) and downstream point (SR3) but are within the ANZECC guidelines for ecosystem protection. The WaterNSW results are similar to results for Boral's Shoalhaven River monitoring, which confirms the Boral monitoring represents baseline water quality.
- Bungonia and Barbers creeks – water quality declines slightly between the upstream and downstream monitoring points, which indicates broader land use and runoff issues. This difference is not significant which indicates the mine does not currently significantly impact water quality in these streams. Light brown sediment has been observed on the bed of Main Gully (a tributary of Bungonia Creek) in the past, which is fed by the Main Gully Spring 'Blow Hole' (a groundwater outlet to the south of the south pit). This indicates that there has been sediment discharge from the Blow Hole in the past.
- Marulan and Tangarang creeks – some water quality parameters improve as water moves downstream along Tangarang and Marulan creeks into Barbers Creek. Barbers Creek has better water quality than its tributaries, which indicates dilution of analytes in the creek.

Table 2.2: Summary of existing water quality and default ANZECC trigger values

Analyte/unit	Trigger value	Statistic	Monitoring site										
			U1	T1	Marulan Up	Marulan Dn	Barbers Up	Barbers Dn	SR1	SR2	SR3	Bungonia Up	Bungonia Dn
Commenced			Feb 2012	Feb 2012	Nov 2014	Nov 2014	Sept 2014	Sept 2014	Jul 2014	Jul 2014	Jul 2014	Jul 2014	Jul 2014
Frequency			Quarterly during flow event	Quarterly during flow event	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly	Monthly to Sep '17 then quarterly
pH	6.5-7.5	Count	3.0	24.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0	31.0	31.0
		20%ile	7.5	7.7	7.6	7.8	7.8	7.9	7.3	7.2	7.2	7.6	7.9
		Median	7.6	8.1	7.8	8.0	8.0	8.0	7.4	7.4	7.4	7.7	8.1
		80%ile	7.8	8.3	7.9	8.2	8.1	8.1	7.5	7.5	7.5	7.9	8.2
Electrical conductivity (EC) @ 25˚C (µS/cm)	350	Count	0	0	25.0	25.0	28.0	27.0	30.0	30.0	30.0	31	31
		20%ile			451.0	648.0	414.0	445.0	84.0	89.0	94.0	447	481
		Median			1,160.0	1,000.0	541.0	553.0	103.0	105.0	110.0	589	581
		80%ile			1,556.0	1,248.0	853.0	933.0	139.0	143.0	146.0	743	682
Total dissolved solids (TDS) (mg/L)	N/A	Count	3.0	24.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0	31	31
		20%ile	98.4	339.8	293.0	421.0	269.0	290.0	55.0	58.0	61.0	290	313
		Median	159.0	444.0	754.0	650.0	352.0	359.0	67.0	69.0	72.0	383	378
		80%ile	175.2	583.4	1,014.0	811.0	555.0	607.0	90.0	93.0	95.0	483	443
Suspended solids (mg/L)	N/A	Count	3.0	24.0	16.0	16.0	18.0	17.0	18.0	18.0	18.0	22	18
		20%ile	5.5	<5.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3	3
		Median	10.0	4.4	7.0	3.0	3.0	3.0	3.0	3.0	3.0	3	3
		80%ile	20.8	40.6	10.0	6.0	3.0	3.0	8.0	6.0	8	5	6
Total nitrogen (mg/L)	0.25	Count	0	0	25.0	25.0	28.0	27.0	30.0	30.0	30.0	28	31
		20%ile			0.48	0.40	0.34	0.20	0.28	0.20	0.30	0.50	1.50
		Median			0.80	0.60	0.40	0.50	0.45	0.40	0.45	0.80	2.30
		80%ile			1.02	0.80	0.66	0.60	0.60	0.50	0.62	1.36	3.60
Total phosphorus (mg/L)	0.02	Count	3	24	25.0	25.0	28.0	27.0	30.0	30.0	30.0	28	31
		20%ile	0.13	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
		Median	0.26	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
		80%ile	0.50	0.03	0.08	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02

Table 2.3: Shoalhaven River monitoring results

Analyte		2010/11	2011/12	2012/13	2013/14	2014/15
Conductivity (µS/cm)	Sample no.	11	8	12	11	11
	Median	107	93	134	110	100
pH (field)	Sample no.	11	8	12	11	11
	Median	7.5	7.5	7.5	7.0	7.2
Suspended solids (mg/L)	Sample no.	11	8	12	11	11
	Median	5	3.5	1	4	4

Groundwater monitoring

There are 11 permanent groundwater monitoring wells in the Project site, as summarised in **Table 2.4**.

Table 2.4: Groundwater monitoring and pumping wells in the Project site

Well ID	Well screen depth (m below ground level)		Screened formation	Purpose
	From	To		
MW1	36.5	60.5	Limestone – north pit	Water quality and level monitoring
MW2	41.4	59.4	Limestone – south pit	Water quality and level monitoring
MW3S	39	48	Weathered regolith	Water quality and level monitoring
MW3D	72	102	Weathered volcanics (dacite)	Water quality and level monitoring
MW4S	26	38	Weathered regolith, volcanics (tuffs)	Water quality and level monitoring
MW4D	83	123	Volcanics (tuffs)	Water quality and level monitoring
MW5	73	97	Weathered regolith, weathered volcanics (dacite)	Water quality and level monitoring
MW6	109.5	127.5	Sandstone	Water quality and level monitoring
MW7	68	80	Volcanics (andesite)	Water quality and level monitoring
WP16[1]	Not known		Limestone	Water quality and pumping (supply)
WP17[2]	Not known		Limestone	Water quality and pumping (supply)

[1] Identified as Licensed Discharge Point 13 in EPL944 and GW110267 in Department of Primary Industries (DPI) Water registry.
[2] GW110268 in DPI Water registry.

Twenty exploration bores were converted to a temporary groundwater monitoring network in 2016 to establish the depth to groundwater. Most bores were dry or collapsed but levels were measured in three bores, which were along the northern portion of the pit and indicated groundwater was deeper than 150 m below ground level. This indicated the western limestone units are largely unsaturated.

Data started being collected from the groundwater monitoring well network in 2014 to provide at least two years of baseline data prior to the SSD application to comply with the *NSW Aquifer Interference Policy* (AIP) (NSW Government, 2012b).

Groundwater levels in the monitoring wells are monitored manually and automatically (daily). Water levels in the in-pit wells fluctuate with rainfall, with levels rising over 10 m on some occasions. Water levels slowly return to static for days and weeks after rainfall as water seeps from ponds on the pit floor.

The lowest recorded groundwater depth in MW1 was approximately 412 m AHD in January 2015 and the highest was approximately 432 m AHD in July 2016, showing a range of 20 m. Groundwater levels in MW2 have a floor of approximately 340 m AHD and have reached a height of 352 m AHD in May 2016, showing a range of 12 m.

The filling and emptying pattern at MW1 indicates there is poor hydraulic connection between the limestone and surrounding fractured rock in this location, as water rises and declines more slowly in this bore. However, water appeared to drain preferentially through larger fractures elsewhere in the pit, indicating MW1 monitors a less permeable matrix. This changed after 2015 to be similar to the MW2 hydrograph, possibly due to development of blast induced fractures around MW1.

Wells adjacent to, but not in, the pits do not show significant response to rain. However, MW3S, MW3D and MW4D have recorded a slow increase over the monitoring period. This indicates a slow recharge by slow lateral flow from surrounding areas and/or slow vertical seepage through the overlying weather regolith. MW4S and MW5 show an overall slow decrease in groundwater levels.

This suggests the regolith layer is a temporary store of recharging rainfall, buffering the fluctuations in groundwater levels below the regolith. In contrast, within the pit area where the regolith has been removed, the fluctuations are more rapid as this buffering layer is not present.

Groundwater quality

The pH and salinity (EC) of groundwater have been sampled from the wells installed in 2014 and WP16 every month for two years since April 2014, with the bores now sampled every quarter. The ionic composition of the groundwater was also analysed to show the groundwater types and source geology.

The groundwater is typically neutral to slightly alkaline, and alkaline in places. It is fresh to slightly brackish. Groundwater from the limestone (MW1, MW2 and WP16) (EC of 270 µS/cm to 1,060 µS/cm) has lower EC than the volcanics. Samples from the volcanics recorded EC up to 3,870 µS/cm (MW5). The range of EC (dissolved salts) indicates the groundwater is of marginal use for drinking water but suitable for stock and environmental water.

Groundwater in both the limestone and volcanics was slightly alkaline to alkaline (mean pH 7.4 to 8).

The cation-anion ratios indicate the groundwater is from three host geological units:

- Tangerang Formation (tuff) – magnesium-potassium-sodium-bicarbonate dominant water;
- Tangerang Formation (Carne Dacite) – magnesium-potassium-sodium-chloride dominant water; and
- Eastern Limestone and Adaminaby Group sandstone – calcium-bicarbonate dominant water.

Groundwater from the non-limestone units has a higher EC. The calcium-bicarbonate water type from the wells screened in the limestone reflects the host geology and dissolution of limestone. The grouping of water quality data from the limestone, Tangerang Formation (Dacite/Tuff) and Adaminaby Sandstone suggests interconnectivity and mixing of groundwater between these units.

Air quality

The local air quality monitoring network comprises:

- Mine and Peppertree Quarry – two high volume air samplers (HVAS) measuring either total suspended particulate matter (TSP) or particulate matter with an aerodynamic radius of less than 10 µm (PM_{10}) and six dust deposition gauges (**Figure 2.4**).
- Lynwood Quarry – two HVAS monitoring PM_{10} and eight dust deposition gauges (**Figure 2.4**).
- Office of Environment and Heritage (OEH) – PM_{10}, particulate matter with an aerodynamic radius of 2.5 µm or less ($PM_{2.5}$), NO_2 and SO_2 monitoring at Wollongong and Bargo.

Air quality criteria are defined further in **Chapter 17**. The following relate to air quality monitoring and results.

- PM_{10}:
  - levels at the mine and Peppertree Quarry are elevated compared to the levels at Lynwood Quarry, possibly because the monitors are closer to extraction activities at the mine and Peppertree Quarry;
  - concentrations follow a seasonal trend and are highest in spring and summer;
  - the annual average PM_{10} concentrations recorded at the mine, Lynwood Quarry, Wollongong and Bargo monitoring stations were below the relevant criterion for all years reviewed between 2011 and 2017 (**Table 2.5**); and
  - background levels exceeded the maximum 24-hour average criterion 15 times at the mine, nine times at Wollongong and 10 times at Bargo between 2011 and 2017 (**Table 2.5**).

- $PM_{2.5}$:
  - the annual average $PM_{2.5}$ concentrations recorded at the Wollongong and Bargo monitoring stations were below the relevant criterion between 2011 and 2017 (**Table 2.6**); and
  - background levels exceeded the maximum 24-hour average criterion three times at Wollongong between 2011 and 2017 (**Table 2.6**), with the highest exceedance likely due to a bushfire.

- TSP – the annual average TSP concentrations recorded at the mine HVAS were below the relevant criterion between 2011 and 2017. Concentrations follow a seasonal trend and are highest in spring and summer (**Table 2.7**).
- Dust deposition:
  - the majority of mine and Peppertree Quarry dust gauges recorded annual average insoluble deposition levels below the relevant criterion between 2012 and 2016 (**Table 2.8**);
  - gauges with readings that exceed the criterion are generally located too close to the mine or Peppertree Quarry and do not represent impacts at sensitive receivers (**Table 2.8**); and
  - some of the gauges that exceed the criterion were contaminated with bird and/or insects, which can increase the insoluble solid content.

- NO_2 and SO_2:
  - the maximum daily 1-hour average NO_2 concentrations recorded at the Wollongong and Bargo monitoring stations were well below the relevant criterion between 2011 and 2017 (refer to Figure 6-11 in **Appendix P**). Background recorded levels show seasonal fluctuation with higher levels in winter;
  - the maximum daily 1-hour average SO_2 concentrations recorded at the Wollongong and Bargo monitoring stations were well below the relevant criterion between 2011 and 2017 (refer to Figure 6-12 in **Appendix P**); and

- The monitoring data from the Wollongong and Bargo monitoring stations are representative of a more densely populated area with greater influences of anthropogenic sources (e.g. power stations, industrial facilities, vehicle exhaust and other combustion sources) compared to the area surrounding the Project site.

Figure 2.4
Environmental monitoring locations

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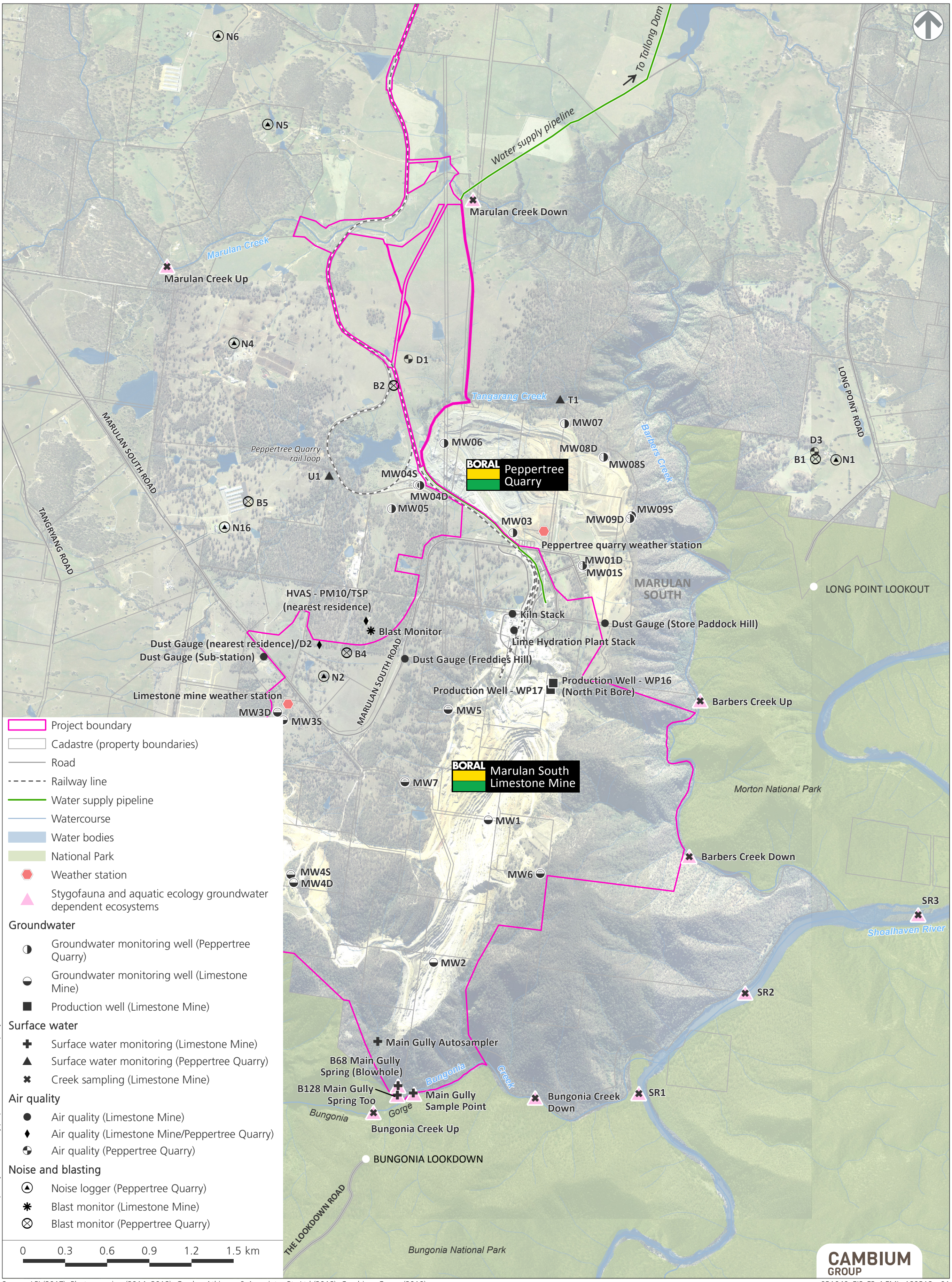
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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Table 2.5: PM_{10} levels from HVAS monitoring

Year	HVAS – Limestone mine	Site 1 – Lynwood*	Site 2 – Lynwood	Wollongong	Bargo
Annual average (µg/m³) (criterion 25 µg/m³)					
2011	-	-	-	17.0	12.9
2012	15.9	8.0	3.9	18.0	14.3
2013	13.8	10.0	-	17.6	15.3
2014	17.9	7.9	-	17.7	14.5
2015	23.7	12.1	-	16.9	13.4
2016	16.8	9.4	9.2	17.3	14.4
2017	24.8	9.1	12.6	17.1	14.1
Maximum 24-hour average (µg/m³) (criterion 50 µg/m³)					
2011	37.5	20.5	8.7	48.5	**89.7**
2012	**70.4**	38.1	11.8	47.5	45.2
2013	42.2	36.7	11.3	**93.8**	**208.9****
2014	**50.5**	20.6	18.2	45.3	**50.8**
2015	**158.3**	31.9	43.4	45.8	**52.2**
2016	**58.2**	23.2	21.9	**52.9**	**58.4**
2017	**64.7**	39.5	36.7	**55.2**	**53.5**

* Subject to technical issues.
** There was a nearby bushfire on the day of this exceedance.

Table 2.6: $PM_{2.5}$ levels from OEH Wollongong and Bargo monitors

Year	Wollongong	Bargo
Annual average (µg/m³) (criterion 8 µg/m³)		
2011	4.6	-
2012	4.6	-
2013	7.7	-
2014	7.0	-
2015	7.6	-
2016	7.4	-
2017	7.1	6.3
Maximum 24-hour average (µg/m³) (criterion 25 µg/m³)		
2011	17.7	-
2012	15.6	-
2013	**88.4**	-
2014	17.3	-
2015	**31.6**	-
2016	**33.7**	11.5
2017	24.7	20.9

Table 2.7: TSP levels from Limestone mine HVAS monitoring

Year	Level (µg/m³)
Annual average (criterion 90 µg/m³)	
2011	32.1
2012	31.4

Year	Level (μg/m³)
2013	28.3
2014	39.5
2015	46.4
2016	38.8
2017	52.1

Table 2.8: Annual average dust deposition at the mine and Peppertree Quarry

Year	Level (μg/m³)					
Annual average (criterion 4 μg/m³)						
	Sub Station	**Freddie's Hill**	**Store Paddock**	**D1**	**D2**	**D3**
2012	3.7	3.4	**7.0**	**6.8**	1.9	2.3
2013	2.5	3.3	3.6	**4.2**	2.2	2.8
2014	2.5	3.4	3.5	**4.5**	1.8	2.8
2015	3.2	3.1	**4.0**	-	2.6	-
2016	2.9	3.3	**7.5**	-	2.5	-

Table 2.9: Annual average dust deposition at Lynwood Quarry

Year	Level (μg/m³)							
Annual average (criterion 4 μg/m³)								
	DD1	**DD2**	**DD3**	**DD4**	**DD5**	**DD6**	**DD7**	**DD8**
2012	1.5	3.6	3.4	1.9	1.2	3.0	1.6	1.5
2013	0.6	1.0	4.5	0.6	0.6	2.1	0.7	0.6
2014	2.1	2.3	1.3	1.4	2.9	1.6	1.0	1.3
2015	1.5	7.5	2.9	2.0	2.9	2.5	0.9	1.1
2016	5.9	1.7	20.	3.1	1.2	1.7	2.8	3.1

Background noise and blasting

Background noise monitoring during the Christmas 2014 shutdown, ongoing quarterly monitoring for Peppertree Quarry, and other background noise levels published in environmental assessments for Peppertree Quarry were analysed to determine the background noise levels (referred to as the rating background levels (RBL)) at residential receivers in the local area, outlined in Table 2.10.

Table 2.10: Rating background levels

Receiver	RBL dB(A)		
	Daytime	Evening	Night
R1	34	34	34
R2	34	34	34
R3	34	34	34
R4	34	33	33
R5	34	33	33
R6	34	33	33
R7	34	33	33
R8	35	34	33

Receiver	RBL dB(A)		
	Daytime	Evening	Night
R9	35	34	33
R10	35	34	33
R11	35	34	33
R12	35	34	33
R13	31	31	30
R14	31	31	30
R15	31	31	30
R16	31	31	30
R17	31	31	30

Note: Daytime 7am-6pm; Evening 6pm-10pm; Night 10pm-7am.

Blast overpressure is monitored near receiver B5. Monitoring data between 2014 and 2018 was reviewed as part of the noise assessment. The mine has not received any complaints due to blasting.

The monitoring data indicated that no blast exceeded the 120 dBLin maximum over pressure criterion and the 2 mm/s long-term regulatory target in ANZECC (1990) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*. The 5% exceedance level for overpressure was 111 dBLin which is below the 115 dBLin criterion.

As B5 is significantly closer to the mine than the closest residential receiver it indicates compliance with the blasting criteria.

2.2.2 Climate

The Project site is in the temperate (no dry season (warm summer)) zone (Bureau of Meteorology, 2001). The Goulburn Airport Automatic Weather Station (AWS) is the nearest weather station to the Project site with long term climate statistics. It is approximately 25 km west-southwest of the Project site.

Boral also operates two weather stations, one at the mine (Limestone mine weather station) and one at Peppertree Quarry (Peppertree quarry weather station).

Average climate data recorded at the Goulburn AWS is summarised in **Table 2.11**.

Table 2.11: Summary of climate data recorded at Goulburn AWS

Parameter		Measurement	Month
Temperature (˚C)			
Mean maximum	Annual	19.7	
	Highest monthly	27.9	January
	Lowest monthly	11.7	July
Mean minimum	Annual	6.1	
	Highest monthly	12.7	January, February
	Lowest monthly	0.3	July
Mean rainfall (mm)	Annual	551.9	
	Highest monthly	60.9	June
	Lowest monthly	25.6	April
Mean 9am wind speed (km/h)	Annual	18.3	
	Highest monthly	19.8	September

Parameter		Measurement	Month
	Lowest monthly	12.2	March

The data show that temperatures range throughout the year from an average maximum of 27.9°C in January to an average minimum of 0.3°C in July. The area experiences moderate rainfall, with an average annual rainfall of approximately 552 mm. Rainfall is generally evenly distributed throughout the year, with the highest mean rainfall in spring and summer and the lowest in autumn. According to long-term Bureau of Meteorology (BoM) records, an average of 67.5 rain days occur per year in Goulburn.

In summer the winds are predominately from the east and east-southeast at the mine and quarry weather stations. The autumn and spring wind distributions share similarities with the annual distributions, with winds ranging from the west to the north-west and east. In winter winds vary from the west and south and south-southeast at the mine whilst dominant winds at Peppertree Quarry are from the west with fewer winds from the other directions.

Further discussion on climate data relevant to the Project site, and its use in the air quality and noise assessments, is provided in **chapters 17** and **19** respectively.

2.2.3 Topography

The Southern Highlands, similar to the Blue Mountains to the north-west, predominantly comprise a level plateau with the occasional high intrusive volcanic remnant mountains, such as Mount Jellore, Mount Gibraltar and Mount Gingenbullen. On the eastern side they decline into a steep escarpment that is heavily divided by the headwaters of the Shoalhaven River.

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. Local relief of Marulan South ranges from around 130 m AHD to over 630 m AHD.

2.2.4 Geology

Consulting geologists at GeoRes Pty Limited were engaged to prepare information for the EIS in response to the DPE–Division of Resources and Geoscience's (DPE-DRG) input to the SEARs (GeoRes, 2018). DPE-DRG's requirements are in **Appendix A** and the GeoRes report is in **Appendix E**, with a summary of the regional and local geology from the GeoRes report presented in the following section. The local geological sequence is shown in **Figure 2.5**. The rock name terminology below is generally consistent with most mine documents back to the 1950s and consequently is used here for continuity. However, parts of the sequence have been re-named in the most recent 2012 mapping (Goulburn and Wollongong 1:250,000 geological map sheet, (Geological Survey of NSW, 2012)). The new names (with mapping abbreviations) are after the older names commonly used at the mine in the local geological description below.

The Marulan South limestone deposit lies within the Lachlan Geosynclinal Province. During the Palaeozoic Era (500 to 300 million years ago) thick sedimentary formations were laid down in the region. The formations included sediments, volcanic lavas and ash, and limestone reefs.

A reef complex formed the Bungonia Limestone Group (now Bungonia Group (Sb)), which was later folded and faulted by crustal collisions and then subsequently levelled by substantial erosion. About 65 million years ago the area was again uplifted giving way to a rejuvenated river system leading to the landscape of today.

The Bungonia Limestone formations at Marulan South consist of a number of generally parallel and north-south striking beds dipping to the west. The Bungonia Limestone includes:

- Eastern Limestone (now Lookdown Limestone Member (Sbcl), lower part of the Cardinal View Formation (Sbc)), which is the oldest, easternmost and thickest unit; and
- Mt. Frome Limestone (now Folly Point Limestone Member (Sbff) of the Frome Hill Formation (Sbf)), which is the younger unit that lies to the west of the Eastern Limestone and is made up of three sub-parrallel sub-units including the Upper Limestone (furthest west), Middle Limestone and Lower Limestone (furthest east).

Separating the limestone units are fine grained sediments including shales, mudstones, siltstones and minor fine sandstones.

The total horizontal width of the Bungonia Limestone is approximately 670m east-west with the Eastern Limestone ranging from 200-350 m and the Mt From Limestone ranging from 50-120 m. The true depth of the Bungonia Limestone is not known as the termination of the limestone is not visible either in the mine or at the bottom of the Bungonia gorge to the south. To date even the deepest drill holes (approximately 300 m) in the mine have ended in limestone.

The Eastern Limestone has the highest grade and was therefore selected for the commencement of mining. The Eastern Limestone is still the focus of current mining operations, however mining of Mt. Frome Middle Limestone commenced in approximately 2016.

The Bungonia Limestone Group is bound to the east by the older Tallong shale beds and in the west by the Tangarang Volcanics (now Tangarang Formation (Dkt) of the Bindook Group (Dk)) (younger shales, volcanic and associated sedimentary rocks). A north-south and various east-west dolerite dykes penetrate the limestone from beneath and the limestone bed is cut off in the north by the Glenrock Granodiorite (now 1 of 12 plutons of the Arthurslie Suite (Da)) intrusion, which is extracted by Peppertree Quarry.

Figure 2.5
Geology - Local context

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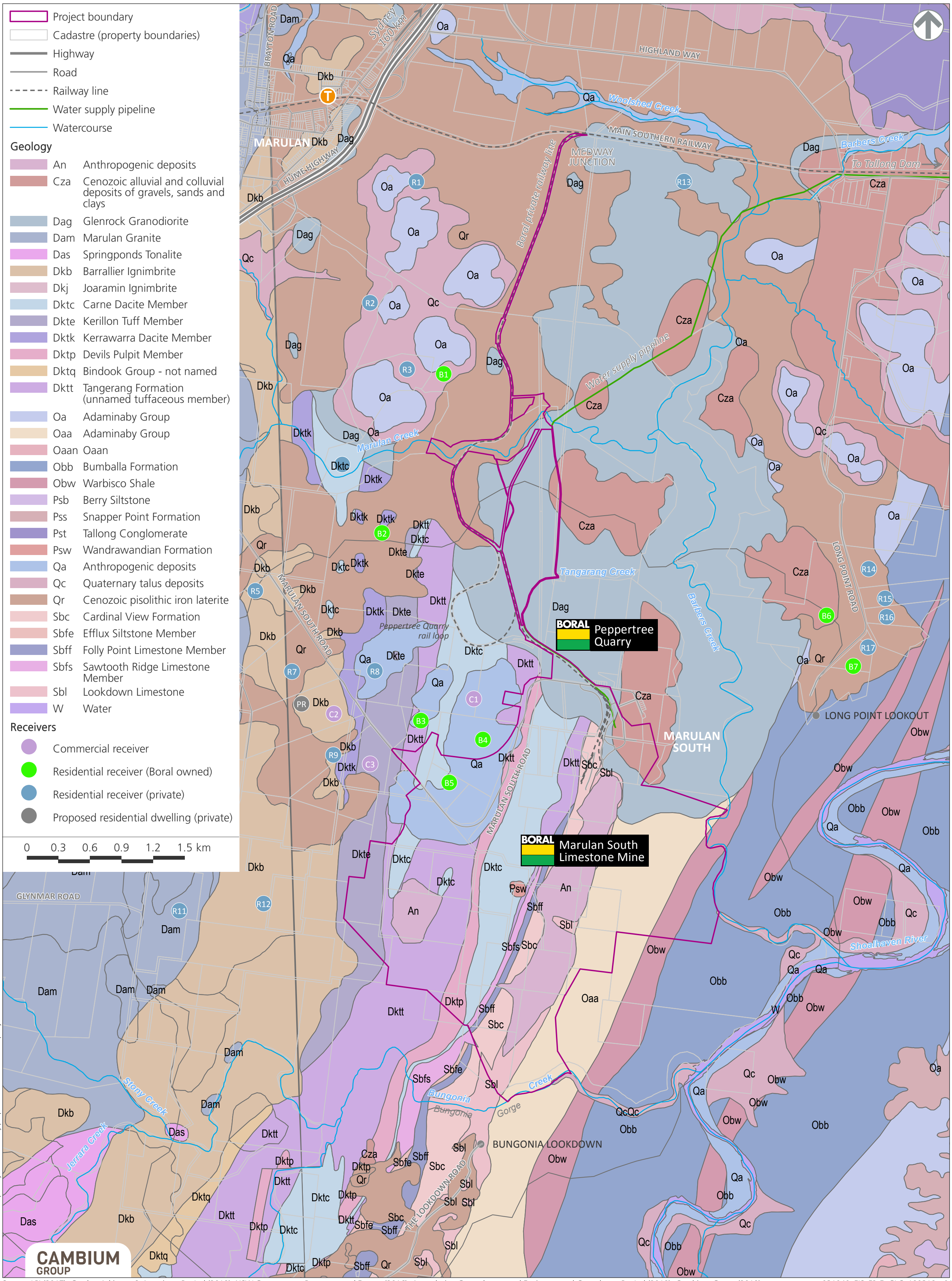
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), NSW Government, Resources and Energy (2016), Australasian Groundwater and Environmental Consultants Pty Ltd (2018), Cambium Group (2019).

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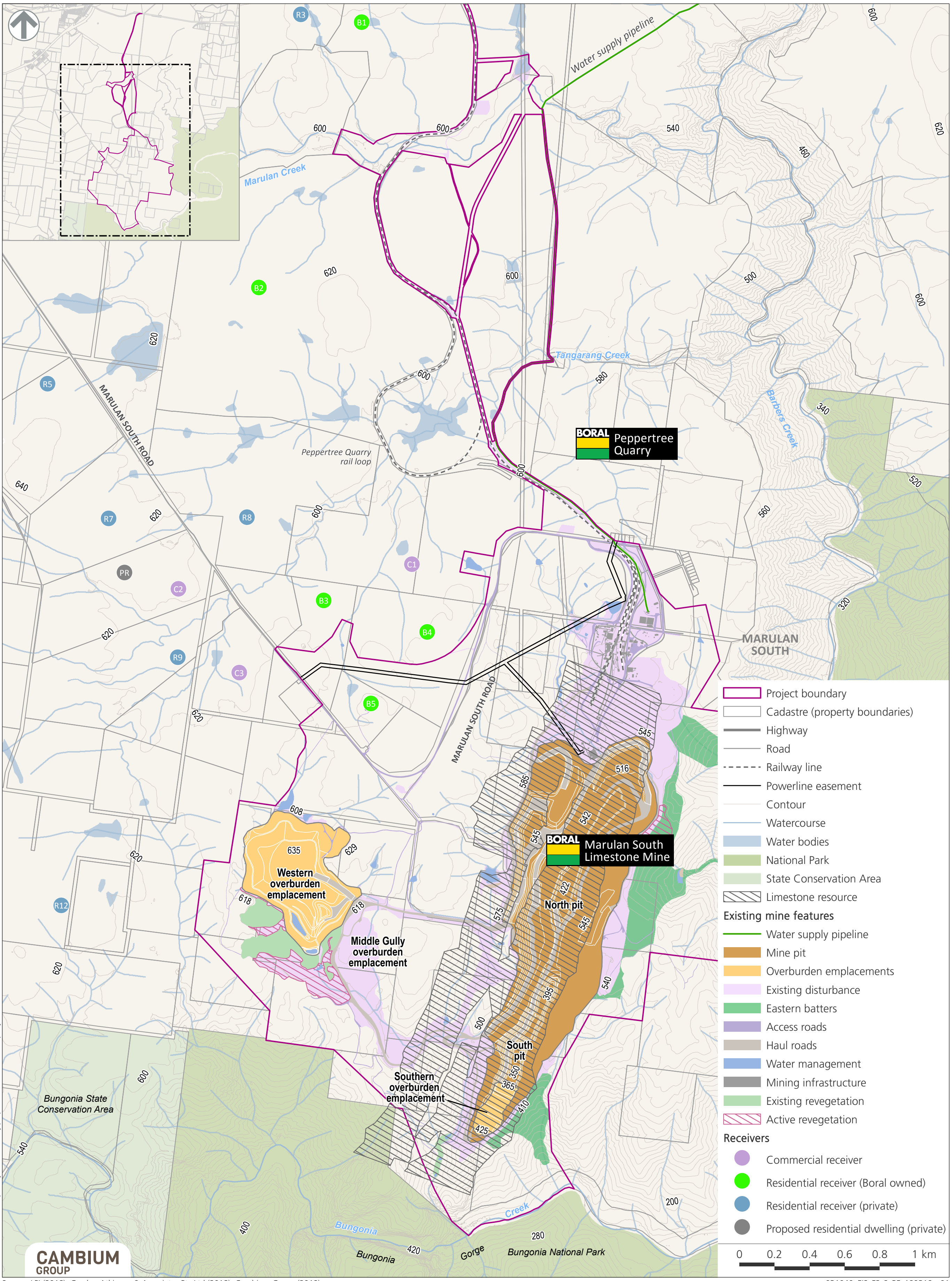
Figure 2.6
Biophysical factors

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



Source: LPI (2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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2.2.5 Surface water resources

Local catchments and drainage

The Project site is in the headwaters of the Barbers Creek and Bungonia Creek tributaries to the Shoalhaven River (**Figure 2.6**). The Project site is drained by ephemeral drainage lines into Barbers Creek to the east and Bungonia Creek to the south (**Figure 2.6**). The Shoalhaven River is, at its closest point, approximately 1.5 km east of the Project site and flows east into Lake Yarrunga (the waterbody behind Tallowa dam), and eventually to the ocean approximately 100 km east of the Project site.

The drainage pattern has been altered in places by mining activities over time. Steep batters have been constructed in external sections of both the north and south pits on the eastern and southern sides of the mine above the steep ravines below.

The southern end of the mine area drains naturally towards Bungonia Creek. Incised gullies near the mine drain into Barbers and Bungonia Creeks before discharging into the Shoalhaven River immediately south-east and east of the mine respectively.

There are a number of small farm dams on ephemeral creeks in the Project site, which 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. However, it remains the main drainage line for the southern part of the Project site.

Marulan Creek and Tangarang Creek are ephemeral drainage lines in 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.

Regional catchment and water sources

As described above, the Project site is in the catchments of Bungonia and Barbers creeks, which flow into the Shoalhaven River. The Shoalhaven River is in the Tallowa dam catchment, which is a drinking water source for Sydney and the Illawarra.

The Project is in the area of the Greater Metropolitan Region Unregulated Area Water Sharing Plan (WSP) and the following surface water sources in the WSP:

- Bungonia Creek Management Zone (commenced July 2011);
- Barbers Creek Management Zone (commenced July 2011); and
- Shoalhaven River Gorge Management Zone (commenced July 2011).

Boral holds a licenced surface water entitlement of 76 million litres (ML) per year for water extracted from Tallong Weir (**Figure 2.6**) in the Barbers Creek Management Zone. The Marulan Creek dam will also be in the Barbers Creek Management Zone.

Watercourses

Apart from the Shoalhaven River, the creeks in the vicinity of the Project are all ephemeral. The Shoalhaven River has the highest flow per unit area, twice that of Bungonia Creek, followed by Barbers Creek and Marulan Creek. Further characteristics of the local watercourses are outlined below.

Marulan Creek

On the escarpment, creek gradient is 0.5% to 1% with grass forming most of the vegetation cover in the creek bed. Further downstream the gradient of the creek increases to as much as 10% in a steep rocky gorge upstream of Barbers Creek.

Barbers Creek

Marulan Creek flows into Barbers Creek. About 1.5 km upstream of Marulan Creek, Barbers Creek enters a steep sided gorge which extends approximately 8 km down to the Shoalhaven River. In this section, Barbers Creek is characterised by a rocky boulder-strewn channel with rock pools. The gradient of the channel ranges from 5% to 6% in this section of Barbers Creek.

Bungonia Creek

The channel of Bungonia Creek is strewn with boulder and pools. It runs through a steep sided narrow gorge for approximately 8.5 km upstream of the Shoalhaven River. The slope of the creek channel adjacent to the Project site is approximately 4%.

Shoalhaven River

The Shoalhaven River has a wide channel with sandy banks at the confluence with Barbers Creek, which indicates significantly lower velocities than those experienced in Bungonia Creek and Barbers Creek.

2.2.6 Groundwater

Australasian Groundwater and Environmental Consultants Pty Limited were engaged to assess the potential impacts of the Project on groundwater in the Project site and region, with the report attached to this EIS in **Appendix H**. The existing groundwater environment is summarised in this section and the results of the groundwater assessment are summarised in **Chapter 9**.

Sources

Groundwater sources in the Project site are shallow unconsolidated aquifers and deep consolidated aquifers. The shallow groundwater is in the pore spaces in the sediment or regolith. The deep groundwater is in the rock fractures in the bedrock, which have been caused by geologic and structural movement associated with intrusive volcanic activity or dissolution of limestone.

The groundwater is in the Goulburn Fractured Rock Groundwater Source (refer to **Section 6.3.10**) and is classified as a ‘low productivity’ groundwater source according to the AIP (refer to **Section 9**).

Users

There are 22 bores registered on the NSW Government’s Pinneena database around the Project site, which are for domestic water supply and a few for industrial use (poultry farmers). Two additional, unregistered, bores were discovered on a poultry farm adjacent to the Project site during a census in February 2015. The registered and unregistered bores are listed in Table 7-1 of **Appendix H**.

Groundwater dependent ecosystems

According to OEH’s (2012) Bioregional Assessment Programme, there is Shoalhaven Gorge Forest in the southern (into Bungonia Gorge) and eastern (into Barbers Creek) slopes of the Project site. This vegetation has high potential for groundwater interaction.

Spring dependent flora of high ecological value was found along Barbers Creek and Bungonia Gorge during the biodiversity survey (refer to **Chapter 14**).

Conceptual hydrological model

The ground and surface water observations were synthesised to produce a conceptual model of how and where water entered, flowed through and exited the underlying geology (**Figure 2.7**).

The main groundwater system in the Project site is the limestone targeted for mining. The steeply dipping limestone unit results in the rock mass being more permeable in the vertical direction than the horizontal direction along bedding planes and joints. Fracturing in the limestone also facilitates the vertical drainage of groundwater, and the fracture networks connect to seepage zones on the gorge slopes. The predominantly north-south jointing/fracture pattern in the limestone is the main flow pathway in the limestone.

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.

Groundwater storage and flow in the limestone body is influenced by fractures, jointing and solution-enhanced fissures. These result in rapid flow through fissures and solution cavities, while the limestone matrix itself is relatively impermeable. Monitoring bores installed in the pit floor did not respond to the accumulation of water above the pit floor, despite water readily draining from the pit indicating the secondary porosity fracture network conveys the water while the primary porosity of the limestone matrix is very tight.

The limestone is intruded with a number of dykes, both parallel and perpendicular to the strike of the limestone body. The dykes oriented perpendicular to the strike act as hydraulic barriers. These low permeability dykes convey groundwater to the surface as demonstrated by the groundwater spring in a dolerite dyke in the north pit. The springs and pools also occur where the steep topography along the incised drainage lines cuts below the level of the water table promoting drainage of groundwater.

Regionally, groundwater flow is generally east-south-east towards the deeply incised gullies of Bungonia and Barber's Creeks.

The water table elevation up gradient from the mine is between 550 m AHD and 600 m AHD with a relatively low gradient. The hydraulic gradient of the water table steepens considerably closer to Bungonia and Barber's creeks with groundwater discharging into the gorge and 'daylighting' at springs on the northern face of the gorge.

The chemistry of spring water closely matches groundwater from the in-pit monitoring bores. This indicates springs on and at the base of the limestone outcrop in Bungonia Gorge, south of the mine are likely to be the main discharge points for the limestone aquifer. Deuterium and Oxygen-18 isotope analysis identifies the aquifer feeding the spring sampled is recharged relatively quickly. Therefore, the recharge zone is likely to be the exposed limestone in the mine and outcrop, where higher permeability and exposure allows direct rainfall recharge.

Tritium dating of the groundwater indicates that the groundwater is 'modern' and that the groundwater residence time is approximately 20 years.

A second source of recharge to the limestone aquifer is the Glenrock Granodiorite intrusion north of the limestone body. As the hydraulic connection of the limestone with the Adaminaby Group and the Tangerang Formation is minimal, the predominant recharge source from outside of the limestone is possibly the granodiorite intrusion to the north. Groundwater from the limestone and overlying Tangerang Volcanics is low in salinity and close to neutral pH. These aquifers provide some base-flow to Bungonia Creek which has a similar water quality signature to the limestone aquifer.

A weathering profile is present west of the pit where the topography flattens, which could contain an elevated water table that has the capacity to be a moderately permeable water bearing unit.

During the lifetime of the mine, gullies immediately west of the south pit were in-filled with overburden. Some of the overburden rock was also dumped southwards towards Bungonia Creek and eastwards towards Barbers Creek, forming coarse slope colluvium/screen. These areas could become a source of runoff seepage in response to having an enhanced rainfall recharge potential as a result of the loose nature of the unconsolidated overburden rock materials.

Figure 2.7
Conceptual groundwater model domain (Simplified west-east cross section)

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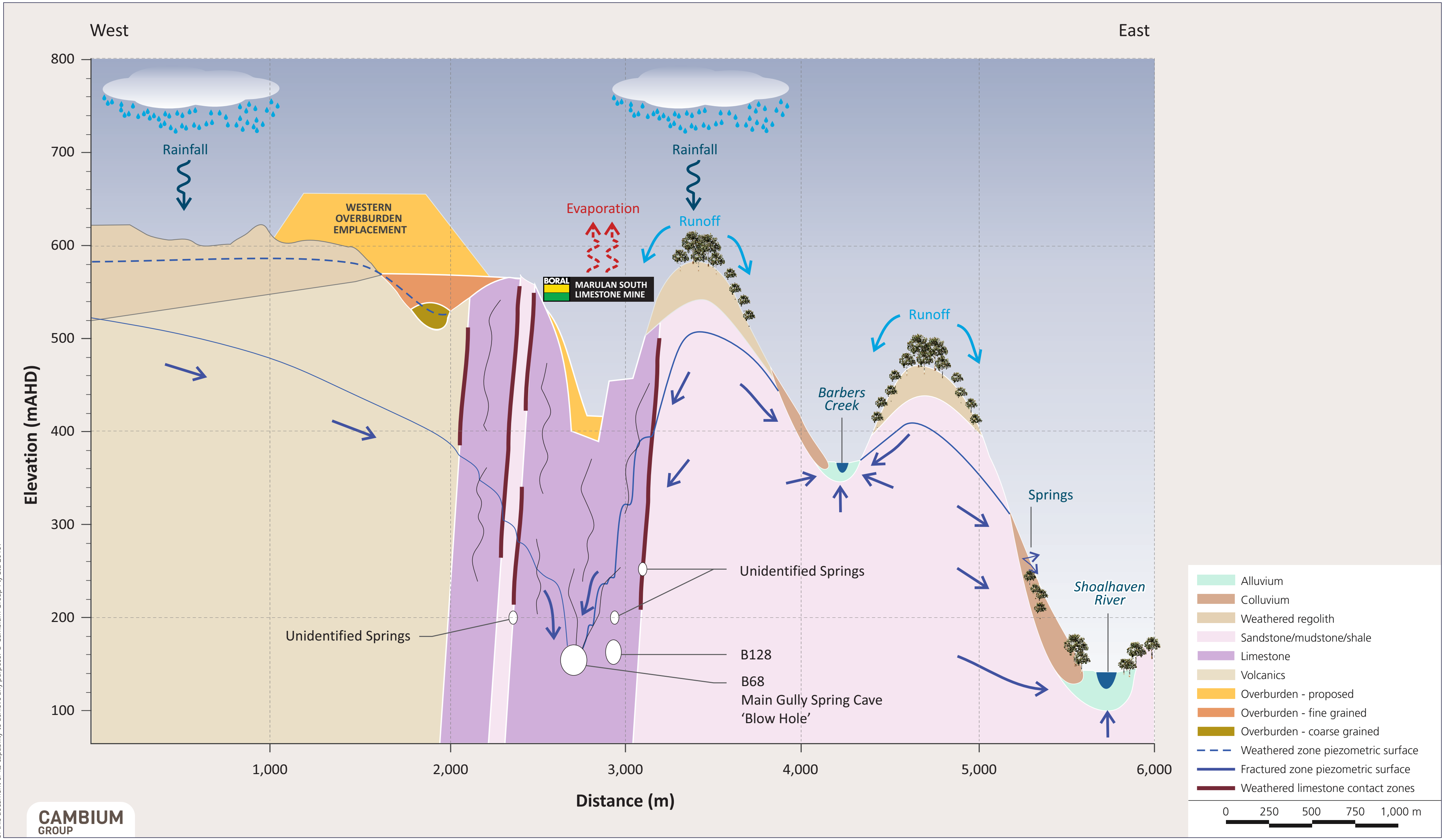

Source: Australasian Groundwater and Environmental Consultants Pty Ltd (2018), Cambium Group (2019).

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2.2.7 Soils

Sixty three soil samples were collected from 13 test pits during field based soil surveys for the *Soil, Land Resources and Rehabilitation Assessment* (LAMAC, 2018) (**Appendix I**).

The soils assessment divided the 846.4 ha Project site into two areas:

- the northern assessment area comprised the site of the Marulan Creek dam; and
- the southern assessment area comprised the pit expansion, out-of-pit overburden emplacements and construction or realignment of infrastructure.

Soil types at the test pits were classified according to the Australian Soil Classification. Soil landscape units were then determined, mapped (**Figure 2.8**) and described (**Table 2.12**).

Anthroposols are the dominant soil type in the assessment areas (40%), followed by Tenosol/Rudosol (27%); Sodosol, red/brown (17%); Tenosol, bleached-orthic/brown-orthic (14%); Kurosol, brown (1.4%); and Rudosol (alluvial) (0.3%).

The acid sulfate soils considerations for the *Phase 1 and 2 Environmental Site Assessment* (ZOIC, 2018) determined that it is unlikely acid sulfate soils are present given the inland location and height of the Project site.

Table 2.12: Description of the soil landscapes in the Project site

Soil landscape/area	Location in assessment area	General landscape	Land use	Typical topsoil depth (A1 horizon)	Fertility
Sodosol, red/brown (143.5 ha)	Northern: majority Southern: north-west	Mid to upper slopes of gently undulating slopes and low rises.	Low density sheep grazing.	Northern assessment area: 15 cm. Southern assessment area: 10 cm.	Sodosols - Moderately Low. Chromosols – Moderately High.
Kurosol, brown (11.5 ha)	Northern: nil Southern: north-west	Flats and drainage depressions.	Low density sheep grazing.	Northern assessment area: N/A. Southern assessment area: 15 cm.	Moderately Low.
Tenosol, bleached-orthic/brown-orthic (119.9 ha)	Northern: nil Southern: central	Ridge crests, upper slopes and steep slopes.	Mine buffer land; historic sheep grazing.	Northern assessment area: N/A. Southern assessment area: 10 cm.	Moderately Low.
Tenosol/Rudosol (steep slopes) (229 ha)	Northern: nil Southern: south-west, south and east	Steep to precipitous slopes and ridgelines.	Native forest.	Northern assessment area: N/A. Southern assessment area: 0 cm.	Low.
Rudosol (alluvial) (2.5 ha)	Northern: nil Southern: eastern and southern boundaries	Stream channels, and adjacent terraces, on valley floor.	Native forest/ conservation area.	Northern assessment area: N/A. Southern assessment area: N/A.	Low.
Disturbed/Anthroposol (mined land) (340 ha)	Northern: nil Southern: central and south-west	Disturbed/rehabilitated areas.	Mining.	Northern assessment area: N/A. Southern assessment area: 0 cm.	Low.

Figure 2.8
Soil landscape units and topsoil stripping

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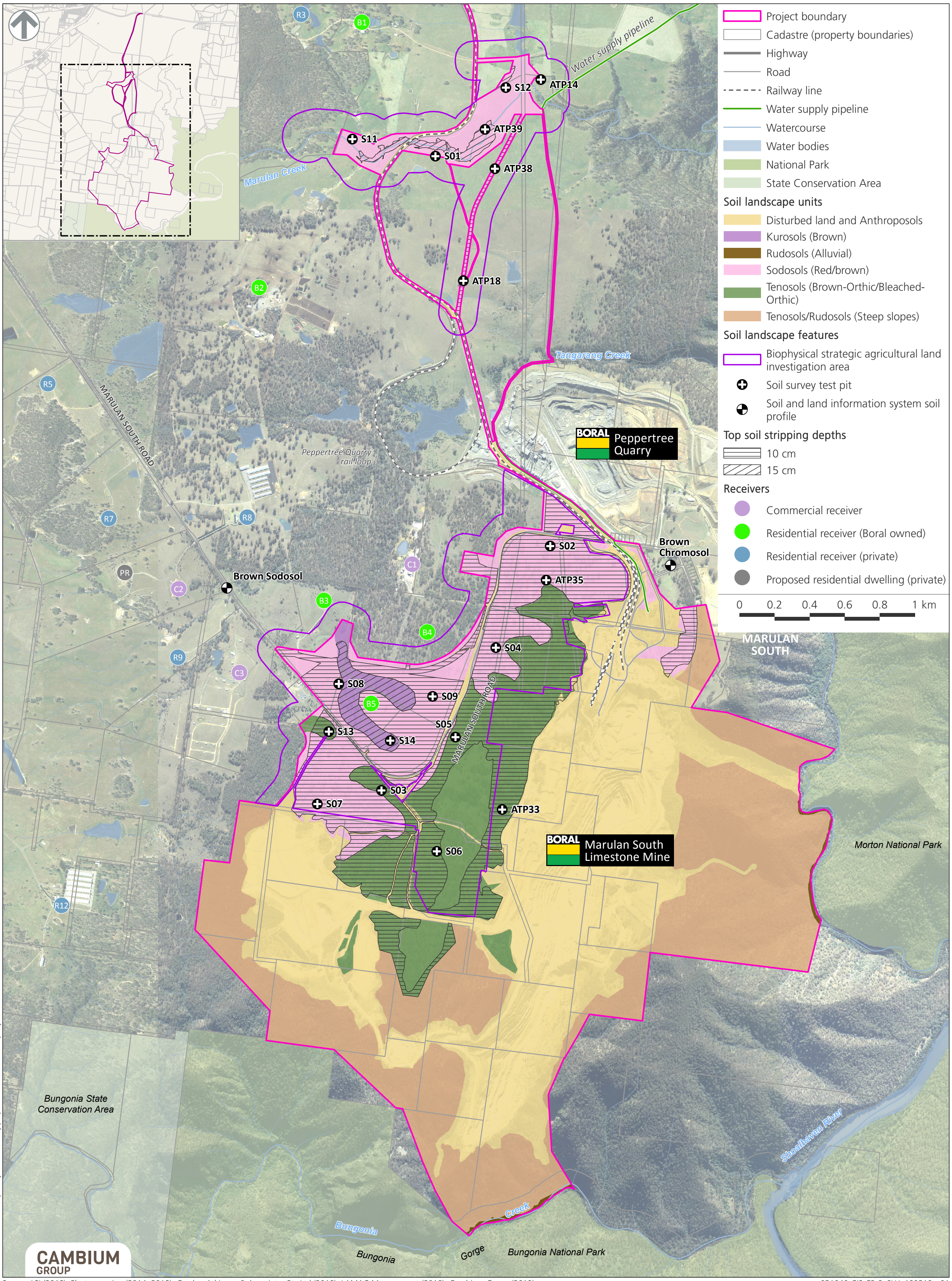

CAMBIUM GROUP

Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), LAMAC Management (2018), Cambium Group (2019).

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2.2.8 Biodiversity

Potential impacts of the Project on biodiversity were assessed in the biodiversity development assessment report (BDAR) (Niche Environment and Heritage, 2019a) in **Appendix K** and summary in **Chapter 12**. Previous assessments of the Project site and adjacent areas were reviewed during the biodiversity assessment to characterise the existing environment and develop a flora and fauna survey strategy. Results of these studies are summarised below.

Soils and vegetation vary markedly across the bioregion in association with variation in altitude, temperature and rain. The Bungonia SCA contains threatened Wingless Raspwort (*Haloragis exalata*), *Pterostylis calceolus* and Chalker's Wattle (*Acacia chalkeri*). There is a Koala (*Phascolarctos cinereus*) population in the area and the Brush-tailed Rock Wallaby (*Petrogale penicillate*) has been observed in the area.

Limestone caves in the area provide bat wintering and nursery sites for several bat species including a population of the vulnerable Large Bent-wing Bat (*Miniopterus schreibersii*).

The previous assessments and their results were:

- Flora:
  - Sinclair Knight Merz (1994) – this survey of the west side of the northern pit identified dry sclerophyll woodland with a tree height of approximately 25 m and a canopy dominated by Apple Box (*Eucalyptus bridgesiana*), Yellow Box (*Eucalyptus melliodora*) and Narrow-leaved Stringybark (*Eucalyptus oblonga*). The mid storey was dominated by juvenile *Euc. spp.* and *Acacia falciformis*, *Acacia implexa* and *Acacia ulicifolia.* Groundcover comprised *Persoonia mollis subsp ledifolia*, *Lonmandra glauca*, *Lonmandra longifolia*, *Bursaria spinosa* and Sweet Pittosporum (*Pittosporum undulatum*). No threatened flora species were identified.
  - URS Corporation (2006) – this survey of the west side of the northern pit identified the above canopy species plus Forest Red Gum (*Eucalyptus tereticornis*) and Thin-leaved Stringybark (*Eucalyptus eugenoides*). No threatened flora species were identified.
  - RPS Harper Sommers O'Sullivan (2009) – this survey of emplacement areas identified the following communities in the study area:
    - Brittle Gum Stringybark;
    - Forest Redgum Stringybark Woodland;
    - Coastal Grey Box Forest Redgum Woodland;
    - cleared/disturbed planted vegetation; and
    - planted trees and shrubs.

    No threatened flora species were identified.
- Fauna: fauna was surveyed around the west of the north pit by Gunninah Environmental Consultants in 1997 and URS Corporation in 2006, which only found common to abundant species. RPS Harper Sommers O'Sullivan (2009) determined the following threatened species could occur in the Project site. However, none were observed during the survey:
  - Gang-Gang Cockatoo (Callocephalon fimbriatum);
  - Glossy Black Cockatoo (Calyptorhynchus lathami);
  - Swift Parrot (Lathamus discolour);
  - Squirrel Glider (Petaurus norfolcensis);
  - Koala;
  - Grey-headed Flying-fox (Pteropus poliocephalus);
  - Large-eared Pied Bat (Chalinolobus dwyeri);
  - Eastern False Pipistrelle (Falsistrellus tasmaniensis);
  - Eastern Bentwing Bat (Miniopterus schreibersii oceanensis); and

- East Coast Freetail-bat (Mormopterus norfolkensis).

2.3 Socio-economic factors

2.3.1 Land ownership

CML 16 (which encompasses ML 1716), covers an area of 616.5 ha and includes land owned by Boral (approximately 475 ha), Crown Land (adjoining to the south and east) and five privately owned titles (**Figure 2.9**). There is also Boral owned land surrounding the mine that does not fall within CML 16.

The Project site is approximately 846.4 ha with land ownership outlined in **Table 2.13**. A full land schedule including all properties within the Project site and a land schedule map is in **Appendix C**.

Table 2.13: Land ownership in the Project site

Land owner	Area of land in Project site
Boral Cement Limited	409.88
Boral Limited	23.14
Boral Resources (NSW) Pty Ltd	47.17
Crown Land	236.61
Freehold	110.48
Undefined	17.94
Gaps	1.15
TOTAL	846.37

2.3.2 Existing land uses

Land use surrounding the mine is a mixture of extractive industry, grazing, rural residential, commercial/industrial and conservation.

Peppertree Quarry borders the mine to the north. The site of the former village of Marulan South is located between the mine and Peppertree Quarry on land owned by Boral. The village was established principally to service the mine but has been uninhabited since the late 1990s. The majority of the village's infrastructure has been removed and only a village hall and former bowling club remains. The bowling club has been converted into administration offices for the mine and the hall is used by the mine services team.

A small number of rural landholdings surround the Boral properties to the north and west, including an agricultural lime manufacturing facility, fireworks storage facility, turkey farm and rural residential (a number of these properties are actively grazed). The main access for these properties is via Marulan South Road. Rural residential properties are also located to the north-east of the mine along Long Point Road. These properties are separated from the mine by the deep Barbers Creek Gorge.

Nearby residences and commercial businesses are considered potentially sensitive receivers and are identified in **Figure 2.9** as 'R' – private residential, 'B' – Boral owned residences and 'C' commercial business.

Figure 2.9
Land ownership

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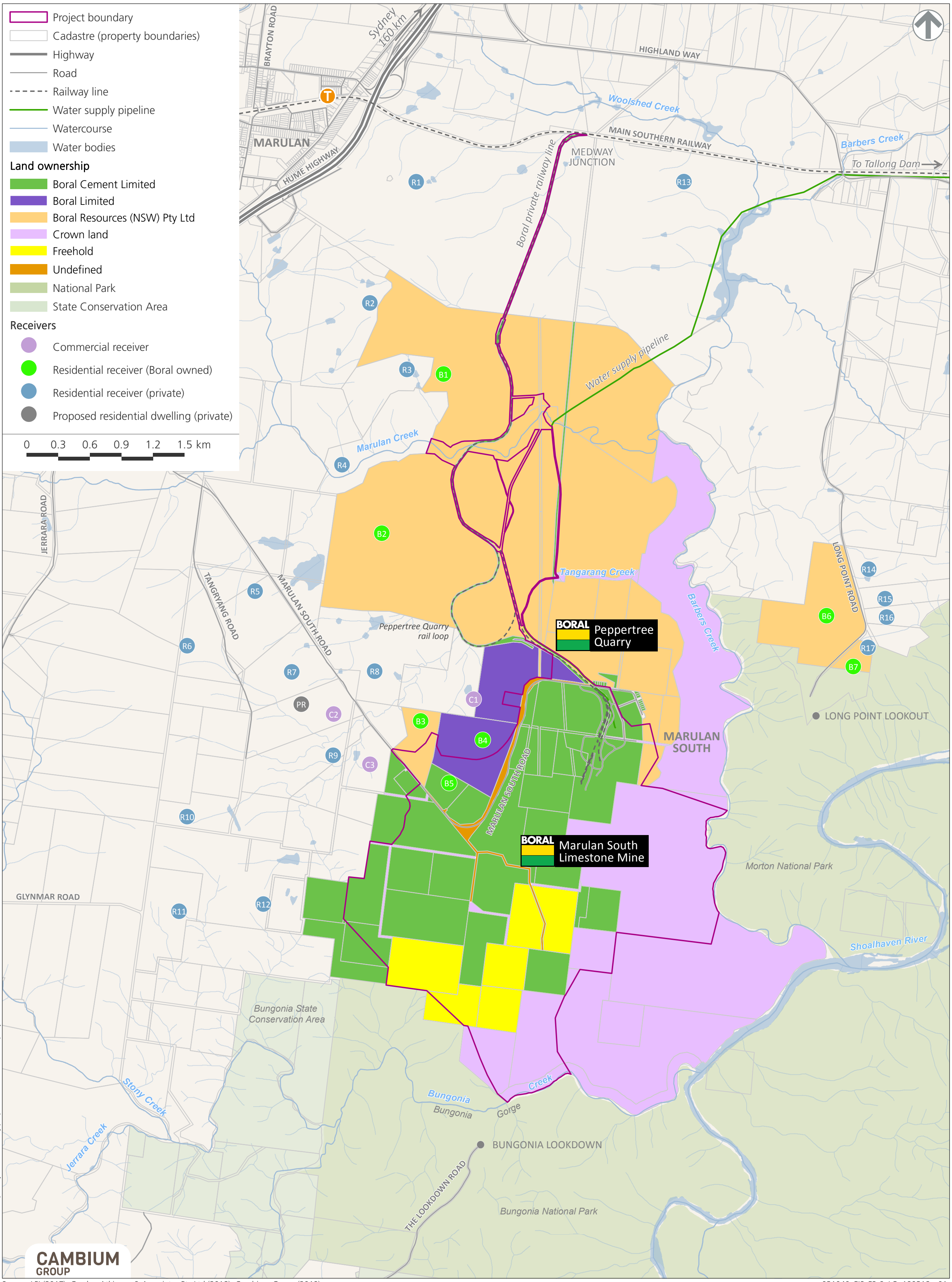

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Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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2.3.3 Community profile

Socio-economic data from the Australian Bureau of Statistics (ABS) and DPE sources were used to develop a snapshot of the local area.

Socio-economic indicators

Marulan correlates with the general statistics for NSW except for the lower median weekly household income and mortgage repayments compared to NSW (Table 2.14).

Table 2.14 Socio-economic indicators

Socio-economic indicator	Marulan	NSW
Male	51.5%	49.3%
Female	48.5%	50.7%
Median age	41	38
Average children per family for families with children	2.0	1.9
Average people per household	2.6	2.6
Median weekly household income	$1,143.00	$1,486.00
Median monthly mortgage repayments	$1,517.00	$1,986.00
Median weekly rent	$280.00	$380.00
Average motor vehicles per dwelling	2.1	1.7

Population

DPE estimates that the LGA could have a population of 37,202 by 2036. The census estimated the 2016 population (30,156) will climb to 32,167 in 2021, 32,863 in 2026, 35,567 in 2031 and 37,202 in 2036.

Indigenous people comprised approximately 3.9% of the Marulan population in the 2016 census. Most of this population was female (63%) with a comparatively low median age of 14.

Family composition in the LGA is compared to NSW in Table 2.15 and the single parent break down compared to NSW is in Table 2.16.

Table 2.15 Family composition

Family Composition	Marulan	Percentage	NSW	Percentage
Couple family without children	143	45.1	709,524	36.6
Couple family with children	124	39.1	887,358	45.7
One parent family	50	15.8	310,906	16.0
Other family	0	0.0	32,438	1.7

Table 2.16 Single parents

Single (or lone) Parents	Marulan (%)	NSW (%)
Male	34	17.8
Female	66	82.2

Education and employment

Of people aged 15 and over in Marulan, 10.8% reported having completed Year 12 as their highest level of educational attainment, 24.4% had completed a Certificate III or IV, 6.6% had completed an Advanced Diploma or Diploma and 8.3% had attained a bachelor degree or higher.

The bulk of the population have specialised knowledge and skills obtained through technical institutions and colleges affording them the opportunity to pursue careers as tradespersons and related workers (**Table 2.17**).

Table 2.17 Occupation fields

Occupation Employed people aged 15 years and over	Marulan	Percentage	NSW	Percentage
Technicians and Trades Workers	83	16.9	429,239	12.7
Labourers	82	16.7	297,887	8.8
Machinery Operators and Drivers	69	14.1	206,839	6.1
Community and Personal Service Workers	57	11.6	350,261	10.4
Managers	56	11.4	456,084	13.5
Clerical and Administrative Workers	54	11.0	467,977	13.8
Sales Workers	44	9.0	311,414	9.2
Professionals	33	6.7	798,126	23.6

Employment rates in Marulan is compared to NSW in Table 2.18.

Table 2.18 Employment rates in Marulan

Employment	Marulan	Percentage	NSW	Percentage
Worked Full-time	302	57.3	2,134,521	59.2
Worked Part-time	159	30.2	1,071,151	29.7
Away from Work	36	6.8	174,654	4.8
Unemployed	30	5.7	225,546	6.3

Income

Median weekly incomes in Marulan are compared to NSW in Table 2.19, with the median weekly personal income for people aged 15 years and over in Marulan being $562.

Table 2.19 Median weekly income

Median weekly income	Marulan	Percentage	NSW	Percentage
Personal	$562	-	$664	-
Family	$1,380	-	$1,780	-
Household	$1,143	-	$1,486	-

Housing

In Marulan 77.8% of private dwellings were occupied during the 2016 census, and 97.9% of the population occupy these private dwellings. Most of the private dwellings contained three (39.4%), or four or more bedrooms (40.8%). Less than 1% of the community occupy flats or apartments and other dwelling types. The average number of bedrooms per occupied private dwelling was 3.2, accommodating an average household size of 2.6 people.

DPE's goal for the LGA is to provide up to 25,200 new homes for the additional 46,350 people expected to live in the region by 2031.

Social disadvantage

The ABS's Index of Relative Disadvantage identifies and ranks areas in terms of people's access to material and social resources, including their ability to participate in society. Marulan is identified as an area with a high level of relative socio-economic disadvantage.

Social infrastructure

Social infrastructure is facilities and services that enhance the social capacity of communities and may include infrastructure related to health, housing, youth, aged care, leisure, community safety facilities and road safety.

There are 28 educational facilities in the LGA, comprising public schools, pre-schools and tertiary education facilities.

Goulburn Base Hospital and a small medical practice in Marulan are the main health infrastructure for Marulan. The hospital is the sole provider of more complex medical procedures and services. Patients are often waiting longer to start treatment in the hospital's emergency department and to be transferred for care in comparison to other hospitals in the Southern NSW Local Health District.

Other data associated with the health facilities and Goulburn Base Hospital in particular provide a more positive result. However, Goulburn Base Hospital performed better than most medium sized hospitals in NSW. The planned major renovation of Goulburn Base Hospital may have a further positive effect on emergency department services.

2.4 Cultural factors

2.4.1 Aboriginal heritage

A 10 km by 10 km area was searched on the Aboriginal Heritage Information System (AHIMS) on 1 September 2014 and 20 February 2018 for the *Marulan Limestone Mine Continued Operations Project – Aboriginal cultural heritage assessment* report (EMM Consulting, 2018a) (**Appendix N**) to identify existing recorded Aboriginal sites in the area. Sites were distributed across multiple landforms but clustered near watercourses. A diverse range of site types occurred, the most common being isolated finds and open camp sites which comprise over 90% of the total sites in the region. Smaller numbers of modified trees and stone arrangements were also present, with one rock shelter with art identified.

Nineteen of the 112 registered sites in the search area were in (4 sites) or adjacent to (15 sites) the Project site (**Table 2.20** and **Figure 2.10**). However, two of the sites previously recorded in the Project site were removed during a previous salvage activity.

Table 2.20: AHIMS sites in and adjacent to the Project site

AHIMS site number / Name	Site description	Location
52-4-0195: M1 (BCSC1)	A site containing five flakes in quartz and silcrete. It appears this site and site 52-4-161 below are the same site but with different AHIMS coordinates. Notwithstanding, the site has been destroyed.	Inside Project site
52-4-161: BCSC1	A site containing approximately 91 artefacts associated with converging minor drainage lines. It appears that this site and site 52-4-0195 above are the same site. It was considered to	Inside Project site

AHIMS site number / Name	Site description	Location
	have no archaeological potential as the area was subject to severe disturbance from historical mining activities. Artefacts were collected prior to impact from additional mining activities. The site has been destroyed.	
52-4-0246: M2	Three silcrete flakes.	Inside Project site
52-4-0276: BCSC IF11	A grey green quartzite flake in a woodland area.	Inside Project site
52-4-0271: BCSC IF3	A red silcrete flake piece in a woodland area on a mid-slope landscape.	Inside Project site
52-4-0272: BCSC IF4	A grey silcrete flake in woodland on a gentle north facing slope.	Inside Project site
52-4-0270: BCSC IF2	A single red brown silcrete flake in the woodland area of the mine at the base of an eroded slope.	Inside Project site
52-4-0274: BCSC IF8	One red silcrete core in the woodland area, near some historic ruins.	Inside Project site
52-4-0273: BCSC IF7	One grey brown red silcrete flake in woodland.	Inside Project site
52-4-0279: BCSC IF9	A grey silcrete flake located in a cleared area.	Inside Project site
52-4-0269: BCSC AS4	An artefact scatter consisting of 22 artefacts of silcrete and chert located on an east facing lower slope.	West of Project site
52-4-0278: BCSC IF13	A white quartz flake on an east facing lower slope.	Inside Project site
52-4-0277: BCSC IF12	A red brown silcrete flake piece on a lower slope facing east.	Inside Project site
52-4-0279: BCSC IF14	A grey green quartzite flake at the base of a slope facing east.	Inside Project site
52-4-0268: BCSC AS3	Two artefacts; a silcrete flake and a quartz flake on an eastern facing lower slope.	Inside Project site
52-4-0267: BCSC AS2	A scatter of two flakes at the base of a woodland area on an east facing lower slope.	Inside Project site
52-4-0266: BCSC AS1	A scatter of seven artefacts including silcrete and quartz flakes and cores. The site is on an east facing lower slope.	Inside Project site
BCSC IF1	One grey silcrete core along an eastern ridgeline in the mid-west gully area of the mine, to the south of a mine access road which connects to the western mine area. It was not located *in situ* and was among eroded soil and shale rock.	Inside Project site
BCSC AS5	A scatter of ten artefacts on a lower slope facing east.	West of Project site

2.4.2 Historic heritage

The following Commonwealth, State and local heritage databases were searched for the *Marulan South Limestone Continued Operations Project – historic heritage assessment and statement of heritage impact* report (EMM Consulting, 2018b) (**Appendix O**):

- National Heritage Register (NHL) made under the EPBC Act;
- Commonwealth Heritage Register (CHL) made under the EPBC Act;
- State Heritage Register (SHR) made under the NSW *Heritage Act 1977* (Heritage Act);
- Heritage and Conservation Register (s170 Register) made under the Heritage Act;
- Schedule 5 of the LEP; and
- State Heritage Inventory (SHI), which is a central collection of statutory heritage listings in NSW.

No items of historic heritage significance have been registered in the Project site. The following listed heritage items are near the Project site:

- Bungonia State Recreation Area (now the Bungonia SCA and Bungonia NP) is listed in the LEP and is adjacent to the southern Project boundary; and
- Glenrock Homestead and Outbuildings is listed on the LEP and the nearest extent of its heritage curtilage is approximately 2.4 km north from the Marulan Creek dam.

Listed heritage items in the wider area are summarised in **Table 2.21** (within 6 km to 6.5 km of the Project site).

Table 2.21: Listed heritage items

Item	Listing	Item ID	Significance
Bungonia NP	LEP	I027	Local
Old Marulan Town	LEP	00127	Local
Marulan Township Conservation Area	LEP	HER 003D	Local
Old Marulan Anglican Cemetery	LEP	I311	Local
St Patrick’s Catholic Cemetery	LEP	I313	Local
Marulan Railway Station and yard	SHR, LEP	01188, I315	State
All Saints Church of England	LEP	I316	Local
Terminus Hotel	LEP	I317	Local
Badlock’s Shed Store (c1870), Marulan Public School	LEP	I318	Local
Postmaster’s residence, Post Office “Mooroowoolen”	LEP	No listing	Local
Dwelling “Waverley”	LEP	I323	Local
Dwelling “Cora-Lyn”, St Stephen’s Uniting Church	LEP	I322	Local
Shop Group, “Wattle Glen”, “Coronation Stores”, Morgan’s General Store, “the Boarding House”	LEP	I321	Local
“Royal Hotel”, “Aunty Mary’s” shop	LEP	I320	Local
Tallong Railway Station, Water Supply	SHR, LEP	01259, I334	State
Glenrock Homestead and Outbuildings	LEP	I314	Local
War Memorial Hall	LEP	I333	Local
Dwelling, Federation, Tallong Public School	LEP	I331	Local

Figure 2.10
Listed historic heritage items - Local area

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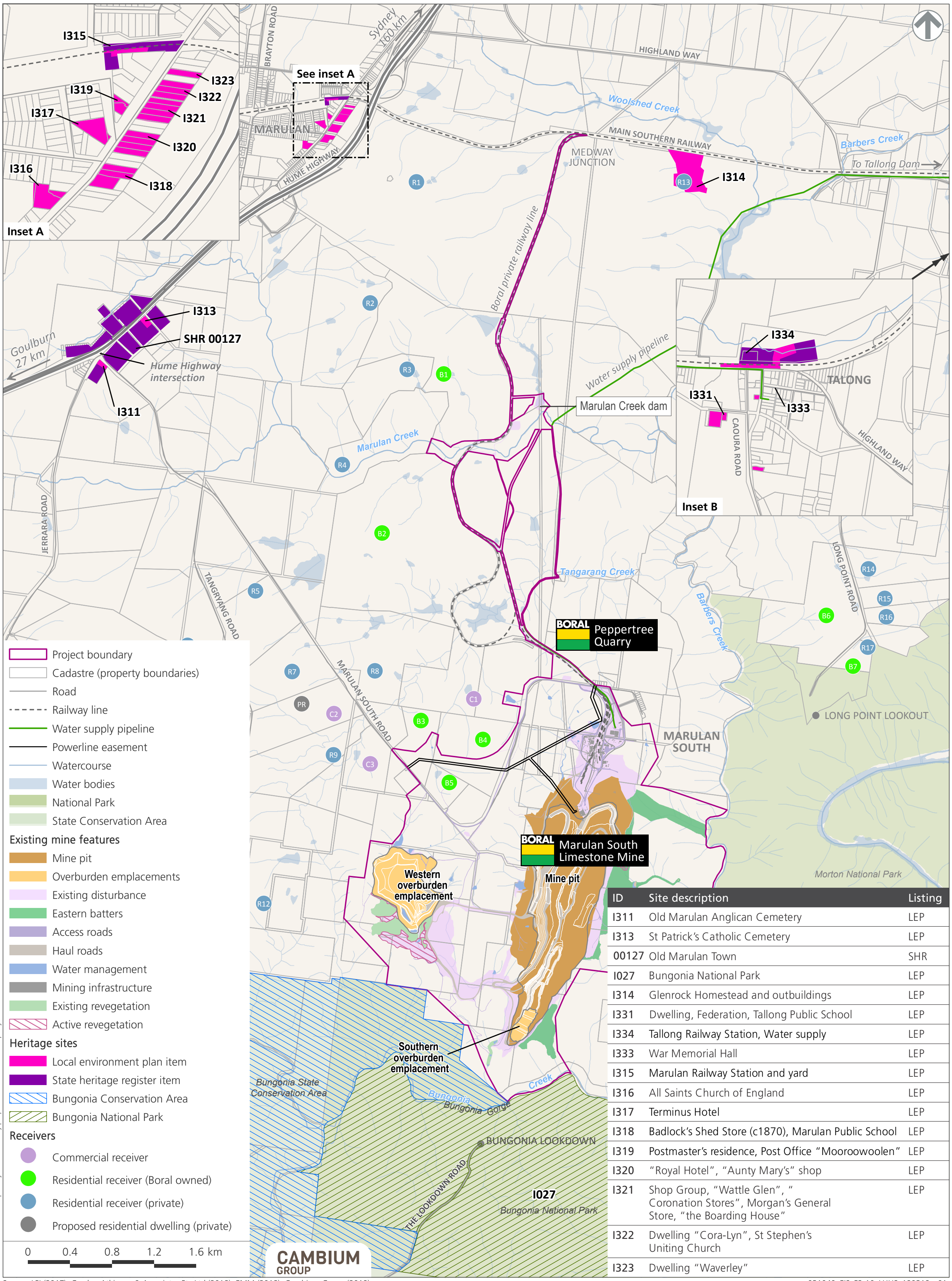

ID	Site description	Listing
I311	Old Marulan Anglican Cemetery	LEP
I313	St Patrick's Catholic Cemetery	LEP
00127	Old Marulan Town	SHR
I027	Bungonia National Park	LEP
I314	Glenrock Homestead and outbuildings	LEP
I331	Dwelling, Federation, Tallong Public School	LEP
I334	Tallong Railway Station, Water supply	LEP
I333	War Memorial Hall	LEP
I315	Marulan Railway Station and yard	LEP
I316	All Saints Church of England	LEP
I317	Terminus Hotel	LEP
I318	Badlock's Shed Store (c1870), Marulan Public School	LEP
I319	Postmaster's residence, Post Office "Mooroowoolen"	LEP
I320	"Royal Hotel", "Aunty Mary's" shop	LEP
I321	Shop Group, "Wattle Glen", " Coronation Stores", Morgan's General Store, "the Boarding House"	LEP
I322	Dwelling "Cora-Lyn", St Stephen's Uniting Church	LEP
I323	Dwelling "Waverley"	LEP

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

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Chapter 3

Existing operations

VOLUME 1

3 EXISTING OPERATIONS

3.1 Mining operations

3.1.1 Existing mining overview

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 recently joined in 2016/2017 by mining the centre ridge to form a single contiguous pit, approximately 2 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.

The current operations are 24-hour, 7 days per week. Blasting is restricted to daylight hours and on weekdays, excluding public holidays.

Figure 3.1 summarises the existing mine operating parameters, while **Figure 3.2** presents the existing disturbance footprint of the mine and **Figure 3.3** presents the existing mining operations.

Figure 3.1
Existing operating parameters

1869

Mine in operation since 1869

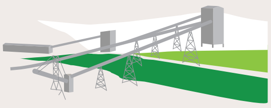
24/7

24/7 operation

191 employees

118 employees on site
73 employees off site

450,000 tonnes



450,000 tonnes per annum by road
330,000 via Hume Highway
120,000 to agricultural lime manufacturing facility

145 million tonnes

Approximately 145 million tonnes of limestone extracted since 1869

500,000 tonnes

500,000 tonnes per annum of manufactured limestone sand transported across the road to Peppertree Quarry

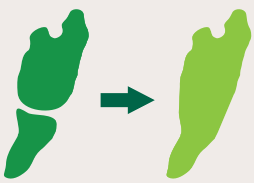
3.38 million tonnes

Up to 3.38 million tonnes of limestone per annum
Up to 200,000 tonnes of shale per annum

2.5 million tonnes

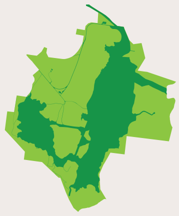
2.5 million tonnes per annum by rail

2016



Mining occurred in north and south pit. In 2016 centre ridge was mined out to create one pit

341.5 hectares



341.5 hectares of ground disturbance associated with historical mining activities

Mining focused on eastern limestone

5.2 million tonnes

Largest limestone mine in Australia
Annual production 3.38 million tonnes of limestone and 1.8 million tonnes overburden = 5.2 million tonnes

Largest limestone mine in the world (Rogers, Michigan) extracts 10.2mtpa

Source: Boral (2018), Cambium Group (2019).

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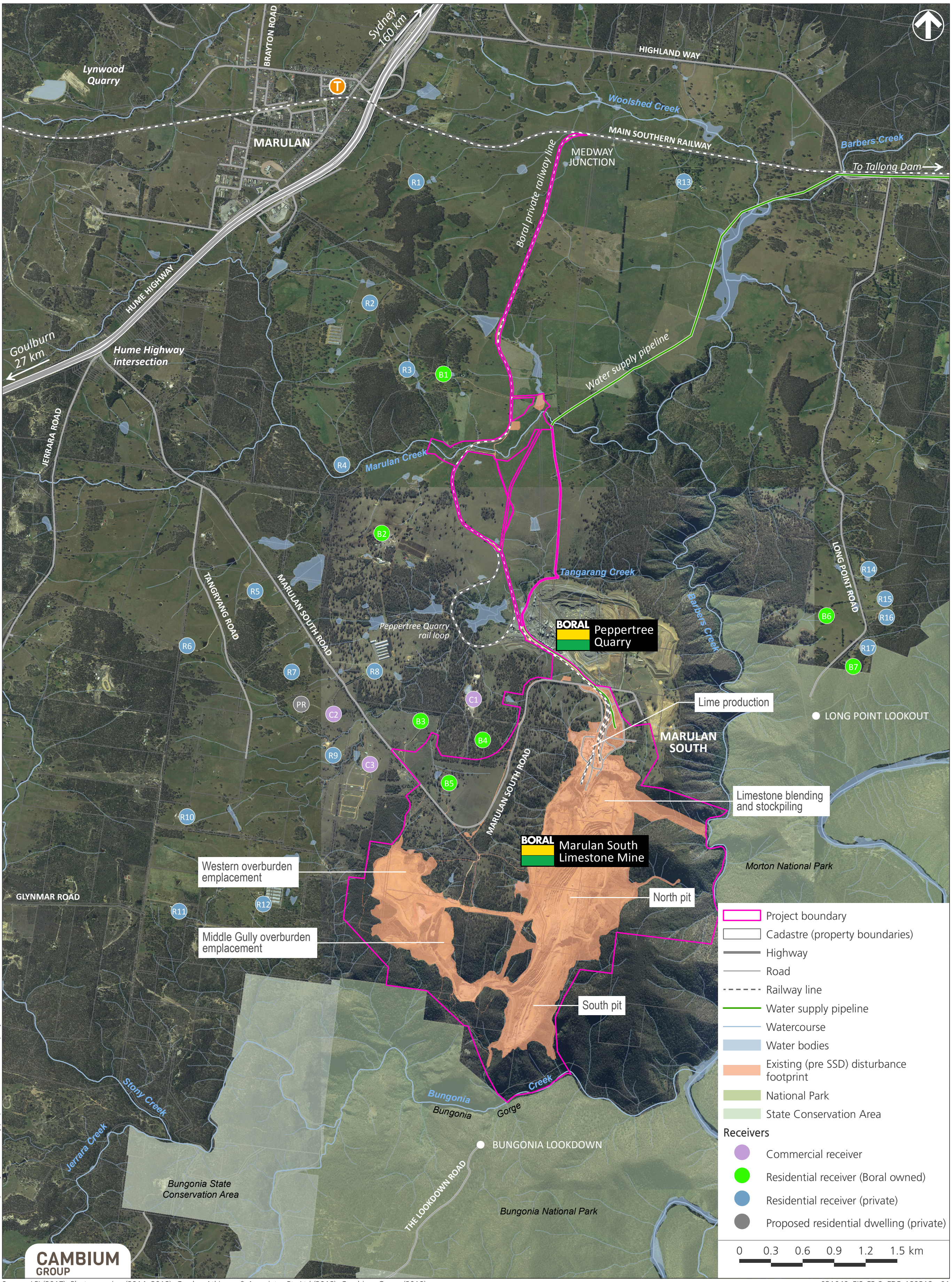
Figure 3.2
Existing (pre SSD) disturbance footprint

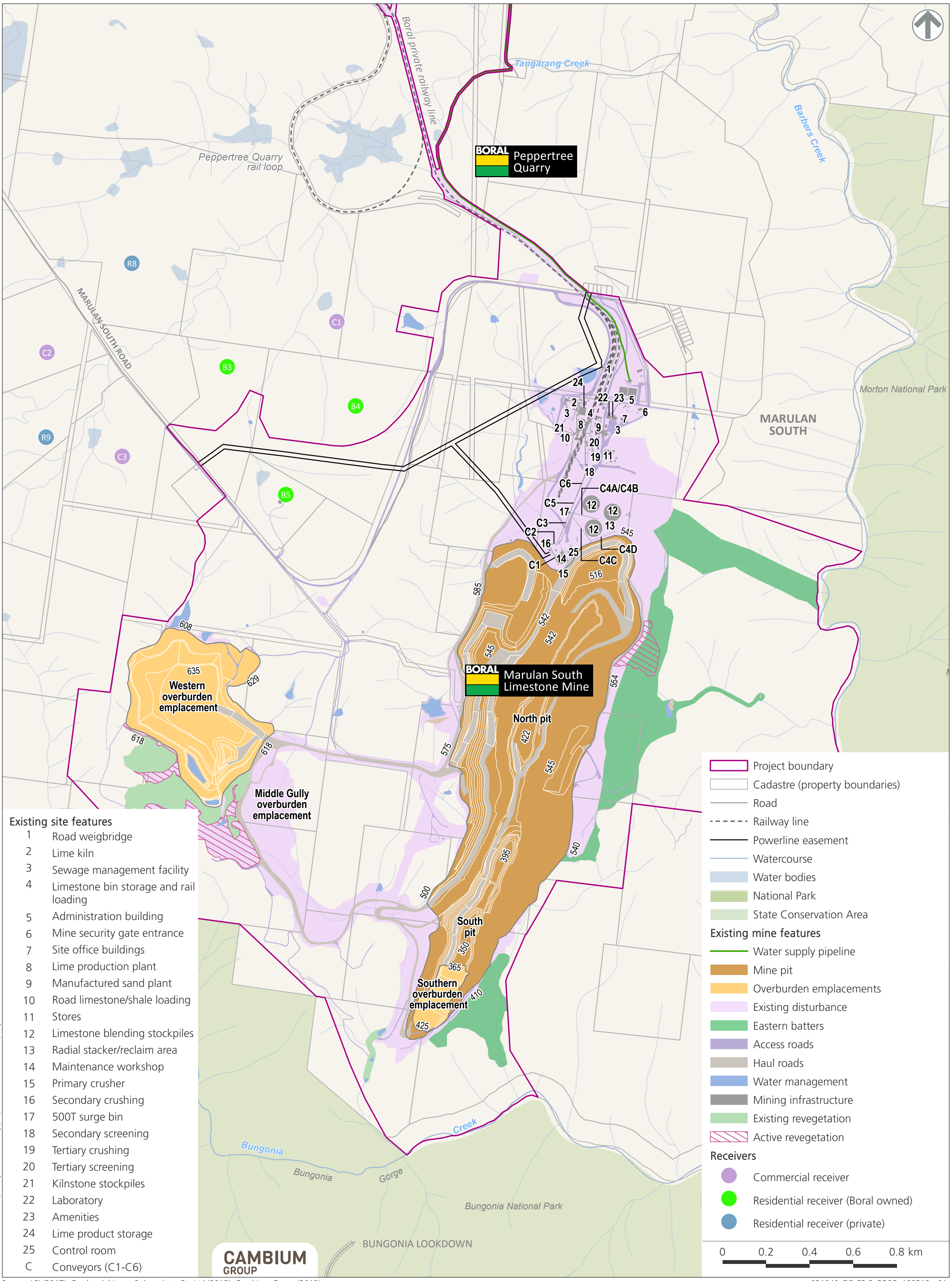


Source: LPI (2017), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F3-2_EDF_190318_v01

Figure 3.3
Existing operations - Stage 0 (Pre SSD approval)

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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3.1.2 Mining method

Exploration

Prior to the north and south pit merger in the early 1970's, exploration was carried out separately by each pit operator and mostly to inform mining requirements at the time for each pit rather than to define the resource.

In 1976 exploration drilling was carried out in the north pit and this again had an operational scope.

In 2005, an exploration program was carried out to meet the needs of the mining operation as well as to define the limestone resource. This work proved to be the basis for the further exploration carried out between 2014 and 2017. There was a staged exploration drilling program between 2014 and 2017 to inform the process to develop the 30-year mine plan for the SSD application.

Further exploration likely to be undertaken prior to the commencement of operations under the SSD application would involve additional 'in-fill' resource definition and quantification drilling in particular for the middle limestone member and areas in and around the northern end of the mine. This would be used to identify further resource and support alternative options for mine development.

Vegetation clearing

Where safe and practical, bulldozers or excavators are used to clear trees ahead of mining operations.

Prior to clearing, all useable timber is removed from the areas for re-use either on-site or for some other use external to the mine site. This includes, but is not be limited to, fence posts, rails and firewood. Any remaining vegetation that is cleared is preferably used in the final rehabilitation (i.e. pushed into windrows along the contour of the land or as 'brush matting', etc.).

Any trees found to contain hollows that would be suitable for use by native fauna are retained when possible in a separate stockpile and placed back on rehabilitated land to provide habitat. The mine has adopted a 'permit to clear' system that is part of the existing 'authority to work' approval documentation. This has been designed to ensure the key environmental considerations are assessed and relevant controls put in place. This is completed prior to any clearing works at the Project site.

Soil stripping

The mine has limited 'topsoil' and 'subsoil' resources and as such Boral recognises the importance of identifying appropriate soil resources and alternate growing media materials available at the site, together with the stripping and management practices required for successful rehabilitation and the achievement of the desired post mining land use.

The following general stripping and stockpiling techniques are implemented where appropriate in order to prevent excessive soil deterioration:

- Soils are stripped in a slightly moist condition and are not stripped in either a dry or wet condition.
- Care is taken during stripping to ensure that suitable and unsuitable material is not mixed.
- Stripped material is placed directly onto reshaped landforms and spread immediately (if mining sequences, equipment scheduling and weather conditions permit).
- Materials used for 'topsoil' placement will, where practical, be to a target average depth of 100 mm.

- Grading, or pushing material into windrows with graders or dozers for later collection by rear dump trucks (loaded by front-end loaders), is used as a less aggressive handling system.
- The surface of stockpiles is left in as rough a condition as possible in order to promote infiltration and minimise erosion until vegetation is re-established. Free-draining stockpiles will also prevent anaerobic zones forming.
- As a general rule, a maximum stockpile depth of 3 m is maintained.
- Stockpiles are seeded and fertilised as soon as possible with an annual cover crop species (e.g. oats or millet) that produce sterile florets or seeds, sown together with fertiliser.
- Prior to re-spreading stockpiled material onto reshaped landforms (particularly onto designated tree seeding areas), an assessment of weed infestation on stockpiles is typically undertaken to determine if individual stockpiles require herbicide application and / or 'scalping' of weed species prior to 'topsoil' spreading.

Overburden removal and emplacement

Weathered rock excavated as overburden is stockpiled in designated overburden emplacement areas, which are progressively rehabilitated. Select overburden material is also re-used for a wide range of purposes including earthen bunding, road repairs, upgrading of drainage works, rehabilitation and construction.

In the early days of the mine, overburden was tipped over the eastern and southern edges of the north and south pits into the Barbers Creek and Bungonia Creek gorges to form what is referred to today as the 'eastern batters' (refer to Figure 3.3). The eastern batters were rehabilitated and in more recent years overburden has been emplaced in the WOE and the Middle Gully overburden emplacement. The Middle Gully overburden emplacement has reached capacity and is under rehabilitation, while the WOE is the mine's current primary active overburden emplacement area.

3.1.3 Mine design

To date the open cut operations have been designed using the following mine design criteria developed from studies originally commenced in 1976 by consultants, Longworth McKenzie:

- Bench or face height 15 m
- Bench slope or face angle 50˚ in weathered zones
- Bench slope or face angle 75˚ below weathered zones
- Berm width between 5 and 8 m
- Haul road minimum width of 18 m

Since 2002 geotechnical investigations have been undertaken at the mine by engineering consultants Pells Sullivan Meynink (PSM) to monitor and review mine stability and geotechnical issues. During 2009 a photogrammetry study was undertaken to capture and record current mine pit geometry and structural patterns to allow for a reappraisal of mine bench layout and slope (face angle) designs.

In August 2009, the following recommendations were made by PSM regarding slope design for the eastern batters of the north pit:

'fresh' limestone

- Bench or face height 15 m
- Bench slope or face angle 65˚

- Berm width 8 m

Weathered materials

- Bench or face height 15 m
- Bench slope or face angle 55˚
- Berm width 9 m

The above recommendations have been integrated into current mine designs. They provide a 45 and 39 degree inter-ramp, slope angle respectively being toward the upper bound of that currently achieved in the east wall for limestone and weathered materials.

To assist with mine design layout including bench levels, ramp location and haul roads a series of permanent survey markers have been established around the mine and are used in conjunction with Topcon GPS survey equipment for survey control and pick-ups.

GEMCOM - Surpac mine modelling software is utilised in mine planning and design.

3.1.4 Blasting

The targeted limestone resource, along with some overburden material above/alongside the resource, are strong and require drilling and blasting to produce fragments suitable for crushing and screening. Traditional drill and blast methods are used at the mine, which require a drill rig stationed on top of each production bench. This rig drills a series of holes that are later charged with explosives, detonators and delays. Boral apply the standard practice of limiting maximum instantaneous charge to stay within the relevant noise and vibration criteria.

In accordance with conditions 13 and 14 of the schedule of conditions attached to CML 16, mining operations at the mine are required to employ practices to limit the effects from blasting as follows:

Ground vibration

Peak particle velocity within the lease area not to exceed 10mm/sec.

Peak particle velocity at any dwelling or occupied premises not to exceed 5mm/sec in more than 5% of the total number of blasts over a period of 12 months.

Blast overpressure

Blast overpressure noise level within the lease area not to exceed 120 dB (linear).

Blast overpressure noise level at any dwelling or occupied premises not to exceed 115 dB (linear) in more than 5% of the total number of blasts over a period of 12 months.

The frequency and size of blasts is determined and varies as mining progresses, and by production requirements and geological constraints.

Drilling and blasting in limestone is undertaken on a typical 5 m x 4 m pattern with 165 mm diameter holes inclined at approximately 75 degrees to meet bench slope design requirements. Minimal blasting of overburden is required.

Typical drill and blast parameters include:

- In-situ density of limestone (t/m^3) 2.7
- Blasts per week 3-4
- Blast hole diameter (mm) 165

- Blast hole inclination (degrees) 75
- Blast hole depth (m) 15 + 3 metres sub-grade
- Blast hole spacing (m) 5
- Blast hole burden (m) 4
- Stemming (m) 5
- Initiation Non-Electric

Typical blasts involve between 27-35 drill holes charged with bulk emulsion explosive. Holes are singularly detonated using non-electric delays and booster charges.

Approximately 6-8 t of explosive are typically used to blast between 17,000 and 25,000 t of limestone requiring some 1,200 t of explosive usage per annum.

The storage, handling and use of explosives at the mine is conducted in accordance with the relevant licensing and statutory requirements including NSW *Work Health and Safety Act (Mines and Petroleum Sites) Act 2013* and regulations and NSW *Explosives Act 2003* and regulations.

On site explosive storages licensed with SafeWork NSW include detonator storage for up to 10,000 detonators and an explosive storage magazine for up to 10,000 kg of explosive (although explosive is no longer stored on site).

In some cases blasting will produce oversized material that does not fit into the primary crusher. In these cases, an excavator with hammer is used to break up the stone or alternatively a small explosive charge might be applied to the individual stones.

Blasting is routinely carried out between 10:00 and 16:00 hours on weekdays and generally early afternoon (excluding Saturdays, Sundays and Public Holidays). Blasting frequency is up to one blast per day on weekdays, excluding public holidays, totalling five blasts per week.

Prior to blasting events, warning sirens are activated in accordance with safe blasting procedures. Additional procedures are followed prior to any blasting event that may affect the public utilising the adjacent recreational reserves of Morton NP, Bungonia NP and Bungonia SCA.

In accordance with Condition M7 of EPL 944, Boral must video record each blast fired during rim removal, or in the area shown on the Plan titled “Blast Affecting Bungonia Gorge”, dated 30 October 1996. The results of such blasting must be submitted to the EPA at the end of the licence reporting period. Boral completed blasting of the rim of the south pit in 2009.

3.1.5 Limestone handling and processing

Processing of mined limestone involves crushing and screening through primary, secondary and tertiary stages depending on product and customer requirements. Limestone processing facilities (Figure 3.4) include primary and secondary crushing, screening, conveying and stockpiling plant and equipment located north-west of the north pit and extending to the tertiary crushing, screening, bin storage and despatch (rail and road) systems that form part of the main processing facilities.

Additional mobile crushing and screening plant is hired as required to meet and trial special product specifications and during plant breakdown and maintenance periods.

Limestone is selected from particular areas within the mine and blended together with shale (when required) at the face, within stockpiles and during the crushing and screening process. Limestone quality is monitored using laboratory analysis of drill hole cuttings and on line using the latest scanning technology.

The majority of crushed limestone product is despatched by rail to customers including BlueScope Steel, the Berrima and Maldon cement works, and Omya.

Kiln stone grade limestone continues to be 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.

Where appropriate a combination of dust sprays, including use of Polo Citrus dust foam, covered conveyors and dust collectors are used to minimise dust throughout the processing plant operations.

Lime kiln and hydrator stack emissions are monitored continuously using instrumentation with data fed back to the kiln control room using the Citect scada system. Shale and white clay are not processed and are stockpiled directly from the pit, ready for dispatch by road to the Berrima and Maldon cement operations.

Lime Production Plant

Limestone crushed to desired aggregate size is conveyed to the pre-heater by conveyor belt. The material is progressively introduced into the rotary kiln, which is fired by a combination of coal and natural gas.

The lime kiln process, called 'calcination', involves the heating of limestone or calcium carbonate rock ($CaCO_3$) to produce 'quicklime' or calcium oxide (CaO), which is an alkali chemical product used in a variety of domestic and industrial applications.

Limestone fines are carried in a flue gas stream to a bag filter. Most of this material is trapped in the bag filter, and clean emissions are discharged into the atmosphere. Stack emissions are continuously monitored for particulate levels. Quicklime material is crushed in either a rolls crusher or a hammer mill as per market requirement, and is conveyed to a screen house for segregating into specific size ranges and stored in four storage bins of up to 400t capacity prior to despatch off-site.

Hydration Plant

An additional process, called 'hydration', involves the addition of controlled quantities of water to the quicklime, to manufacture hydrated lime (hydrate) or calcium hydroxide, ($Ca(OH)_2$), which is also an alkali chemical product, but in powdered form.

The material is milled in a closed-circuit ball mill and air classifier in order to remove any coarse particles. Hydrated lime is then stored in two x 250 t silos and two x 100t silos prior to despatch.

In summary, mined limestone is used to manufacture both quicklime and hydrated lime on-site, but principally to produce a sized range of limestone products for use in cement manufacture at Boral's Berrima cement works, and for use in the steel industry at Bluescope Steel's Wollongong steel works.

Sand Plant

In 2012, Boral obtained development consent to construct a sand plant within the limestone processing plant for the manufacture of limestone sand, in order to satisfy the demand of an emerging market, in which the sand is used directly, or blended with other sands for use in production of concrete. The sand plant is situated east of the processing plant and to the north of the north pit.

The sand plant is fed with approximately 8 mm sized limestone aggregate by conveyor from the tertiary crusher. The sand plant then further crushes, screens and classifies the tertiary crushed limestone to meet desired size specifications. The finished manufactured limestone sand product is then stored in an overhead product silo ready for transport by truck to the adjoining Peppertree Quarry for blending and despatch by rail.

By-product material is fed back into the processing plant to be re-used in other products or stored in the by-product silo before being despatched by road transportation.

The sand plant currently produces 500,000tpa and is capable of producing up to 1 Mtpa of manufactured limestone sand.

Approximately 6 ML of water is required by the sand plant per annum to increase the moisture content of the manufactured limestone sand product for dust suppression purposes. This water is supplied from the Tallong Weir under existing surface water licences.

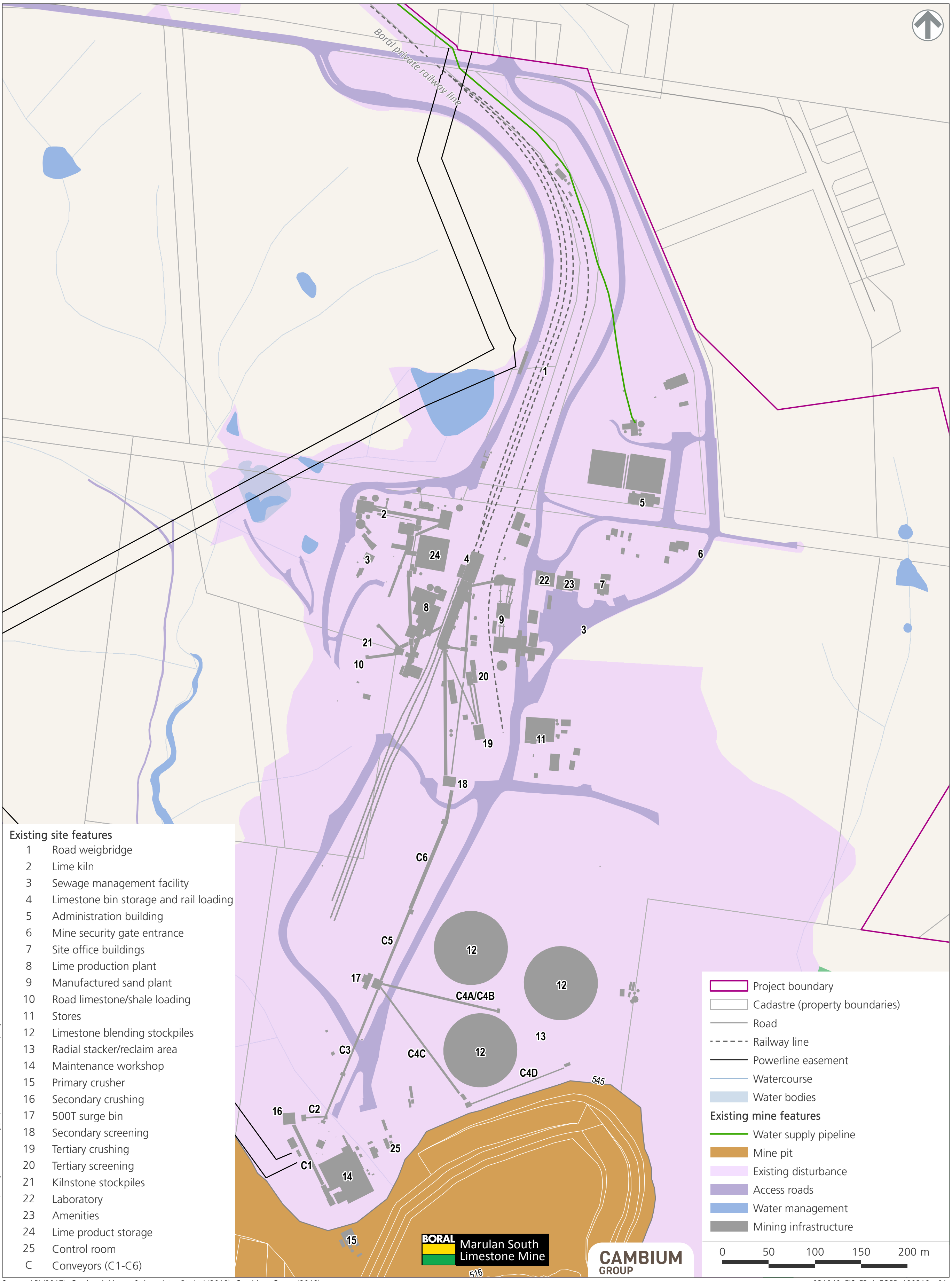
Stockpiles

Boral's existing limestone blending and product stockpiles have a nominal capacity of 400,000 t, whilst the limestone storage bin capacity for rail despatch is approximately 20,000 t.

The existing stockpile and reclaim area at the northern end of north pit is used to store limestone that has passed through the primary and secondary crushers. Smaller stockpiles of special crushed and screened limestone products are generally loaded by front end loader for road despatch.

Figure 3.4
Existing operations - Processing plant

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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3.1.6 Rehabilitation

Recent rehabilitation of the mine has been in accordance with the *Marulan South Limestone Mine Rehabilitation Strategy* report prepared by GSS Environmental in November 2010.

The rehabilitation strategy was developed to consolidate the range of historical mine rehabilitation activities into one document.

The historical aim of rehabilitation at the mine has been to re-establish vegetation on disturbed areas that provides as similar function as practical (in terms of landform stability and biodiversity) as the pre-mining vegetation communities. The current strategy contains the following specific objectives (GSSE, 2010b):

Achievement of acceptable post-disturbance land use suitability – rehabilitation of mined land will aim to create a stable landform with land use capability and/or suitability similar to that prior to disturbance, unless other beneficial land uses are pre-determined and agreed.

Creation of stable post-disturbance landform – Disturbed land will be rehabilitated to a condition that is self-sustaining, or where maintenance requirements are consistent with the agreed post mining land use(s).

Preservation of downstream water quality – Surface and groundwater that leave the Project site are not significantly degraded, with water quality being maintained at levels that are acceptable for downstream users.

A well-coordinated rehabilitation program is being implemented at the mine to achieve these objectives, which includes the following principles:

- sound landform design, integrating suitable surface water management;
- effective soil management techniques including identification, stripping, stockpiling, re-spreading and appropriate weed control;
- demonstrated revegetation techniques compatible with modified landform and soil conditions, and resulting in communities tolerant of environmental pressures such as fire and drought events;
- protecting newly revegetated areas from livestock and feral grazing animals for at least five years (or until vegetation sustainability is sufficiently established); and
- rehabilitation monitoring, using a recognised (statistically viable) method, that assesses rehabilitation development towards agreed acceptance criteria and post-mining land use.

During the current MOP period (2018-2023), the two principal areas with a focus on rehabilitation included the:

- WOE, and
- reformed Eastern (Barbers Creek) waste emplacement area.

In addition, monitoring and maintenance of previously completed revegetation will continue.

3.1.7 Plant and equipment

The mobile plant and equipment currently used at the mine includes, but is not limited to, the items listed in Table 3.1.

Table 3.1: List of plant and equipment

Description	No.	Primary function	Manufacturer	Model
Primary mobile plant				
Rear dump truck	1	Limestone / overburden haulage	Caterpillar	777B
Rear dump truck	3	Limestone / overburden haulage	Caterpillar	777C
Rear dump truck	2	Limestone / overburden haulage	Caterpillar	777D
Articulated dump truck	1	Lime plant work	Caterpillar	250D
Front end loader	2	Primary loader - limestone / overburden	Caterpillar	993K
Front end loader	1	Back-up and stockpile loader	Caterpillar	992G
Excavator (40 t)	1	Limestone excavator/rock-breaker	Caterpillar	245
Grader	1	Haul road maintenance	Komatsu	14
Drill rig	1	Drilling limestone	Altas Copco	LM800
Water cart (90,000 L)	1	Haul roads, waste emplacement and site dust suppression	Caterpillar	777
Excavator (65 t)	1	Overburden removal	Caterpillar	-
Dozer	1	Overburden emplacement	Komatsu	D375A-5
Auxiliary mobile plant				
Front end loader	1	Stockpile loader	Komatsu	WA 800-3
Front end Loader	1	Lime Plant loader	Komatsu	WA 100-3
Front end loader	1	Stockpile loader	Caterpillar	988
Excavator (out of service)	1		Liebherr	R984
Mobile crane (25 t)	1	General site maintenance	Tadano	-
Forklift	1	General site maintenance	Mitsubishi	FD50
Backhoe loader	1	General site maintenance	Caterpillar	432D
Explosives mixing and handling truck	1	Drill and Blast	Iveco Acco	2350G
Skid steer bobcat	2	General site maintenance	Bobcat	Mustang
Service truck	1	General site maintenance	Hinto	GT8JKMA
Light service truck	1	General site maintenance	Perway	
Light vehicle (four wheel drive)	1	Rail despatcher's vehicle	Kawasaki	YR2012
Kanga loader	1	General site maintenance	Ford	UF MAY 96
Maintenance transport	1	General site maintenance	ISUZU	NPS250
Road sweeper	1	Sealed road cleaning	Tennant	830
Mower	1	General site maintenance	Kubota	BX2230

3.1.8 Water supply and management

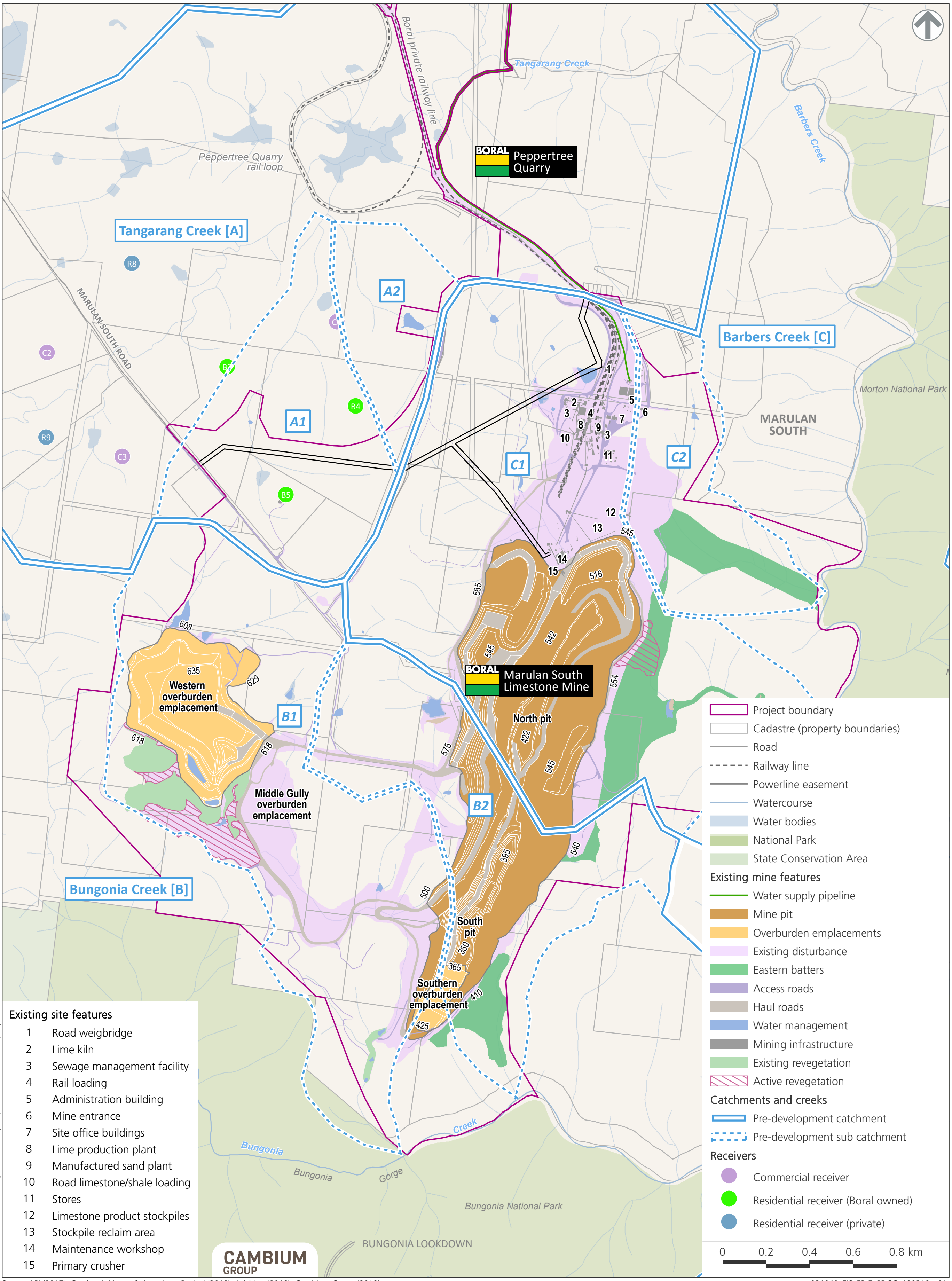
Since commencing operations in 1830 the mine pit has excised portions of a number of catchments that previously drained to Barbers Creek and Bungonia Creek. In particular, the drainage patterns inferred from the earliest available aerial photography (see **Figure 3.5**) indicate that prior to mining, a large catchment (about 350 ha) drained in an easterly direction towards a tributary of Barbers Creek in which the existing gabion wall sediment filter is located.

The mine pit now cuts across the original drainage line and as a result, approximately 104 ha of land to the west and north of the pit drains into the pit (about 138 ha) (refer to **Figure 3.6**). In addition:

- the mine pit has encroached into the area that originally drained to tributaries of Main Gully;
- the WOE has created a 'closed' catchment (about 20 ha) that is now excised from the catchment that originally drained to Main Gully; and
- drainage works have diverted a large proportion of the original Main Gully catchment into the south pit.

Figure 3.5
Pre-development catchments and creeks

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

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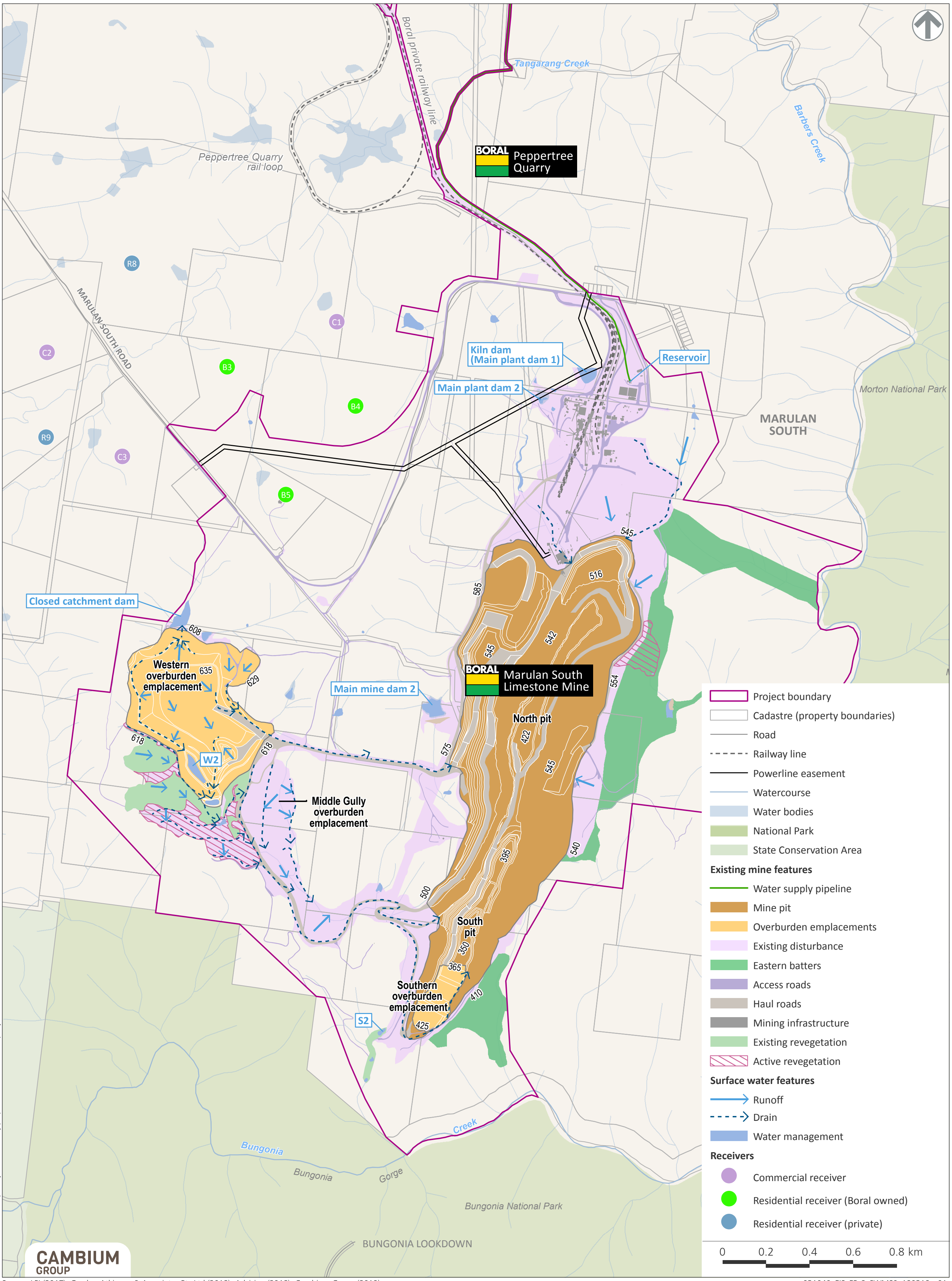
Figure 3.6
Surface water management - Stage 0 (pre SSD approval)

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

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Overburden emplacement and drainage

Historically, the mine had three major drainage systems:

The eastern system

For many years, overburden from the mine was placed on the eastern side of the mine forming steep unconsolidated batters (the 'eastern batters'). As shown on Figure 3.5, prior to mining in the area the natural topography in the north-east of the site generally drained eastward/southeast toward Barber's Creek from the edge of the plateau into the gorges below. The north pit has intercepted a number of the upper tributary ephemeral drainage lines in this area and flows from the north and west, including the limestone processing area. Natural gullies to the east of the north pit have been used for overburden emplacement in the area known as the eastern (Barbers Creek) emplacement. Overburden emplacement in this area has now ceased and the remaining disturbed areas are being rehabilitated.

A sediment filter basin constructed with gabion baskets (by helicopter due to steep terrain) is located downstream in the main drainage line prior to entry to Barbers Creek. As part of the Project, rehabilitation works will continue on the eastern batters (see **Appendix I**).

An upstream drainage line in the north-east of the site previously drained southward toward the north pit and was diverted east of the north pit into the natural drainage line feeding to Barbers Creek via the filter dam. This upper catchment, which now drains predominantly to the north pit, includes both upstream clean water runoff from vegetated areas mixed with sediment laden runoff from the operations area.

The northern system

The northern system drains the area around the process plant, workshop, administration building and lime plant. This catchment drains via a series of sediment basins into the north pit. Water management infrastructure comprises main plant dam 1 (also referred to as the kiln dam) to the north of the processing plant area and main plant dam 2 directly to the west of the processing plant area. Runoff from the processing plant area and process water from the processing plant is directed towards a triple interceptor sediment trap and a minor sediment basin, before being discharged to main plant dam 2 for subsequent recycling.

The southern system

The southern system drains the WOE and haul roads. Matrix (2005) describes a drainage channel directing runoff from the WOE along the southern haul road into the sump of the south pit where it subsequently drained into the local groundwater system. Matrix (2005) identified that, at the time, the channel along the haul road was undersized and some flow was diverted along a haul road into the adjacent main gully area and Bungonia Gorge. The precise location of this drainage system is not clear. However, this channel was upgraded in late 2005 to ensure that a design flow of 18 m^3/s could be directed into the south pit. This ensured that, at the time of writing of the 2009 Surface Water Assessment (GSSE, 2009), all sediment-laden surface runoff from the southern system was diverted to the south pit via the southern haul road and the sediment check basin.

A small area of the Project site on the western side of the south pit down-slope of the mine disturbance area drains towards Bungonia Creek via Main Gully which contains three sediment basins. Table 3.2 summarises the approximate capacity and contributing catchment areas of the existing sediment basins.

Table 3.2: Existing sediment basins

Sediment dam	Estimated dam capacity (ML)	Approximate catchment area (ha)	Notes
Southern Haul Road Check Basin	0.08	6.5	Pre-treatment sediment check basin in roadside drainage near Main Gully diversion of Southern Haul Road, prior to entry to south pit.
Main Gully Primary Sediment Basin 1	5.8	2 Mainly haul road	Large sediment basin wall. First basin in Main Gully series of three sediment basins. 2008 AEMR lists basin capacity as 5.8 ML Estimated by GSSE (2009) as 5 ML.
Main Gully Sediment Basin 2 (Lower South East Sediment Basin)	0.2	2 Mainly haul road	Second in-line sediment basin in Main Gully, prior to discharge via the auto-sampler point into Bungonia Creek gorge.
Main Gully Sediment Basin 3	0.8	2 Mainly haul road	Final sediment basin in Main Gully series prior to discharge.
Plant Sediment Basin	0.3	N/A	Completed late 2007, when main plant dam 1 diversion works were undertaken.

Mine water supply including existing site water supply dams

The the main clean water source for the mine is the ‘external’ source of Tallong dam, an 85 ML water storage dam leased from the State Rail Authority and located 10 km to the north. Water is transferred to the mine from Tallong Weir via a pipeline. Mine water supply is supplemented by surface runoff collected in water storage dams that is used for dust suppression (as discussed below) and two on-site groundwater bores (refer to Figure 3.3). Table 3.3 summarises the approximate capacity and contributing catchments of the existing mine water supply dams. Table 3.4 summarises Boral’s existing water entitlements. An agreement was also in place with a local landholder to supply water from a large farm dam, Glenrock dam, should the site ever reach a minimum onsite supply level. This agreement has never been implemented.

Potable water supply is provided in 15 L water bottles issued to the mine by the store.

Effluent from the office and workshop facilities is treated by licensed on-site wastewater treatment systems and treated effluent is disposed of by irrigation onto a designated effluent irrigation area.

Table 3.3: Existing mine water supply dams

Water supply dam	Estimated dam volume (ML)	Catchment / water source	Notes
Main plant dam 1 (kiln dam)	27	Limited catchment.	Used for storage of flows transferred from Tallong Weir.
Main plant dam 2	11	Runoff from processing plant area.	Pollution control dam and controls/recycles run-off from the lime plant.
Main mine dam 1	12	Limited catchment from north-east.	Historically, this provided a source of water for dust suppression prior to being subsumed within the Western Overburden Emplacement.

Water supply dam	Estimated dam volume (ML)	Catchment / water source	Notes
Main mine dam 2	43	0.21 km^2 catchment.	This dam was previously fed by water pumped from main mine dam 1 and water was utilised periodically for dust suppression by the mine.

Table 3.4: Boral's existing water entitlements

WAL No.	Works approval	Water source	Management zone	Entitlement (ML)
Unregulated river				
WAL25207	10WA102352	Shoalhaven River Water Source Tallong weir	Barbers Creek Management Zone	76
WAL25373	10WA102377	Shoalhaven River Water Source Glenrock dam on Barbers Creek	Barbers Creek Management Zone	10
Total: unregulated river				**86**
Domestic and stock				
WAL25352	10WA102352	Shoalhaven River Water Source Barbers Creek	Barbers Creek Management Zone	1
Aquifer				
WAL24697	10WA116142	Goulburn Fractured Rock Groundwater Source Production Wells WP16 (north pit bore) and WP17 in the northern end of the north pit		12
WAL41976		Goulburn Fractured Rock Groundwater Source		838
Total: aquifer				**850**

3.1.9 Rail infrastructure and transportation

A single line rail track owned and maintained by Boral links the Project site to the Great Southern Railway at Medway Junction, which is approximately 8 km to the north of the mine. In addition, a 1.2 km long passing line (triple line track) was constructed at Medway Junction as part of construction of the Peppertree Quarry. This line will also be used by the mine to enhance access to the Main Southern Railway.

Boral currently transports the majority of finished products by rail, with up to six trains departing the mine per day.

3.1.10 Road infrastructure and transportation

Site access from the Hume Highway is via the 9 km Marulan South Road. Materials and supplies continue to be transported to site and limestone, shale and lime products continue to be despatched by truck from site. Approximate existing road transport volumes are outlined in **Table 3.5**.

Table 3.5: Existing annual road transport volumes (approximate)

Product	Volume (tpa)	Destination
Lime products	130,000	Hume Highway
Limestone aggregates	50,000	Hume Highway
Clay shale	80,000	Hume Highway
Fine limestone	70,000	Hume Highway
Sub-total	*330,000*	Hume Highway via Marulan South Road
Limestone products	120,000	Agricultural lime manufacturing facility via Marulan South Road
Total	**450,000**	
Crushed and air classified limestone sand	500,000	Peppertree Quarry (internal roads crossing Marulan South Road)

Vehicle movements associated with existing operations are approximately 278 light vehicle movements (two way trips) per day, 150 heavy vehicle movements (two way trips) per day and 8-10 heavy vehicle movements (two way trips) or 4-5 truckloads (one way trips) per hour.

3.1.11 Utility infrastructure

Electricity

Power supply to the mine is via a 33/11 kV high voltage power line that commences at a sub-station on the southern side of Marulan South Road, immediately west of the Project boundary.

Gas and coal

Natural gas required to fuel the lime kiln is supplied via a high pressure gas pipeline. Coal for kiln fuel is delivered by road to the coal handling facility.

Telecommunications

Mine communications are via telephone line and satellite optical fibre network.

3.1.12 Administration offices and staff parking

The site of the former village of Marulan South is located between the mine and Peppertree Quarry on Boral owned land. The village was established principally to service the mine but has been uninhabited since the late 1990s. The majority of the village's infrastructure has been removed and only a village hall and former bowling club remains. The bowling club has been converted into administration offices for the mine and the hall is used by the mine services team. Car parking facilities for mine personnel are provided adjacent to the main administration building.

3.1.13 Wastewater

The following sewage treatment facilities operate at the mine:

- One main 'envirocycle unit' that receives effluent from the main offices, laboratory, bathrooms, store and conference room. The effluent is then irrigated onto an open grassed area of approximately 1 ha, where it is evaporated.
- Two lime plant 'envirocycle units' servicing the kiln control room, hydration, dispatch and workshop areas. These units are inspected weekly and emptied by a licenced disposal contractor.
- Two septic tanks, one of which is located at the 'machine shop' / primary crusher, with the other adjacent to 'Fettlers' shed'.
- A third septic system which services the former 'Club' facility, now known as the services department, north of the main office.

The 'machine shop' / primary crusher and 'Club' septic tanks are inspected and pumped out regularly by a licensed disposal contractor, while the 'Fettler's shed' unit is adequately serviced by absorption trenches.

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

3.1.14 Waste management

The main waste streams generated by the mine are general solid wastes and hazardous and liquid wastes generated from operations and servicing of equipment.

Overburden and reject lime waste material are stockpiled in the WOE (Figure 3.3), while all other waste generated at the site is separated, collected in designated waste disposal bins, reused where possible, or disposed of at an appropriately licenced waste facility.

Additional context regarding waste streams generated by existing mining operations, and the quantities, fate and management of these wastes is outlined in **Chapter 22**.

3.1.15 Hazardous materials

There are one petrol, one diesel, two LPG, one oils, one compressed gas, and one distillate dangers goods depots at the mine, which are used and maintained in accordance with new licensing for Acknowledgement of Notification of Dangerous Goods on Premises - Licence Number 35/008099.

Hazardous and dangerous material facilities are inspected at least annually by an externally accredited inspector to check for any problems or upgrades required under the regulations.

As required, all enclosures to fuel facilities are bunded to meet AS 1940 Storage and Handling of Flammable and Combustible Liquids, 2017.

The asbestos register titled "Asbestos Survey Report" Report No. 6011/02/ASR, dated 13 July 2005 is available on-site in accordance with NOHSC (WorkSafe) Code of Practice and OH&S Regulation 2001.

A Phase 1 Contaminated Land Assessment was undertaken during 2010 to update and further identify potential land contamination issues on site. The results from this assessment, and the recommendations within, are used by Boral to manage potentially contaminated lands that may be mined.

The Tallong water supply pipeline was realigned during the 2009-2015 MOP period in accordance with the recommendations of the Phase 1 Contaminated Land Assessment.

Boral removed an approximately 1,100 m section of the Tallong AC water pipeline in June 2011 during the establishment and relocation of services for Peppertree Quarry. Boral engaged Longstone Pty Ltd (ABN 20083458664), a licensed local asbestos removal contractor, to remove the section of pipeline.

This section of the AC water pipeline was removed in accordance with the safe work method statement, dated 25 May 2011, in approximately 6 days between 3 June 2011 to 10 June 2011.

All asbestos materials removed were delivered to the Council's waste facility at 100 Sinclair Street, Goulburn. Robson Environmental sampled soil and visually inspected a section of the AC water pipe route.

3.1.16 Bushfire management

The mine's Bushfire Management Plan (Boral, 2015) provides risk control measures for protection of property and lives from bushfires. The mine has firefighting equipment including:

- fast fill hoses and connections;
- two water tankers;
- clean water dams with maintained access points;
- earthmoving equipment;
- water pumps;
- portable radios;
- fire alarms; and
- first aid rooms and supplies.

This equipment will be made available on request to the Rural Fire Service (RFS) for use during an emergency.

The Marulan RFS continues to monitor bushfire risk and conducts an annual inspection to determine levels of natural fuel sources in and around the mine lease area. Bushfire risk is minimised by carrying out hazard reduction as required in accordance with the necessary permits and regulations.

In addition, fire risks associated with natural fodder or grassed paddocks in and surrounding the lease area continue to be controlled by sheep grazing or by leasing rights for grazing.

Whilst training in firefighting is not formally conducted by the mine, a number of employees are active members of the RFS.

3.1.17 Public safety

Members of the public who access to the mine without authorisation from Bungonia Gorge could be at risk from blasting. Procedures are implemented prior to blasting in areas declared as "Blast Affecting Bungonia Gorge" (refer to **Section 3.1.4**).

A site security plan was updated in 2006 which incorporates fencing, security gates and electronic monitoring to improve site security and reduce the risk of un-authorised public access. This plan has been subject to annual reviews with the latest version awaiting final approval by safety inspectors from the Department of Primary Industries (DPI).

The security plan and system includes:

- one 6 m sliding gate at the main office, and associated chain mesh fencing to ensure appropriate scrutiny of all site visitors;
- one pedestrian gate near the old bowling club car park (now the visitor's car park) to allow access to the office to ensure visitor sign in;
- two swing gates on Lime Kiln Road prior to the main weighbridge and associated chain mesh fencing to allow entry only through the gate itself;
- additional chain mesh fencing to the mine perimeter, around the main entry, to ensure the possible points of entry and exit are limited to the control points, being the gates; and
- signage for both the new and existing mine perimeter fencing.

The security system has been improved with the relocation of the administration and training functions to the old bowling club rooms. All visitors now report to a main office and register prior to entry to the area covered by CML 16.

Review and upgrade of the site's induction system for visitors, contractors and employees is an ongoing component of the Boral Site Safety Management Plan.

3.2 Workforce and operational hours

The current operations are 24-hour, 7 days per week (including mining, processing, despatch and maintenance) with personnel employed on a series of eight, 10 and 12 hour shifts to cover the different operational aspects of the mine. Shifts generally run from 07.30am for either 8, 10, or 12 hours. There are approximately 56 employees on 8 hour day shifts, 8 employees on 10 hour day shifts and 34 employees on 12 hour alternating shifts.

Blasting is restricted to daylight hours and on weekdays, excluding public holidays.

Approximately 191 full time personnel are employed in connection with the mine, including lime manufacturing, administration and logistics. This includes 118 personnel on-site (excluding contractor personnel) and another 73 that are employed at other locations e.g. Berrima and Maldon Cement Works and North Ryde that would otherwise not be employed if it weren't for the mine. Most personnel are long serving employees who reside in the local Marulan and surrounding Goulburn Mulwaree district.

Employees travel to the mine either by bus or personal vehicles. Parking facilities are provided adjacent to the main administration building. Accommodation facilities are not required at the mine as employees generally reside locally.

3.3 Approval history

The following sections present the leases, consents and licences that Boral currently hold to operate the mine.

3.3.1 Consolidated Mining Lease No. 16

The mine has historically been covered by over 66 mining titles including mineral leases, mining leases, mining purposes leases, private lands (mining purposes) leases, private lands leases and a special lease. As at 23 April 2004, all previous titles were consolidated into CML 16 which remains valid until 26th February 2023.

CML 16, held by Boral, covers an area of approximately 616.5 ha, which includes land owned by Boral, Crown Land (adjoining to the south and east) and five privately owned titles. CML 16 was granted for the purpose of prospecting and mining for agricultural lime, clay/shale, iron minerals, limestone, marble, and structural clay.

CML 16 contains 27 conditions covering mining, rehabilitation and environmental management. In addition, the lease is subject to various surface exemptions and depth restrictions as detailed in the 2018-2023 MOP and presented on **Figure 3.7**.

3.3.2 Mining Lease No. 1716

Mining Lease No. 1716 (ML 1716) was granted for a term of 21 years by the then Department of Industry, Resources and Energy on 4 September 2015 for mining clay/shale, iron minerals, limestone, marble, and structural clay.

Granting of ML 1716 effectively removed the mining depth restriction of 30.48 m below the surface of CML 16 within 12.04 ha of Boral freehold land (Lot 1702 in DP 610507). Refer to Figure 3.7 showing the location of ML 1716 in relation to the boundary of CML 16.

The lease includes eight conditions covering mining, rehabilitation and environmental management.

3.3.3 Mining Operations Plan 2018-2023

Overview

The mine is currently operating under the 2018-2023 MOP approved by the DPE–RG for the period 1 March 2018 to 26 February 2023.

The MOP has been prepared for the mine, in relation to the two mining authorisations, CML 16 and ML 1716.

The MOP has been prepared to incorporate all activities associated with the continued mining and processing of limestone and shale up to the expiry date of CML 16.

The contents of the MOP provide relevant information on the mining, processing and rehabilitation operations necessary for compliance with existing conditions imposed on the mine by Boral's mining leases, development consents, other approvals and licences and NSW Trade and Investment's (2013) *ESG3: Mining Operations Plan Guidelines September*.

Mining activities described in the MOP will remain consistent with current approvals as detailed in the 2009 - 2015 MOP and supporting review of environmental factors (REF) dated 1st December 2010 as approved by the then Department of Industry and Investment on 30 March 2011. As mining activities will remain within the established disturbance footprint and project approval boundaries a new REF was not required to support the 2018-2023 MOP.

In conjunction with this SSD application, Boral will apply for a new mining authority. The approval of the proposed 30-year SSD application and grant of a mining authority will require a new MOP submission consistent with all new consents, authorisations and licence conditions.

Activities over the 2018-2023 MOP term

During the approximate 5-year MOP term, Boral proposes to continue mining limestone at a rate of up to 3.38 Mtpa and will remove overburden at a rate of up to 2 Mtpa. In addition, clay shale will continue to be extracted at a rate of up to 200,000 tpa.

Over this period Boral proposes to mine approximately 16 Mt of limestone to 350 m AHD elevation in the south pit and approximately 425 m AHD elevation in the north pit. Mining is concentrated in the south pit to extract available limestone prior to the commencement of in-pit overburden emplacement.

The mining of limestone as scheduled requires the removal of approximately 7.3 Mt of overburden during the MOP period. Additional overburden removal at rates up to 2 Mtpa are likely in order to maintain access to adequate quantities of limestone for blending, balanced with the availability of both above ground and in-pit overburden emplacement area capacities.

Overburden will be emplaced in the WOE to approximately 635 m elevation as well as initial backfill into the southern end of the south pit during 2019 as emplacement capacity becomes available following completion of limestone mining to 350 m elevation.

No new disturbance beyond approved disturbance boundaries is permitted therefore no stripping of topsoil materials is planned.

Product despatched from site includes crushed and sized limestone including limestone sand, quicklime and hydrated lime. Waste lime comprising quicklime, hydrated lime or limestone or any combination of the three is trucked to the WOE and is encapsulated within an existing 2 ha area of the emplacement.

3.3.4 Development consents

The mine previously operated under the Goulburn Mulwaree LEP 1995, which adopted the 1980 model planning provisions. These model provisions allowed the continued operation of mines which were in existence on the day that the LEP was gazetted.

That LEP has been replaced by the Goulburn Mulwaree LEP 2009.

Currently limestone mining and processing operations within CML 16 are subject to two development consents that precede the 1995 LEP (refer to **Figure 3.7**) including:

- the Barbers Creek Disposal Area for which development consent was granted on 21 February 1972 to Southern Portland Cement Limited; and
- Q8 Quarry and Main Gully Disposal Area for which development consent was granted on 16 October 1974 to BCSC.

The remaining lease area is operated under ‘continuing use rights’, pursuant to section 109 of the EP&A Act, as defined by the boundary of disturbance as at 1 August 2007 presented in the 2018-2023 MOP 1A.

The mine has also been the subject of a number of more recent development consents and various licences as outlined in **Table 3.6** and Table 3.7. Boral intends to consolidate these development consents under SSD 7009 with the exception of Application No. 129/0405/OSMF which was approved under the *Local Government Act 1993* and can therefore not be incorporated into the SSD.

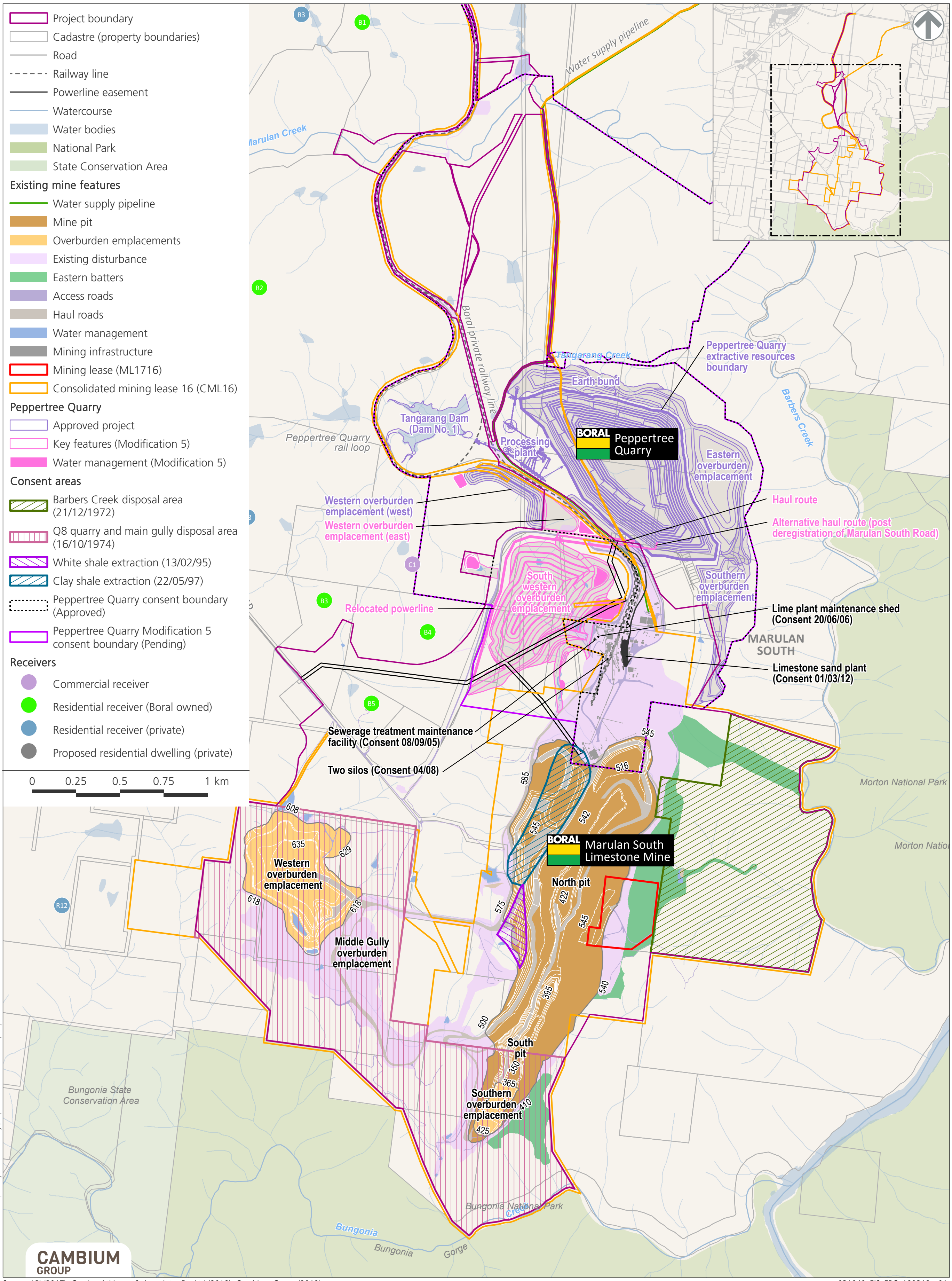
Table 3.6: Planning approval history

Date of development consent	DA/MOD Number	Details
13 February 1995	DA No. 2802	Proposed white clay extraction on land described as Portion 83 and public road with Portion 83 in the Parish of Marulan.
22 May 1997	DA No. 118/967	Proposed clay shale extraction within the Marulan South Limestone Quarry on land described as Portions 81, 82, 132, 114, ML 8, and ML 16 in the Parish of Marulan.
8 September 2005	Application No. 129/0405/OSMF	On-site sewerage management facility, involving the upgrade of septic facilities at the Lime Plant.

Date of development consent	DA/MOD Number	Details
April 2008	DA No. 646/0405/DA	Two 200 m^3 silos installed adjacent to the existing lime product storage and load out facility.
20 June 2006	DA No. 546/0506/DA	Lime plant maintenance shed.
1 March 2012	DA No. 0156/112	Limestone Sand Plant capable of producing up to 800,000 tpa of manufactured sand.

Figure 3.7
Existing planning context

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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Table 3.7: Other licences

Description	Licence number	Licence authority	Comments
Acknowledgement of notification of hazardous chemicals on premises	NDG/008099	SafeWork NSW	Depots include petrol & diesel storage, flammable liquid, compressed gas, petroleum gas and explosives. As of 01/01/15 changes to notification rely on updating Schedule 11 Notification of Hazardous Chemicals when there is a change only. Site plans and emergency contacts to be kept in the manifest box (February 2016, removed ammonium nitrate depot).
Explosives licence to import	11-100005-004	SafeWork NSW	Issued to Orica for supply of explosives. Cert No 000004-000018012. Valid until 15 June 2021.
Licence for the manufacture of explosives	XMNF100033	SafeWork NSW	Valid until 29 October 2020.
Apparatus licence land mobile 'two-way' systems	1203917 1958988 1958989 9922223	Australian Communications and Media Authority	Expiry date: 21/07/19. Expiry date: 23/01/19. Expiry date: 22/02/19.
Radiation management licence	5061123	NSW OEH-EPA	Licence to sell/possess radioactive substances or items containing radioactive substances. Licence re-issued to 21 August 2019.
Motor vehicles repairers licence (NSW *Motor Vehicles Repairs Act 1980*)	MVRL 36381	NSW Fair Trading Motor Vehicle Repair Industry Authority	Motor mechanic fixed workshop. Licence re-issued to 2 January 2021 refer to annual statement renewal.
Refrigerant trading authorisation certificate	AU 04450	Department of the Environment	Refrigerant trading authorisation expiry date 10 March 2021.
Water access licence (Two bores, north pit) previously 10BL602077 and 10BL602078 Lot 7300, DP1149129	WAL 24697 10WA116142	NSW DPI-Water	Extraction of 12 ML per annum of groundwater for industrial purposes. Bores WP16 & WP17. Cert. of Title issued 9 May 2013. Works approval valid to 10 August 2024.
Two surface water licences (One overshot dam and two pumps) previously 10SL012214 Lot 1, DP37041	WAL 25352 WAL 25207 10WA102352	NSW DPI–Water	Water supply (76 ML) for mining and (1 ML) for domestic purposes per annum from Barbers Creek. (See Note 1) Works Approval valid to 30 June 2024.
Surface water licence (One 38 mm centrifugal pump) previously 10SL025561 Lot 204, DP870194	WAL 25373 10WA102377	NSW DPI-Water	Water supply (10ML) for mining purposes per annum from Barbers Creek. Works approval valid to 25 April 2026.
Bore licences	10BL605442 10BL605443 10BL605444 10BL605445 10BL605449	NSW DPI-Water	Six monitoring bore licences issued 10 Oct 2013 in perpetuity.

Description	Licence number	Licence authority	Comments
	10BL605450		
Groundwater	ROI17-1-061	NSW DPI–Water	838 ML groundwater allocation granted 27 September 2017.

Note 1: From 1 July 2012, the total volume of water taken in any three consecutive water years under this access licence must not exceed a volume which is equal to the lesser of either:
A. the sum of:

1. water in the account from the available water determinations in those 3 consecutive water years, plus
2. water in the account carried over from the water year prior to those 3 consecutive water years, plus
3. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus
4. any water re-credited by the Minister to the account in those 3 consecutive water years, or

B. the sum of:

1. the share component of this licence at the beginning of the first year in those 3 consecutive water years, plus
2. the share component of this licence at the beginning of the second year in those 3 consecutive water years, plus
3. the share component of this licence at the beginning of the third year in those 3 consecutive water years, plus
4. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus
5. any water re-credited by the Minister to the account in those 3 consecutive water years.

3.4 Environment Protection Licence (EPL) 944

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.

3.5 Environmental management

The mine is managed in accordance with the 2018-2023 MOP and supporting REF for CML 16 and ML 1716 together with the conditions of consents, leases and licences.

In addition, environmental issues and opportunities continue to be managed in accordance with site environmental management/improvement plans using Boral’s ‘Story-Board’ and ‘A3 Report’ system. Components of site environmental management/improvement plans include;

- the Boral Environmental Policy;
- Boral’s ‘LEAN’ approach to operational excellence;
- Site Environmental Management Committee;
- internal company monthly reporting of environmental protection actions/breaches;
- environmental awareness training;
- environmental risk assessments;
- Marulan Dust Management Plan; and
- Marulan Lime Plant Environmental Management Plan.

Boral also maintains a comprehensive environmental monitoring network at and surrounding the mine (**Figure 2.4**). Data captured from these environmental monitors is used by mine management to monitor compliance with their EPL, MOP and associated REF and other regulatory requirements.

Chapter 4

The proposed Project

VOLUME 1

4 THE PROPOSED PROJECT

4.1 Project site and study area

The Project site is identified in the 'Project boundary' presented on most figures in this EIS. The Project site is intended to cover both historical and proposed future areas of disturbance. The Project site includes two geographically separate areas:

- the existing mine including the proposed 30-year mine footprint and associated infrastructure (Figure 4.1); and
- the proposed Marulan Creek dam to be located on Marulan Creek, within Boral landholdings approximately 2.5 km north of the mine entrance (**Figure 4.2**).

The Project site covers an area of 846.4 ha. The existing pre SSD disturbance footprint associated with historical mining activities is 341.5 ha with 256.5 ha of new disturbance associated with the proposed 30-year mine plan. Total mining related disturbance (pre-SSD disturbance and 30-year SSD disturbance) is 598 ha (**Figure 4.3**).

The Project site has been adopted as the 'study area' for the site surveys and assessments undertaken as part of all technical investigations outlined in **chapters 8** to **26**. Therefore, these two terms are synonymous.

4.2 Sensitive receivers

To assess potential impacts from the Project on nearby landowners, sensitive receivers are identified (Figure 2.9) and categorised as 'R' – private residential, 'B' – Boral owned residences and 'C' commercial business. These sensitive receivers and their approximate distance to the nearest mining activity associated with the Project (e.g. extraction of overburden and limestone, emplacement of overburden, processing of limestone) are outlined in **Table 4.1.**

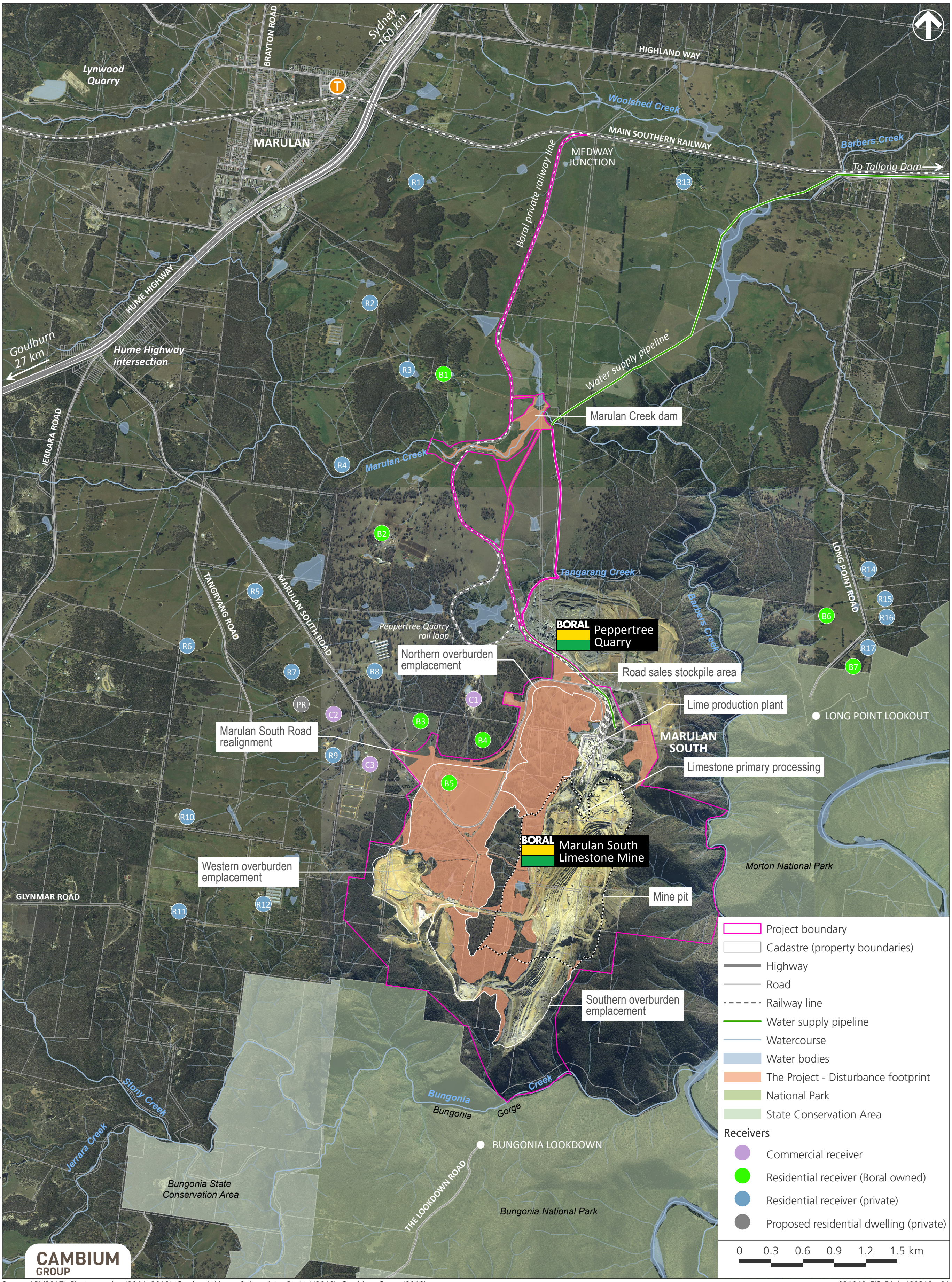
Table 4.1: Sensitive receivers

Receiver Number	Receiver Type	Approximate Distance (m) from the mine
R1	Residential (private)	3,780
R2	Residential (private)	3,780
R3	Residential (private)	3,060
R4	Residential (private)	2,650
R5	Residential (private)	1,990
R6	Residential (private)	2,180
R7	Residential (private)	1,205
R8	Residential (private)	760
R9	Residential (private)	555
R10	Residential (private)	1,965
R11	Residential (private)	2,125
R12	Residential (private)	1,350
R13	Residential (private)	4,665
R14	Residential (private)	2,545
R15	Residential (private)	2,530
R16	Residential (private)	2,465

Receiver Number	Receiver Type	Approximate Distance (m) from the mine
R17	Residential (private)	2,195
PR	Proposed residential dwelling (private)	960
C1	Commercial	275
C2	Commercial	650
C3	Commercial	245
B1	Residential (Boral owned)	2875
B2	Residential (Boral owned)	1905
B3	Residential (Boral owned)	250
B4	Residential (Boral owned)	170
B5	Residential (Boral owned)	Within Project site
B6	Residential (Boral owned)	1,965
B7	Residential (Boral owned)	2,005

Figure 4.1
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 (2019).

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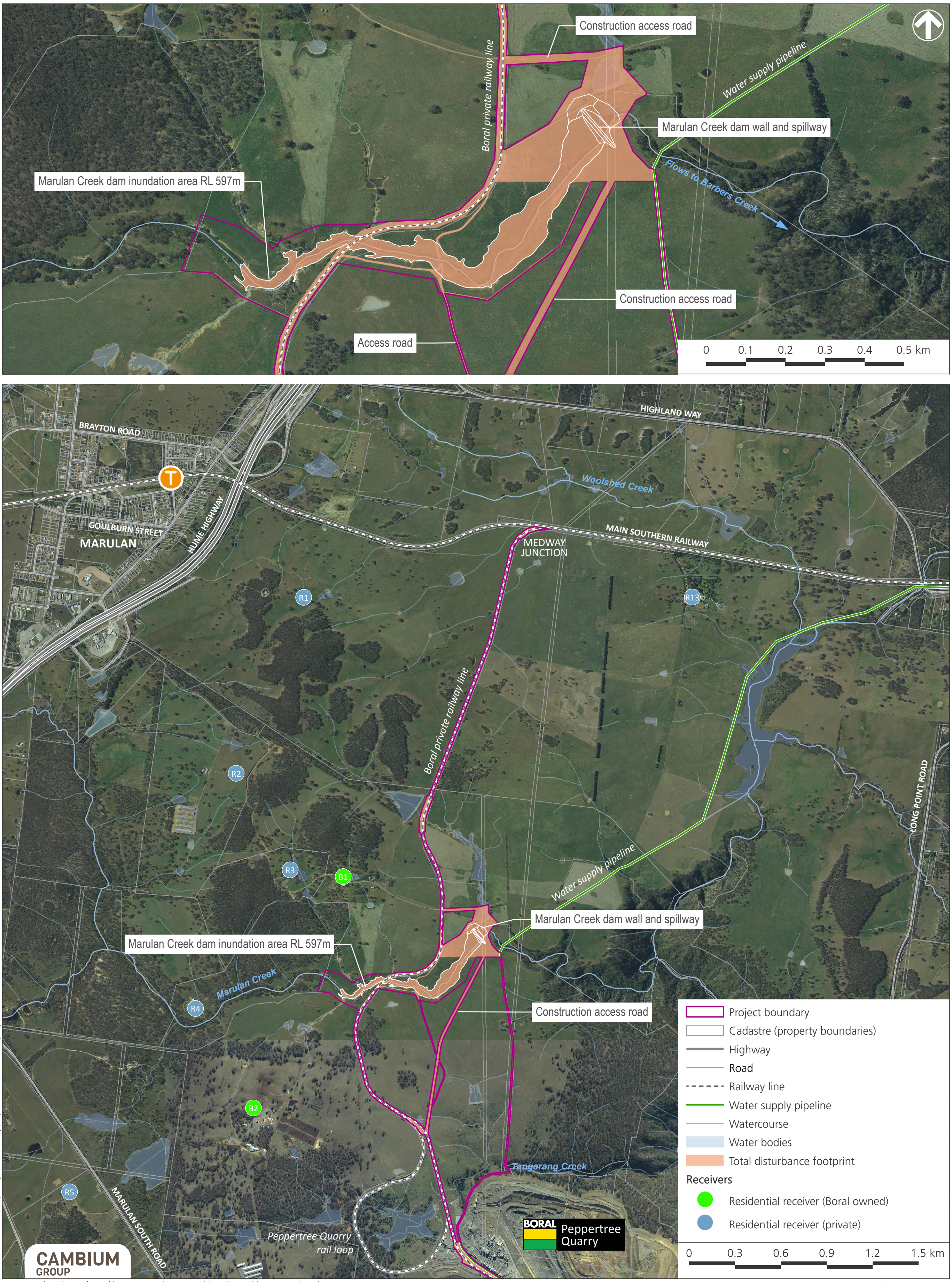
Figure 4.2
Marulan Creek Dam - Disturbance footprint

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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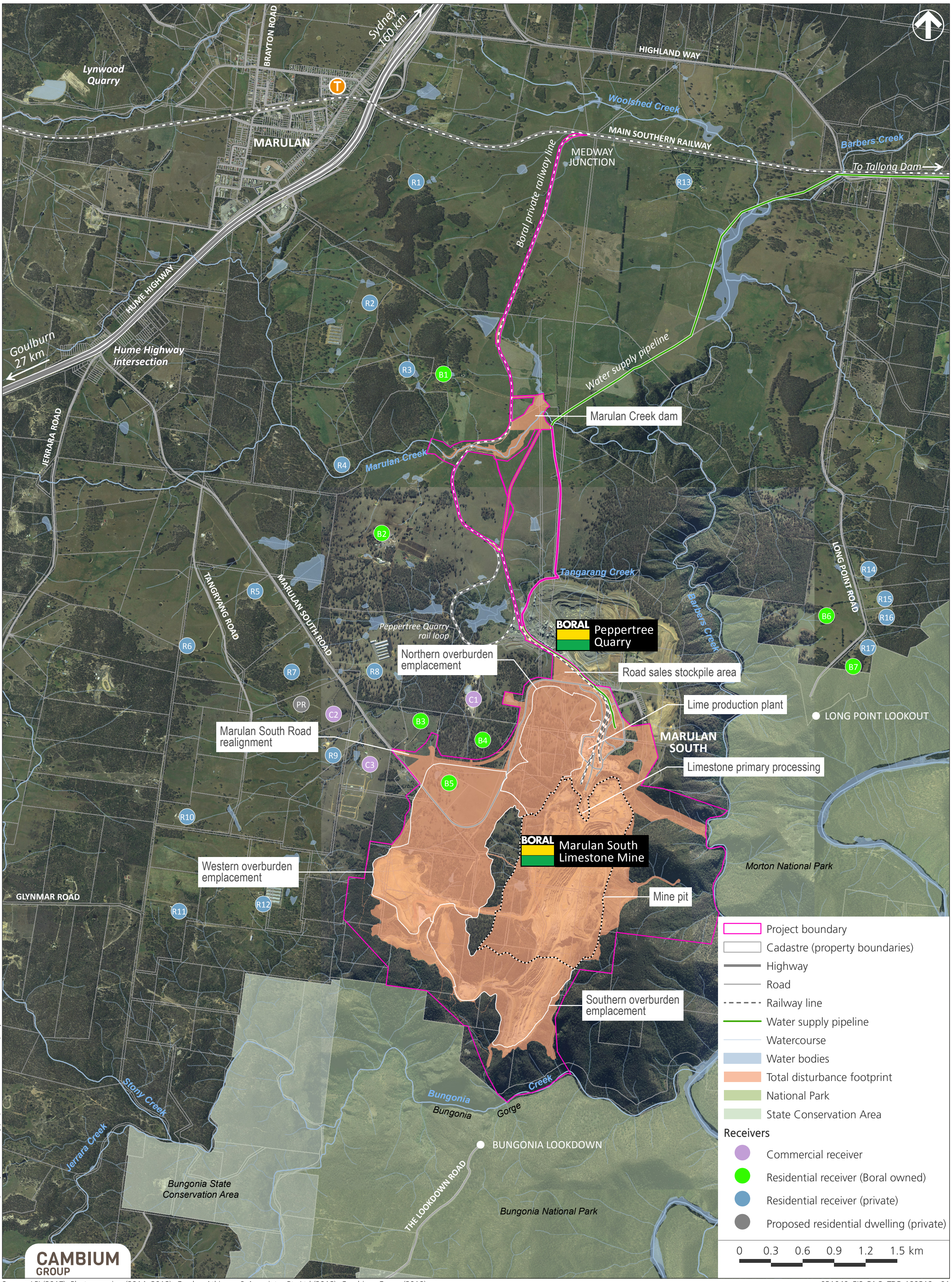
Figure 4.3
The Mine - Total disturbance footprint

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 (2019).

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4.3 Continued mining operations overview

Boral proposes to continue mining limestone from the mine at a rate of up to 4 Mtpa for a period of up to 30 years. This represents an increase in extraction rate from historic levels (peak of 3.38 Mtpa) due to forecast increased demand from the construction industry. Shale will continue to be extracted at a rate of up to 200,000 tpa.

The proposed 30-year mine plan accesses approximately 120 Mt of limestone down to a depth of 335 m AHD. The mine footprint focuses on an expansion of the north 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 in 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 (Figure 4.10).

In addition to mining approximately 5 Mt of shale, the extraction of the limestone requires the removal of approximately 108 Mt of overburden over the 30-year period. This material will be emplaced within existing and proposed overburden emplacement areas (Figure 4.10).

The existing mining operations and mining methods, as described in **Chapter 3** would continue to be implemented for the continued operation of the mine. Limestone will continue to be mined using drilling and blasting methods. Shale will continue to be mined by excavator/front end loader. Limestone, shale and overburden will be transported to the primary crusher, stockpile areas and overburden emplacements respectively, using the load and haul fleet of trucks.

Products produced at the mine will continue to be despatched by road and rail, with the majority despatched by rail.

The limestone sand plant produces a crushed and air classified limestone sand for use in concrete. The mine currently produces 500,000 tpa for Peppertree Quarry and it is proposed to increase production of manufactured sand to approximately 1 Mtpa.

Peppertree Quarry currently has approval to emplace some of its overburden in the south pit mine void. As the south pit is required for the emplacement of over 30 Mt of overburden from the mine after the removal of accessible limestone, Boral proposes to emplace up to 15 Mt of overburden from Peppertree Quarry in the northern overburden emplacement (NOE) (Figure 4.10).

4.4 Associated infrastructure

Existing infrastructure, plant and equipment as described in **Chapter 3**, would continue to be utilised as part of the Project. Changes to the existing mining infrastructure or new mining infrastructure that is required to support the continuation of mining over the next 30 years is outlined in the following sections.

4.4.1 Processing

The existing facilities for processing limestone as described in **Chapter 3**, will continue to be used to produce graded and blended limestone products that are despatched from site for use primarily in cement manufacture, steel making, commercial and agricultural applications.

It is not envisaged that any significant changes to the existing limestone processing plant will be required for the Project, except for routine repair and maintenance, or minor modifications to existing infrastructure.

The stockpile and reclaim area at the northern end of the north pit will be relocated during the fifth year of Stage 1 of the 30-year mine plan to enable full development of the mine plan. The relocation of the stockpile reclaim area is discussed further in **Section 4.4.1**.

Shale and white clay will not be processed and will be stockpiled directly from the pit, ready for dispatch by road to the Berrima and Maldon cement operations.

4.4.2 Water supply

As outlined in **Section 4.4.2** and in **Appendix G** mine water supply for the 30-year Project life including dust suppression, processing activities and some non-potable amenities cannot be met entirely from collection of runoff in existing and new on-site dams and from Tallong Weir via the Tallong water pipeline. The continuation of water supply from Tallong Weir is also uncertain as this supply is under a lease agreement. Therefore, Boral requires additional water storage and propose the construction of a new in-stream water supply dam on Marulan Creek (**Figure 4.2**) with the following characteristics:

- a homogeneous earth fill dam with a crest level at 600 m AHD;
- full storage level at 597 m AHD;
- full storage capacity of 118 ML;
- embankment batter slopes at 2.5H:1V; and
- spillway width designed for the estimated 1% annual exceedance probability (AEP) design peak flow for the Marulan Creek dam catchment (120 m^3/s) (PSM, 2016).

This dam will be on Boral owned land north of Peppertree Quarry and will use Boral's adjoining Tallong water supply pipeline to transfer water to the mine. A pump station will need to be constructed adjacent to the dam wall and a connecting pipeline installed from the dam via the pump station to the existing water supply pipeline. This dam will require the purchase of water entitlements as outlined in **Section 6.3.10**.

The existing Peppertree Quarry dam on Tangarang Creek maintains environmental flows to prevent any potential impacts upon downstream ecology. The Marulan Creek dam has been designed to comply with similar requirements for environmental flows as described further in **Section 8.2.2**.

The proposed Marulan Creek dam will be constructed over 3 months in Stage 1 of the 30-year mine plan. Construction of access roads will need to be established to the Marulan Creek dam wall from both the north and south of the creek (**Figure 4.2** and **Figure 4.11**).

4.4.3 Rail

The single line rail track owned and maintained by Boral is located within the Project site and provides access to the Great Southern Railway at Medway Junction, located approximately 8 km to the north of the mine.

No changes are proposed to the existing rail infrastructure.

4.4.4 Realignment of Marulan South Road

Road access from the mine to the Hume Highway is via Marulan South Road. The proposed WOE extends northwards over Marulan South Road. Boral proposes to realign a section of Marulan South Road, to accommodate the northern portion of the WOE (**Figure 4.4**).

The section of Marulan South Road to be realigned will be designed for an 80 km/h design speed, and to Council's relevant standards and specifications. The road will be designed and constructed with a 7 m wide sealed road pavement, plus 0.5 m sealed shoulders on either side, as part of 1 m wide shoulders.

A culvert will be constructed under the road to maintain drainage of a tributary of Tangarang Creek that arises to the south of the road and drains in a northerly direction into Tangarang Creek.

The road will be constructed on land owned by Boral, and the realigned section of road will be transferred to Council as a public road, as part of land swap arrangements between Council and Boral.

The realignment of Marulan South Road and associated infrastructure is anticipated to be constructed over a period of approximately 4 months.

4.4.5 Deproclamation of public roads

Boral proposes the deregistration (deproclamation) all public roads in the former village of Marulan South as well as the section of Marulan South Road between Boral's operations and the entrance to the agricultural lime manufacturing facility (Figure 4.4).

Suitable turning and other required traffic management changes will be provided adjacent the entrance of the agricultural lime manufacturing facility at the end of the public road section.

4.4.6 Upgrade of Marulan South Road

Boral has committed to upgrading Marulan South Road from the site to the Hume Highway interchange. The upgrade is likely to involve:

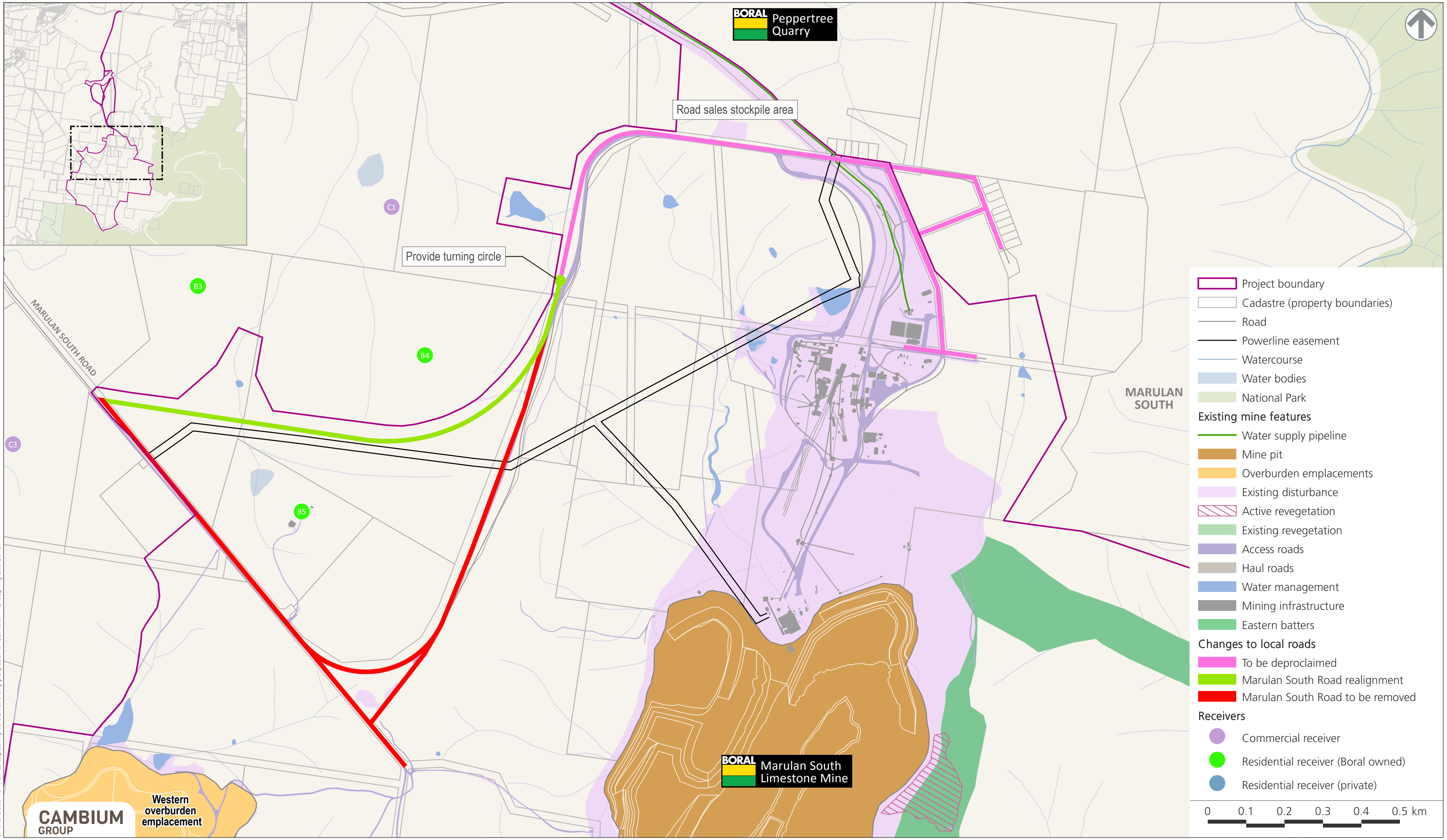
- widening sections of the road;
- rebuilding sections of the road in poor condition;
- resealing the road;
- widening and sealing driveways thereby improving school bus stopping and turning areas; and
- improved safety standards from those of the current road design and condition.

The upgrade of Marulan South Road will be to Austroads and relevant Council standards and specifications.

Boral is still in discussion with Council on the scope of the road upgrade works.

Figure 4.4
Changes to local roads

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Transport and PUrban Planning (2018), Cambium Group (2019).

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4.4.7 Road sales stockpile area

A new road sales stockpile area is proposed on the northern side of Marulan South Road, immediately west of the mine and Peppertree Quarry entrances (**Figure 4.4**). The road sales stockpile area will include a weighbridge and wheel wash and will store up to 50,000 t of limestone aggregates/sand per annum and 150,000 t of Peppertree Quarry aggregates/blended products.

The aggregate/sand from Peppertree Quarry, to be stockpiled in the road sales stockpile area, will be transported along internal roads within the Peppertree Quarry site, to the north of the stockpile area.

The aggregate/sand from the mine to be stockpiled in the road sales stockpile area will be transported via Marulan South Road.

The road sales stockpile area will be constructed in the first year of Stage 1 of the 30-year mine plan over a period of approximately 2 months.

4.4.8 Road sales stockpile area – NOE intersection

The proposed road sales stockpile area would also require the construction of a new cross junction intersection on Marulan South Road, some 310 m west of the rail level crossing near the entrance to the mine and 175 m west of the truck access road to the mine.

The intersection will be located at/near the change of the speed limit between 60 km/h and 80 km/h. If this section of Marulan South Road is to remain a public road, then it is recommended that the 60 km/h speed limit that applies in the old Marulan South village, be extended 200 m to the west, so that the new intersection is located in the 60 km/h speed limit area.

This intersection will also provide access to the proposed NOE on the southern side of Marulan South Road and south of the road sales stockpile area, for trucks hauling overburden from Peppertree Quarry. Trucks hauling overburden from the Peppertree Quarry pit to the NOE will travel along one of two routes:

- along Marulan South Road to and from the east turning left in and right out of the NOE access road; or
- along internal haul roads in the Peppertree Quarry to the new intersection at the road sales stockpile area access road, crossing over Marulan South Road to enter the NOE entrance and will return the same way.

Two design options are proposed for this new intersection:

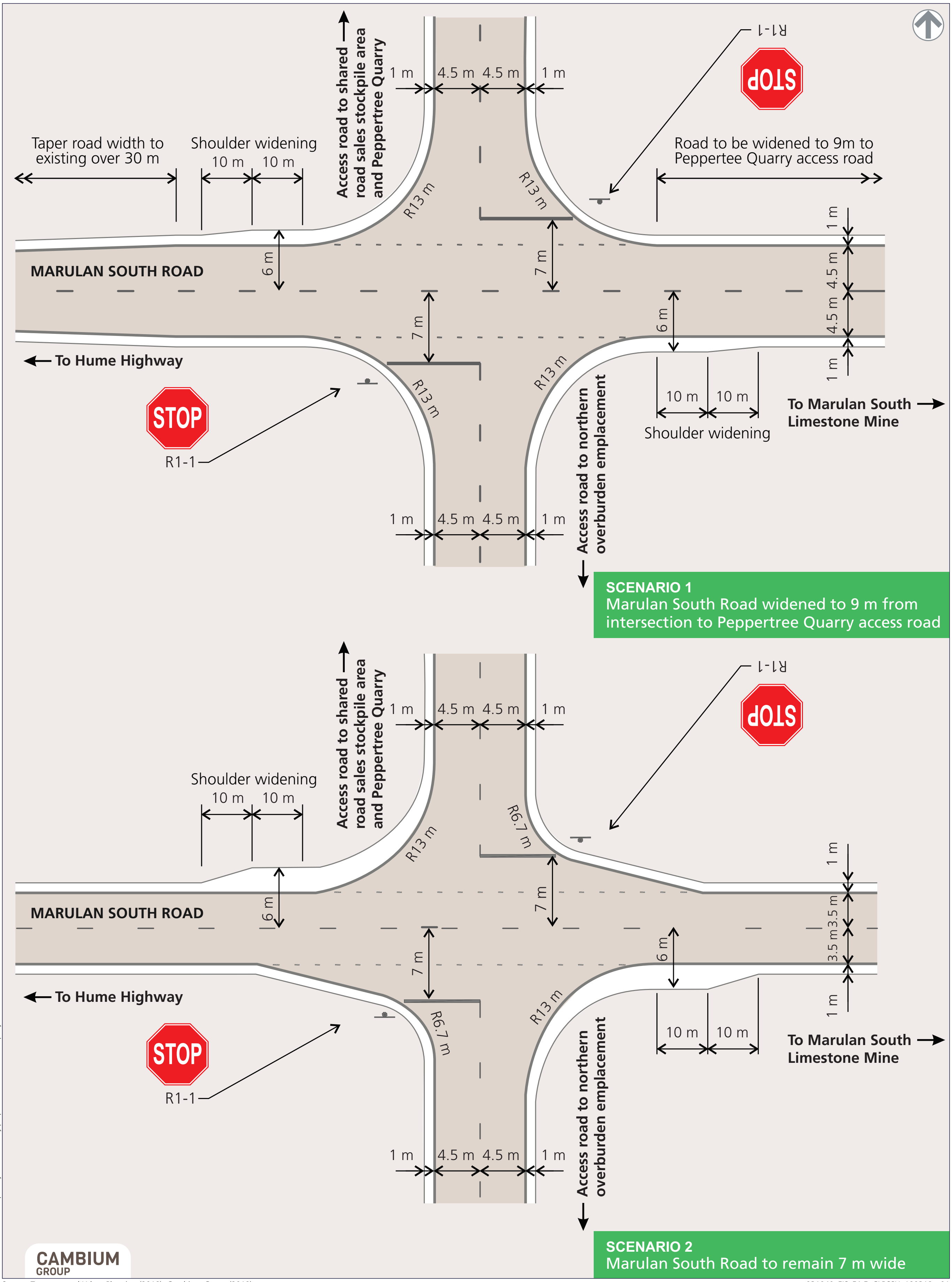
- Unsignalised – with stop signs on the northern and southern approaches to Marulan South Road. This is likely to be the design if Marulan South Road is not de-proclaimed east of the agricultural lime manufacturing facility driveway (as discussed above).
- Signalised – this is likely to be the design if Marulan South Road is de-proclaimed east of the agricultural lime manufacturing facility driveway.

The intersection will be designed with suitable geometry including wider road pavement on Marulan South Road to cater for the wider trucks that will transport the overburden from Peppertree Quarry to the NOE.

A concept layout for the unsignalised and signalised intersection is shown in **Figure 4.5** and **Figure 4.6** respectively.

Figure 4.5
Concept layout of shared road sales stockpile area/Marulan South Road intersection - Unsignalised

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



Source: Transport and Urban Planning (2018), Cambium Group (2019).

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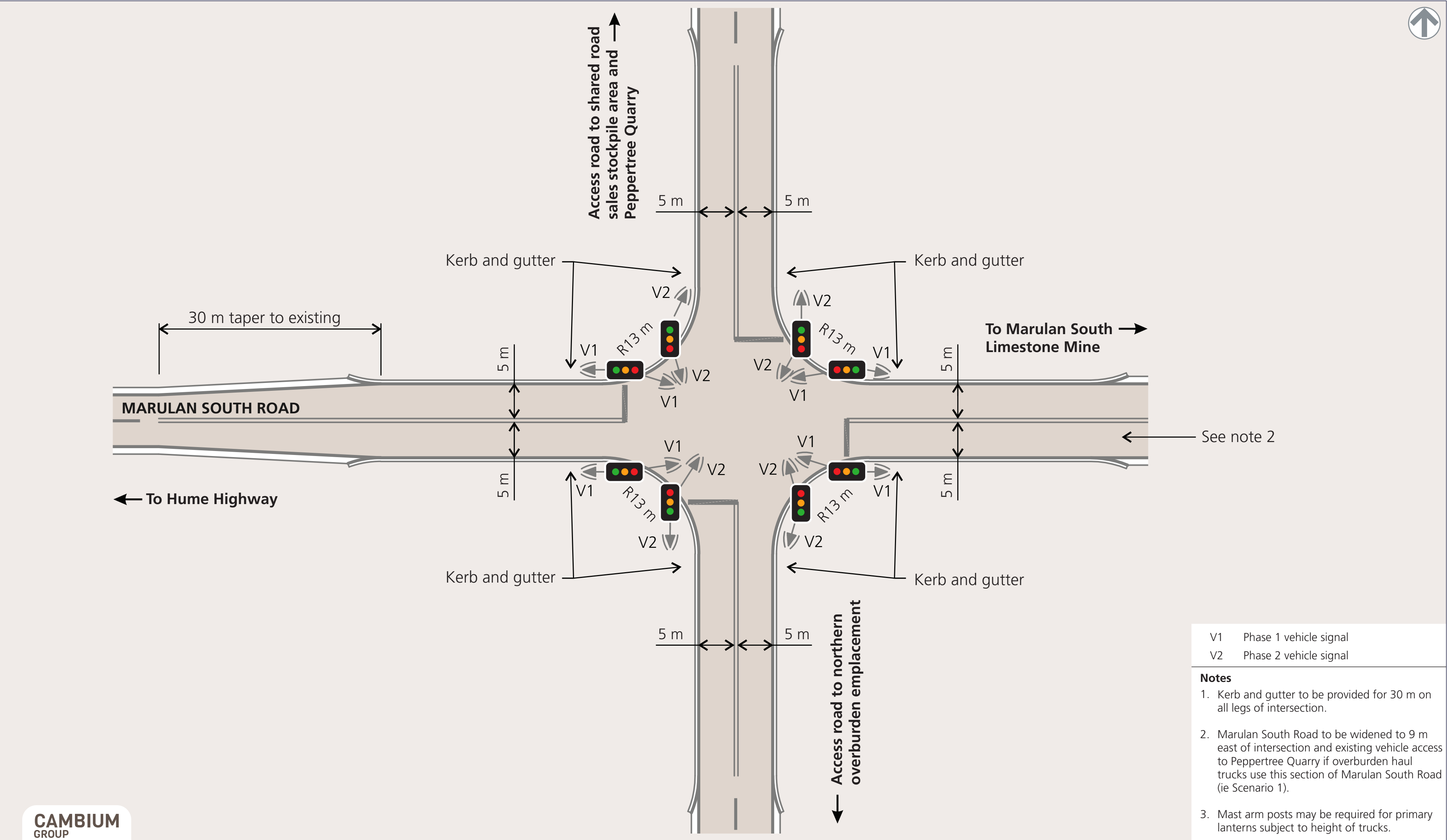
Figure 4.6
Concept layout of shared road sales stockpile area - Marulan South Road intersection with traffic signals



V1 Phase 1 vehicle signal
V2 Phase 2 vehicle signal

Notes

1. Kerb and gutter to be provided for 30 m on all legs of intersection.
2. Marulan South Road to be widened to 9 m east of intersection and existing vehicle access to Peppertree Quarry if overburden haul trucks use this section of Marulan South Road (ie Scenario 1).
3. Mast arm posts may be required for primary lanterns subject to height of trucks.

Source: Transport and Urban Planning (2018), Cambium Group (2019).

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4.4.9 Power

Power supply to the mine is via a high voltage power line that originates from a sub-station on the southern side of Marulan South Road, immediately west of the Project boundary. A section of this power line will be relocated to accommodate the NOE (**Figure 4.10**).

The powerline which supplies electricity to the mine passes through the area where the NOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the NOE) to the intersection with Cooper Crescent (immediately west of the railway line), where it will connect to an existing overhead powerline that diverts south into the mine's infrastructure area (refer to **Figure 4.10**).

The powerline will be approximately 1,300 m long and will require up to an approximately 25 m wide easement along its length.

4.5 30-year mine staging and rehabilitation plan

The 30-year mine development period is a 'nominal' or estimated period based on mining approximately 120 Mt of limestone at 4 Mtpa. Mining is subject to a range of factors including changing economic conditions, new technology, market fluctuations and varying product requirements. These factors will all influence the rate of mine production and the mine development period.

Further prospecting/exploration will be undertaken as an ongoing mining activity throughout the 30-year mine development period to further improve understanding of the quantity and quality of limestone resource, the contact boundaries with surrounding sediments and inform mine planning.

The 120 Mt to be mined is part of a much larger limestone deposit identified and estimated by GeoRes (2018) to be 640 Mt. It is anticipated that operations will continue beyond this initial 30-year mining period as discussed further in the post 30-year mine concept in **Section 4.8**.

The 30-year mine staging and rehabilitation schedule is therefore conceptual and subject to further, final land use planning options that include the continuation of mining. The 30-year mine rehabilitation concept provides a 'snap shot of the rehabilitated landform and retained structures at the end of this development period and in particular considers the safety and visual aspects of this initial stage of mine development.

The 30-year mine staging and rehabilitation schedule has been arranged into four stages as summarised in the 30-year mining schedule in **Figure 4.7**, the 30-year rehabilitation schedule in **Figure 4.8**, and as described in **Section 4.5**.

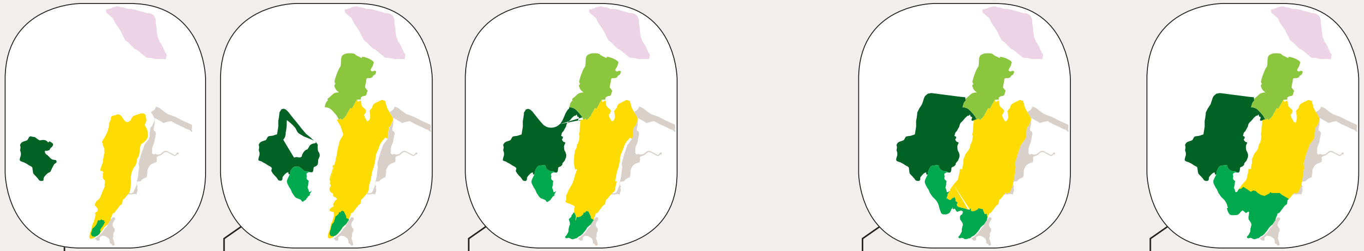
A total area of 245.4 ha is proposed for rehabilitation over the 30-year mine development, requiring an average rehabilitation target of 8.2 ha per year.

The progressive development of the water management system, as depicted in **Figure 4.13, Figure 4.15**, **Figure 4.17**, **Figure 4.19** and **Figure 4.22** and described in **Section 4.5**, accounts for the ongoing development of the mine as well as the continuing rehabilitation of sections of the overburden emplacements once the final level and landform has been achieved. Water management structures, such as sediment basins, storage dams and drains, as well as indicative drainage pathways, are described in **Section 4.5**. A schematic of the water management system is provided in **Figure 4.9**.

Figure 4.7
30 year mining schedule

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

- Mine pit
- Northern overburden emplacement
- Southern overburden emplacement
- Western overburden emplacement
- Peppertree Quarry
- Eastern batters



4 Mtpa Limestone		Cap Mt	Stage	Cum.	PRE SSD			STAGE 1					STAGE 2								STAGE 3						STAGE 4										
							SSD YR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			Mt	Mt	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49
PRE SSD	Overburden		5.54	5.54	1.80	1.86	1.88																														
	Limestone		9.90	9.90	3.30	3.30	3.30																														
	Shale		0.36	0.36	0.12	0.12	0.12																														
STAGE 1	Overburden		18.40	23.94				2.86	3.86	3.86	3.86	3.96																									
	Limestone		20.00	29.90				4.00	4.00	4.00	4.00	4.00																									
	Shale		0.70	1.06				0.14	0.14	0.14	0.14	0.14																									
STAGE 2	Overburden		28.38	52.32									3.86	3.86	3.86	3.86	3.86	3.86	3.86	1.36																	
	Limestone		29.00	58.90									4.00	4.00	4.00	4.00	4.00	4.00	4.00	1.00																	
	Shale		1.02	2.08									0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.04																	
STAGE 3	Overburden		31.66	83.98																2.50	4.86	4.86	4.86	4.86	4.86	4.86											
	Limestone		27.00	85.90																3.00	4.00	4.00	4.00	4.00	4.00	4.00											
	Shale		0.94	3.02																0.10	0.14	0.14	0.14	0.14	0.14	0.14											
STAGE 4	Overburden		29.27	113.25																							2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.60	2.60	2.47
	Limestone		41.80	127.70																							3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80
	Shale		1.43	4.45																							0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
EMPLACEMENTS																																					
NOE	Peppertree Quarry		15.20					3.00	3.10	3.00	3.10	3.00																									
	Boral Cement Limited		3.00					0.60	0.60	0.60	0.60	0.60																									
	Total emplaced		18.20					3.60	3.70	3.60	3.70	3.60																									
	Balance	18.2																																			
WOE	Pre SSD		3.7		1.80	0.96	0.98																														
	Stage 1 emplaced south (635 ext)		5.2					1.20	1.20	1.20	1.20	0.40																									
	Stage 2 emplaced south (658m)		21.06										3.36	3.36	2.86	2.86	3.00	3.00	2.62																		
	Balance South	30.0																																			
	Stage 3 emplaced north (659m)		20.5																	2.06	3.60	3.60	3.60	3.60	3.36	0.68											
	Balance North	20.5																																			
	Balance WOBE	50.5																																			
SOE	In pit to 395/400m		1.80			0.90	0.90																														
	In pit (425m) west (615)		10.20					1.06	2.06	2.06	2.06	2.96																									
	In pit (470m) west (635)		7.32										0.50	0.50	1.00	1.00	0.86	0.86	1.24	1.36																	
	In pit and west join (500m)		8.46																	0.44	1.26	1.26	1.26	1.26	1.50	1.48											
	In pit (520 to 500/495m)		31.97																							2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.60	2.60	2.47
	Balance	59.8																																			
	TOTAL	128.5																																			

Source: Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-7_30YMS_190318_v01

Figure 4.8
30 year rehabilitation schedule

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

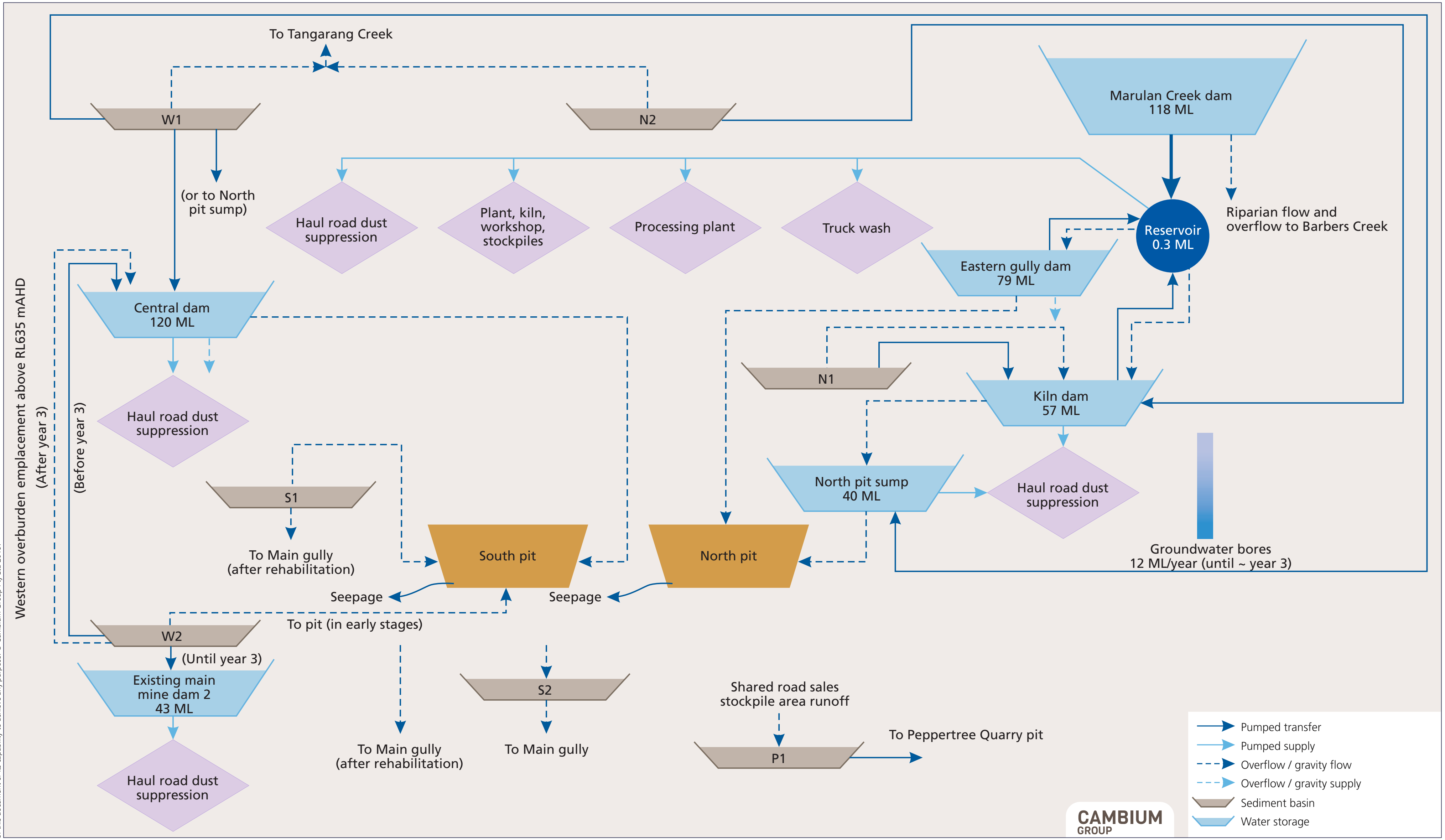
	PRE SSD	STAGE 1	STAGE 2	STAGE 3	STAGE 4
Stage (Years)	0	5	8	6	11
Cumulative (Years)	0	5	13	19	30
Hectares	(ha)	(ha)	(ha)	(ha)	(ha)
Eastern batters	38.0	38.0	38.0	38.0	38.0
EXISTING REHABILITATION (CUMULATIVE)					
Barbers Creek overburden emplacement		2.4	2.4	2.4	2.4
Western overburden emplacement	8.8	16.5	47.5	98.1	146.7
Southern overburden emplacement (In-pit)			1.7	9.8	56.4
Southern overburden emplacement (West)				11.8	
Northern overburden emplacement			36.9	36.9	37.7
Dams			3.4	3.4	3.7
High voltage power line easement/miscellaneous					7.3
Total (Existing rehabilitation)	**8.8**	**18.9**	**91.7**	**162.3**	**254.2**
ACTIVE REHABILITATION					
Barbers Creek overburden emplacement	2.4				
Western overburden emplacement	7.8	20.8	29.9	13.9	
Southern overburden emplacement (In-pit)		1.7	7.5	3.8	
Southern overburden emplacement (West)			11.8	7.1	
Northern overburden emplacement		10.2			
Total (Active rehabilitation)	10.2	32.7	49.2	24.8	
Mine pit	**116.0**	**155.0**	**164.0**	**182.0**	**156.0**

Mine pit
Northern overburden emplacement
Southern overburden emplacement
Western overburden emplacement
Peppertree Quarry
Eastern batters

Source: Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

Figure 4.9
Water management system schematic

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

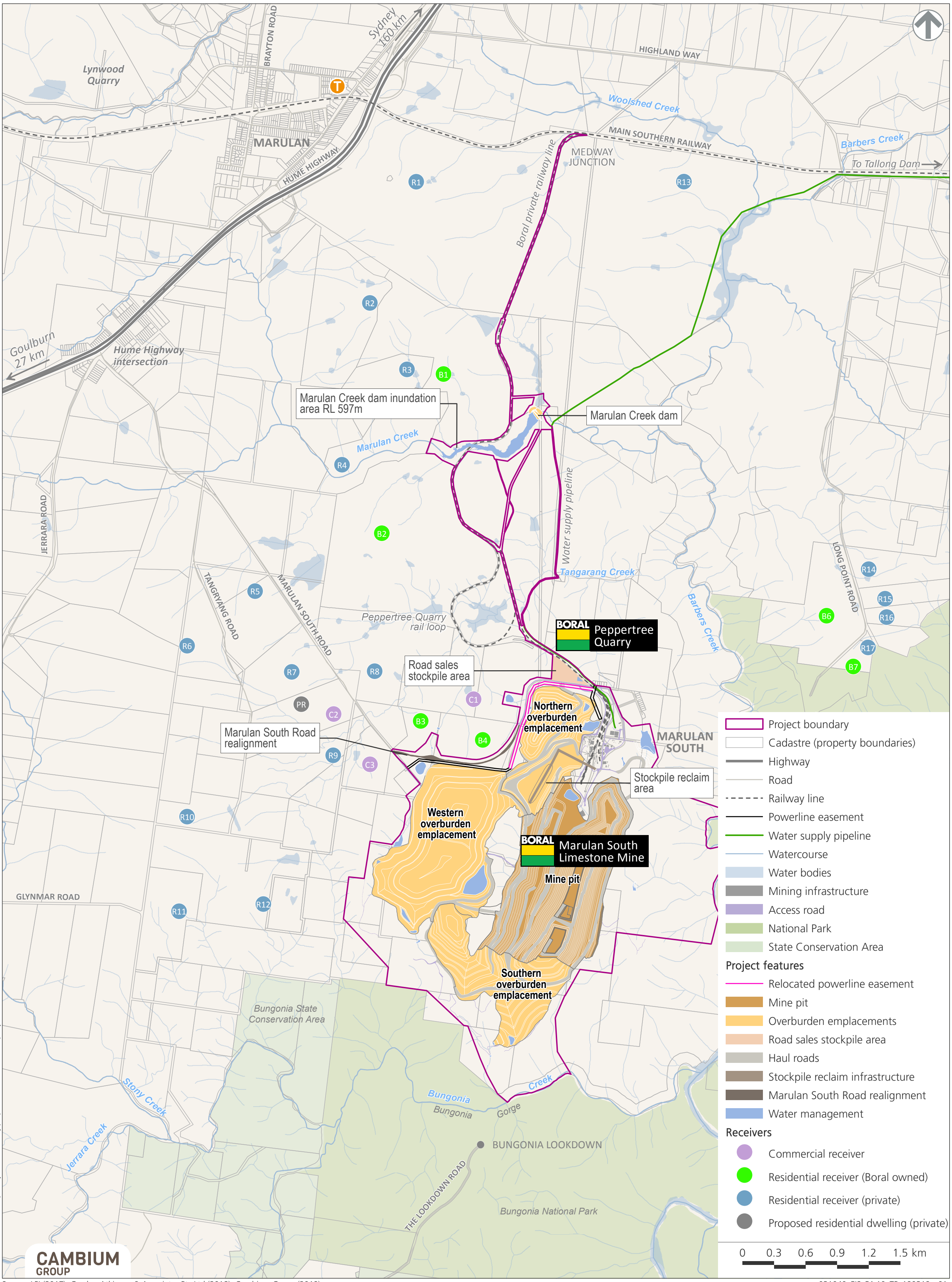


Source: Advisian (2018), Cambium Group (2019).

031040_EIS_F4-9_WMSS_190319_v01

Figure 4.10
The Project

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

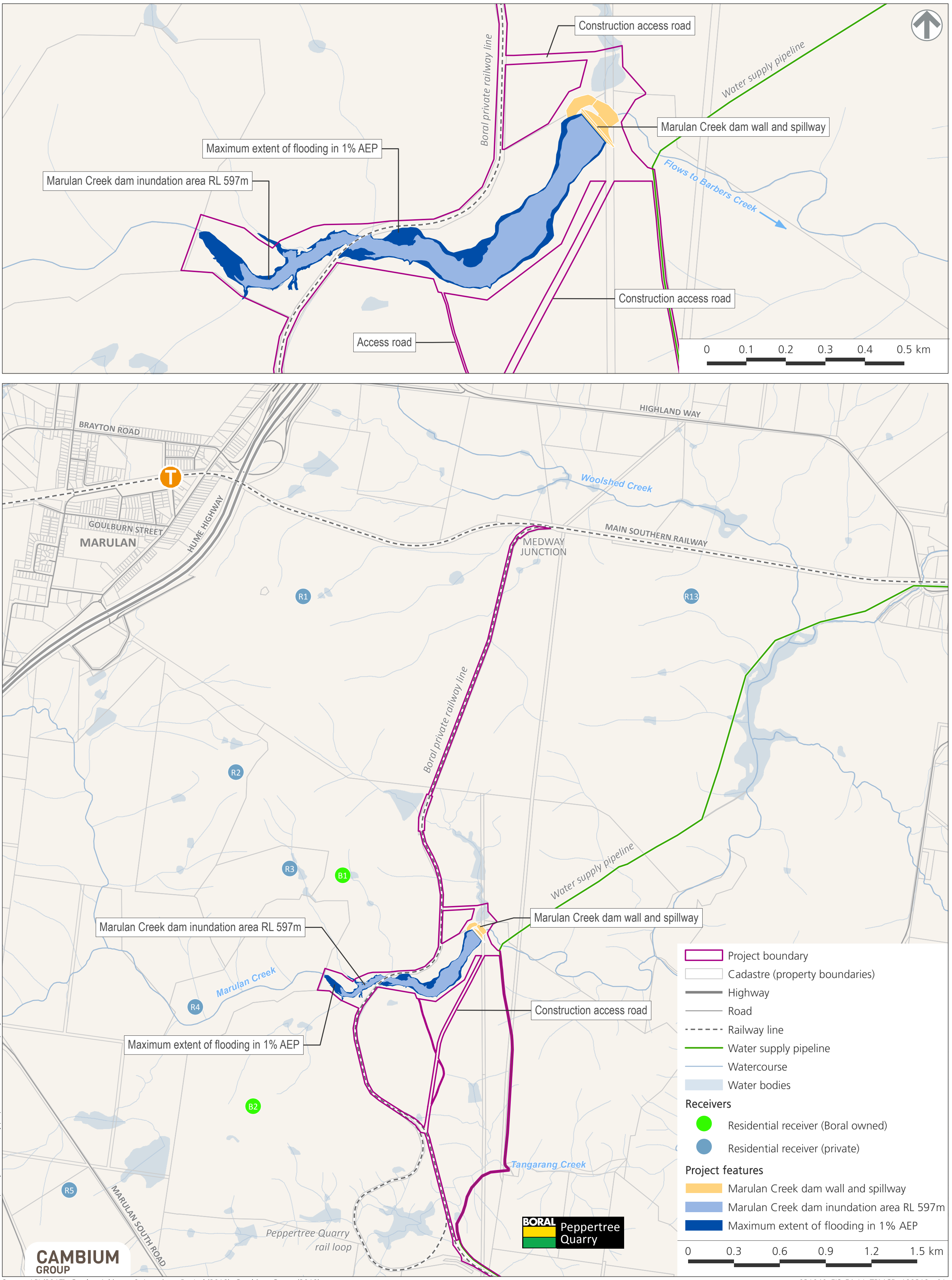


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-10_TP_190319_v01

Figure 4.11
The Project (Marulan Creek Dam)

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION
SURFACE WATER ASSESSMENT



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-11_TPMCD_190319_v01

4.5.1 Stage 0 – Pre SSD and current mine operations

Mining

Stage 0 of the Project is defined as current mining operations to be undertaken. It is estimated that this Stage could operate for a period of up to three years. Mining operations likely to be undertaken prior to the SSD 30-year mine plan are described in the sub-section titled “Activities over the 2018-2023 MOP term” in **Section 3.3.3**. The likely status of the mine at the end of Stage 0 (start of Stage 1) are presented in Figure 3.3.

Surface water management

Historical surface water management practices implemented at the mine prior to the commencement of the SSD 30-year mine plan are described in **Section 3.1.8**. The likely status of surface water management at the end of Stage 0 (start of Stage 1) are presented in Figure 3.6. This includes the proposed W2 sediment basin capacity split between two new sediment basins on the southern side of WOE at approximately 620 m AHD and 610 m AHD elevations.

Rehabilitation

At the end of Stage 0 (start of Stage 1) the WOE will have 7.8 ha of active revegetation and 8.8 ha of existing revegetation. The active and existing revegetation areas can be considered ‘growth medium development’ and ‘ecosystem and land use establishment’ phases respectively when compared with ESG3: MOP Guidelines (NSW Trade and Investment, 2013). Active revegetation in the WOE includes the recent re-working of the lower southern batters.

Active overburden emplacements correspond with the ‘landform establishment’ rehabilitation phase of the MOP Guidelines. For the WOE this includes an existing area for waste lime emplacement, areas of Middle Gully overburden emplacement and lower Middle Gully overburden emplacements that will eventually form the western section of the southern overburden emplacement (SOE).

Backfilling with overburden in the south end of the south pit over 4.2 ha has commenced in benches from the 350 m floor level and subject to actual overburden quantities removed, may reach the 425 m elevation.

The eastern batters comprise older and existing south-eastern scree slopes, Barbers Creek and Bryce’s overburden emplacements and a combined total area of 38.0 ha. A small 2.4 ha area of active Barber’s Creek overburden emplacement is proposed for revegetation during Stage 0.

4.5.2 Stage 1

Mining

Stage 1 will likely occur over 5 years and will involve the removal and emplacement of approximately 18.4 Mt of overburden from the western part of the mine pit to provide access to approximately 20 Mt of limestone resource (**Figure 4.12**). Approximately 700,000 t of shale will also be extracted.

Overburden emplacement during stage 1 will involve:

- 10.2 Mt emplaced in the southern part of the WOE to 635 m;
- 5.2 Mt emplaced in the SOE to 425 m in the in-pit part and to 615 m in the western out-of-pit part of the emplacement; and
- 18.2 Mt emplaced in the NOE of which 3 Mt is from the mine and between 13 Mt and 15 Mt is from Peppertree Quarry. Overburden from Peppertree Quarry will complete most of the

northern part of the NOE to 650 m, with the remainder coming from the mine. Three million tonnes of overburden from the mine will be used to construct the earthworks platform that forms the southern part of the NOE for the new stockpile reclaim area with a finished level of 600 m. The NOE is complete at the end of Stage 1.

Other key mine infrastructure changes in Stage 1 include:

- realignment of a section of the mine's high voltage supply power line to accommodate the NOE;
- relocation of existing and construction of new stockpile reclaim infrastructure to the north-west of the mine pit to allow for the northern expansion of the mine which will subsume the existing stockpile reclaim area. The new stockpile reclaim infrastructure will comprise use of the existing primary crusher /secondary crushers at 545 m level with crushed limestone conveyed up the existing conveyor to screen house/transfer station where limestone is conveyed westward across the existing rail back shunt onto a nominal 500 kt stockpile via an overhead linear tripper. Reclaim is via a similar route from an underground tunnel with draw down vibratory feeders onto reclaim and transfer conveyors back to the screen house/transfer station; and
- construction of the shared road sales stockpile area to store finished aggregates from the mine and Peppertree Quarry for dispatch by road.

Surface water management

Surface water management proposed during Stage 1 involves (**Figure 4.13)**:

- construction of the new Marulan Creek, Central and Eastern Gully water storage dams, enlargement of the existing kiln dam;
- upgrade Tallong Weir to Marulan pipeline to allow connection of the Marulan Creek dam to the mine reservoir;
- installation of a pipeline connecting the Eastern Gully dam to the kiln dam via the reservoir;
- construction of the north pit sump towards the end of Stage 1 following north-west mine pit development;
- construction of sediment basins N1 and N2 in preparation for emplacement of overburden in the NOE;
- completion of construction of sediment basin W1 to control runoff from the upper slopes of the WOE that progresses northwards toward Marulan South Road;
- installation of pipelines to connect sediment basins N1 and N2 to the kiln dam, eastern gully dam to kiln dam via the reservoir, and sediment basins W1 and W2 to the central dam; and
- construction of sediment basin P1 to receive runoff from the new shared road sales stockpile area.

Rehabilitation

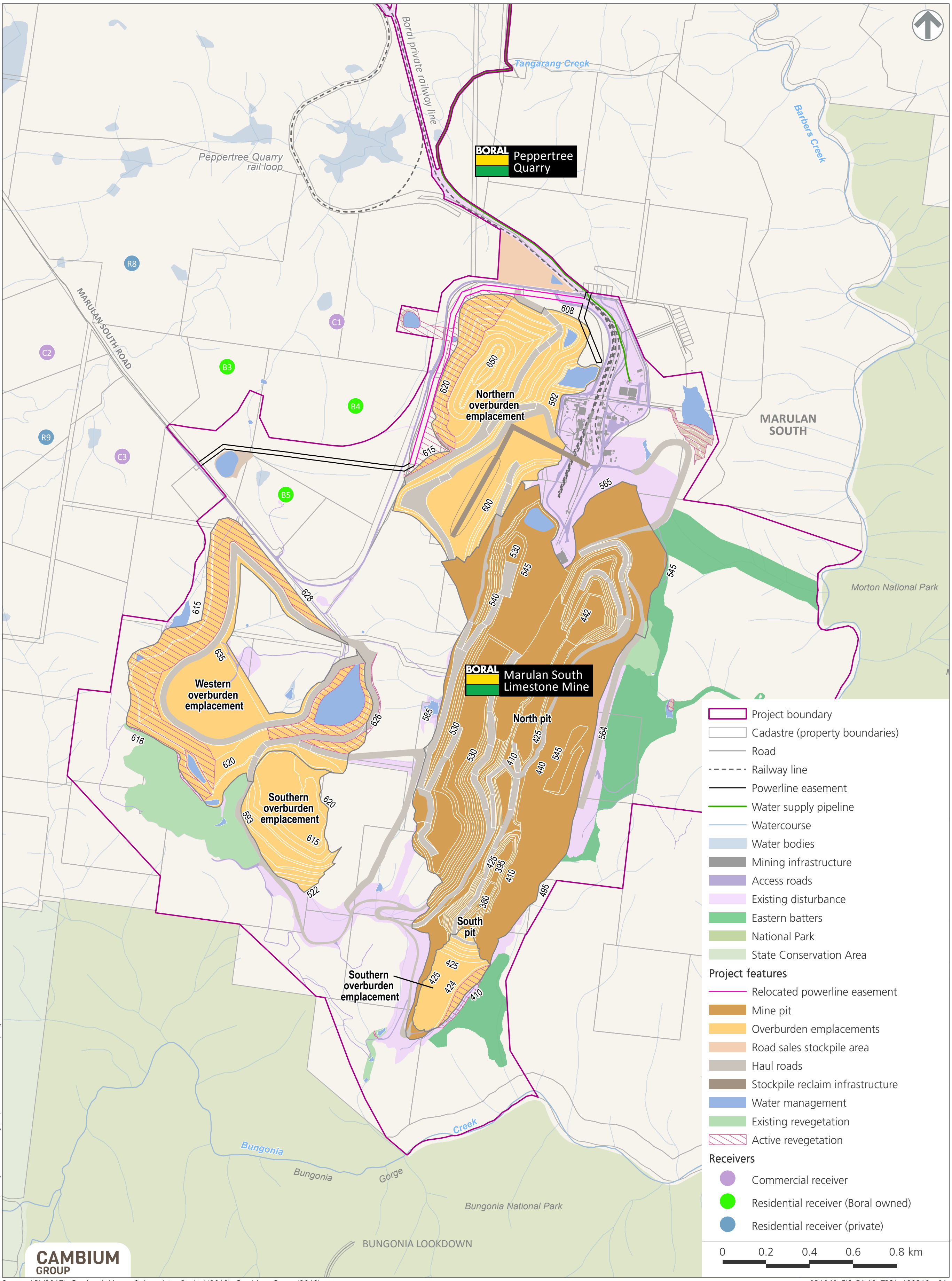
Stage 1 rehabilitation activities proposed over a 5-year period include:

- Establish existing rehabilitation or 'ecosystem and land use establishment' over 16.5 ha of the lower slopes of the WOE and the 2.4 ha of the active Barbers Creek overburden emplacement.
- Commence growth medium development or active rehabilitation over 10.2 ha of the western and northern lower slopes of the completed NOE.
- Commence active rehabilitation over 20.8 ha of the western and northern lower slopes of the extended WOE. In addition, any final batters constructed for the associated central dam and similarly for the Eastern Gully dam would be revegetated for slope stabilisation.
- Commence active rehabilitation of 1.7 ha of the south-eastern 'outer' slopes of overburden backfilled into the in-pit part of the SOE.

In the 5-year, Stage 1 period 32.7 ha of new, active revegetation is targeted with 18.9 ha of existing revegetation established and subject to ongoing maintenance.

Figure 4.12
The Project - Stage 1 (5 years)

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

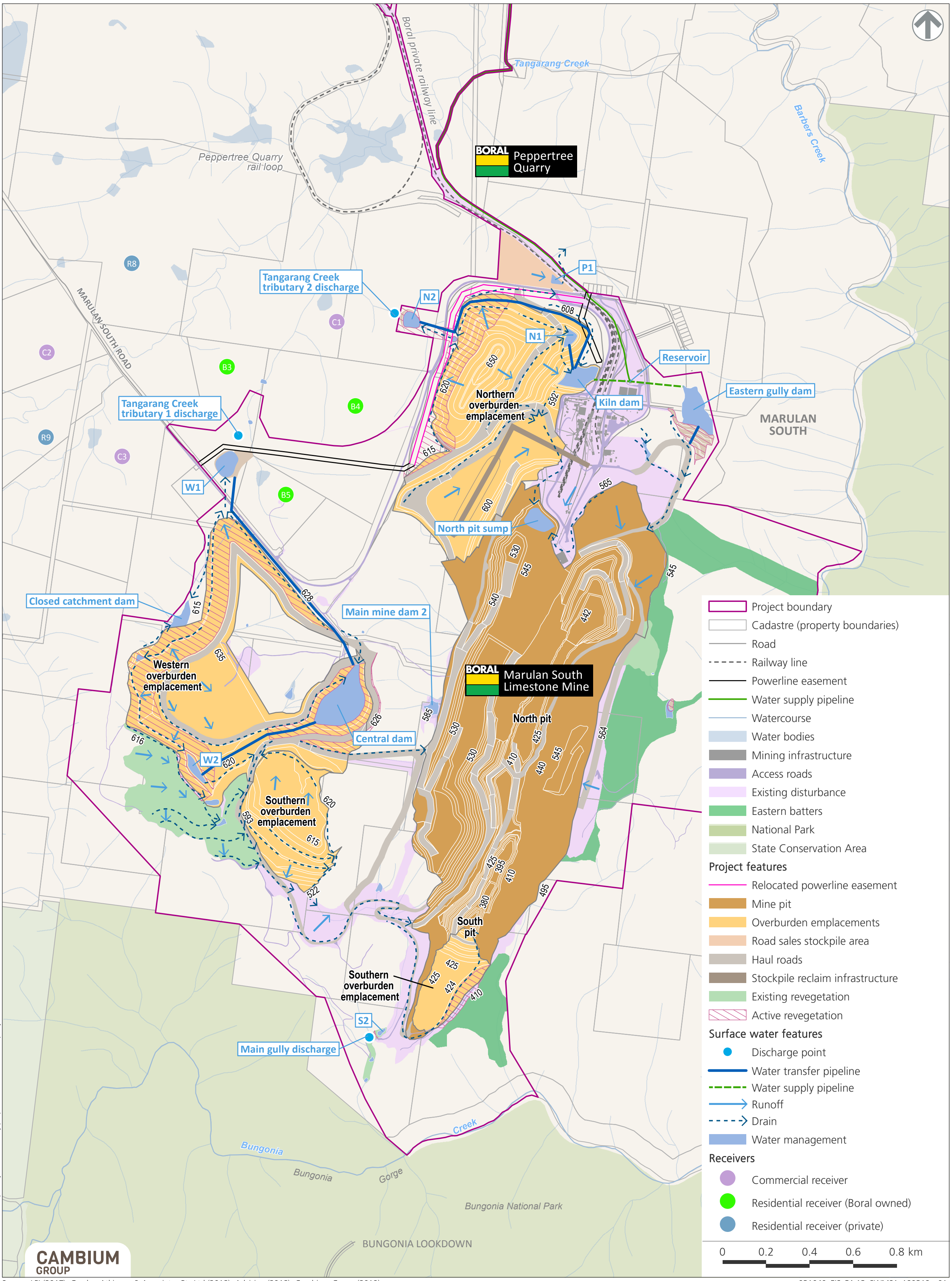


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-12_TPS1_190319_v01

Figure 4.13
Surface water management - Stage 1

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

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4.5.3 Stage 2

Mining

Stage 2 will likely occur over 8 years and will involve the removal and emplacement of approximately 28.38 Mt of overburden material from the western part of the mine pit, to provide access to approximately 29 Mt of limestone resource (**Figure 4.14)**. Approximately 1.02 Mt of shale will also be extracted.

Overburden emplacement during stage 2 will involve:

- 21.06 Mt emplaced in the southern part of the WOE to 658 m. By the end of Stage 2 the southern part of the WOE will be at its maximum height and extent prior to the realignment of Marulan South Road.
- 7.32 Mt emplaced in the SOE to 470 m in the in-pit part and to 635 m in the western out-of-pit part of the emplacement.

Surface water management

Surface water management during Stage 2 will involve (**Figure 4.15**):

- Construction of sediment basin S1 at approximately 440 m as the level of overburden in the in-pit part of the SOE rises above the level of the south pit rim. Water captured in this sediment basin will be used for revegetation purposes and dust suppression in the immediate area. Any overflow will 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.

Rehabilitation

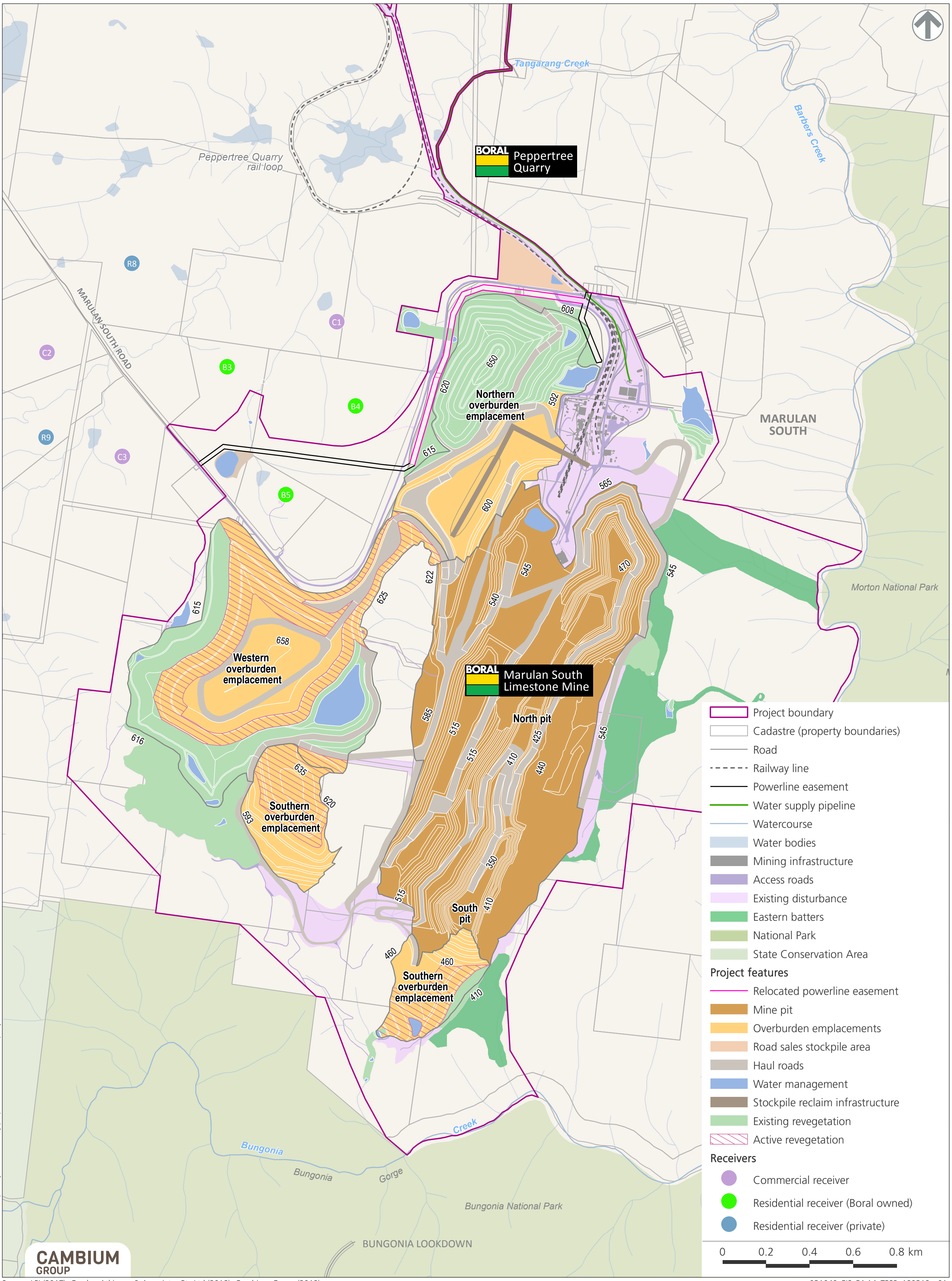
Stage 2 rehabilitation activities proposed over an 8-year period will include:

- establishing a further 31 ha of the WOE rehabilitation along western and southern slopes including central dam;
- commencement of revegetation of an additional 29.9 ha of upper slopes of the WOE southern batters and north-east haul road access facing toward Marulan South Road up to approximately 650 m AHD;
- completion of rehabilitation of 36.9 ha of the NOE to 650 m AHD;
- establishing initial 1.7 ha of rehabilitation on the south-eastern, outer slopes of overburden in the in-pit SOE and commence a further 7.5 ha of active revegetation; and
- commencement of active revegetation of 11.8 ha of the completed western out-of-pit section of the SOE between 615 m AHD and the domed 635 m AHD top.

In the 8-year Stage 2 period 49.2 ha of new active revegetation is targeted with 91.7 ha of existing revegetation established and subject to ongoing maintenance.

Figure 4.14
The Project - Stage 2 (8 years)

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

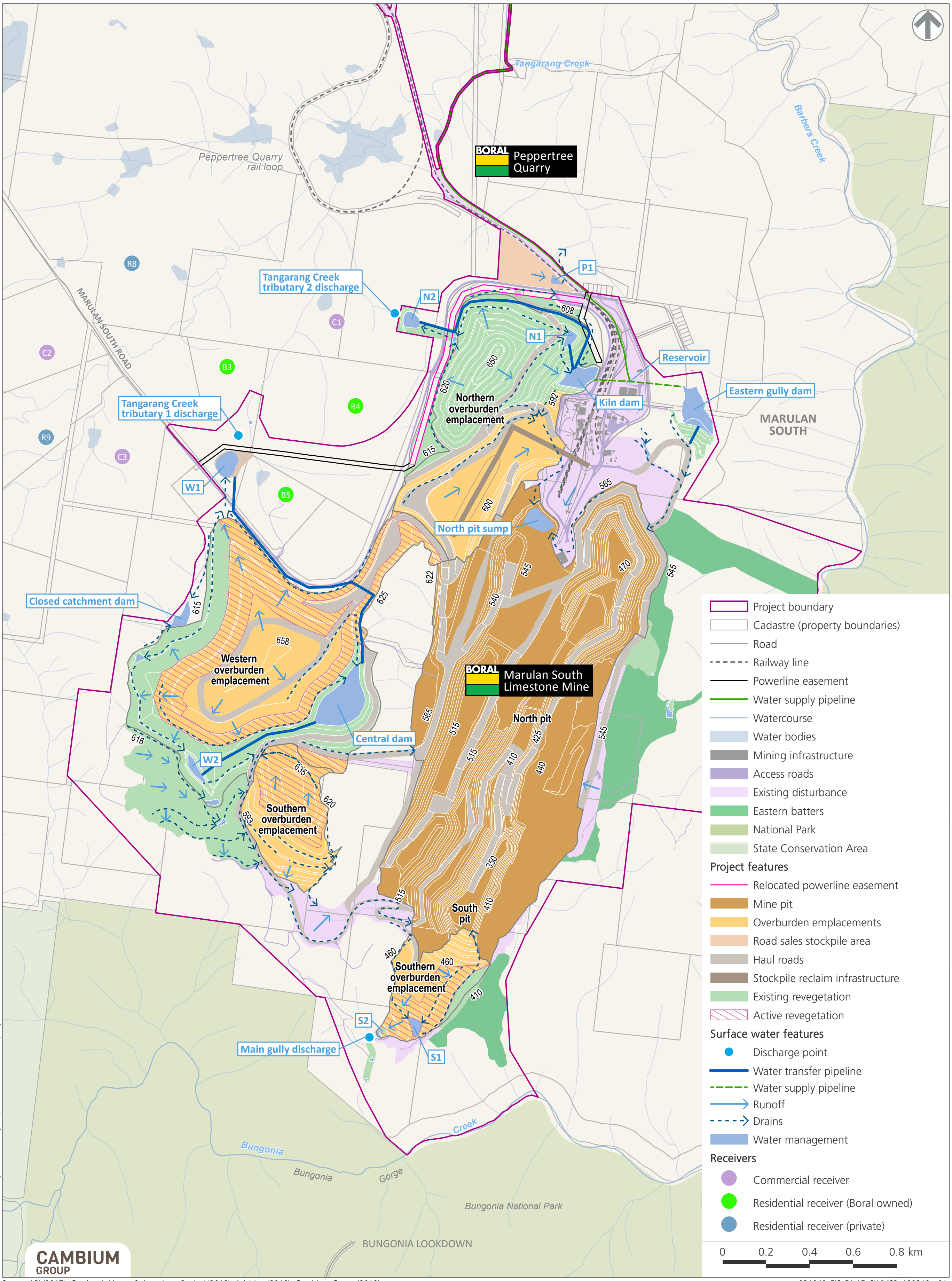


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-14_TPS2_190319_v01

Figure 4.15
Surface water management - Stage 2

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

031040_EIS_F4-15_SWMS2_190319_v01

4.5.4 Stage 3

Mining

Stage 3 is anticipated to be conducted over a period of approximately 6-years and will involve the removal and emplacement of approximately 31.66 Mt of overburden material from the western part of the mine pit, to provide access to approximately 27 Mt of limestone resource (**Figure 4.16**). Limestone mining targeting the middle and upper limestone resource creates a smaller west pit. Approximately 940,000 t of shale will also be extracted.

Overburden emplacement during stage 3 will involve:

- 20.5 Mt emplaced in the northern part of the WOE to 659 m completing this emplacement; and
- 8.46 Mt emplaced in the SOE to 500 m where the in-pit part and out-of-pit part of the emplacement join.

Other key mine infrastructure changes in Stage 3 involve the realignment of a section of Marulan South Road to allow for the northern expansion of the WOE. Old rural residential buildings and infrastructure of the Boral owned residence B5 will need to be demolished to make way for the extended WOE.

Surface water management

Surface water management during Stage 3 will involve (**Figure 4.17**):

- decommissioning of sediment basins N1 and N2 as actively managed sediment basins once rehabilitation of the NOE (northern section) is well established, but would likely be retained for water storage and transfer as required for ongoing land management;
- installation of erosion and sediment controls for the construction of the new realigned section of Marulan South Road;
- potential redirection of overflow from Sediment Basin W2 by pipe or into a channel that discharges into the western tributary of Main Gully once rehabilitation of the batter slopes of the southern section of the WOE is completed and runoff water quality is appropriate; and
- runoff collected in the west pit will seep into groundwater, with any overflow reporting to the south pit.

Rehabilitation

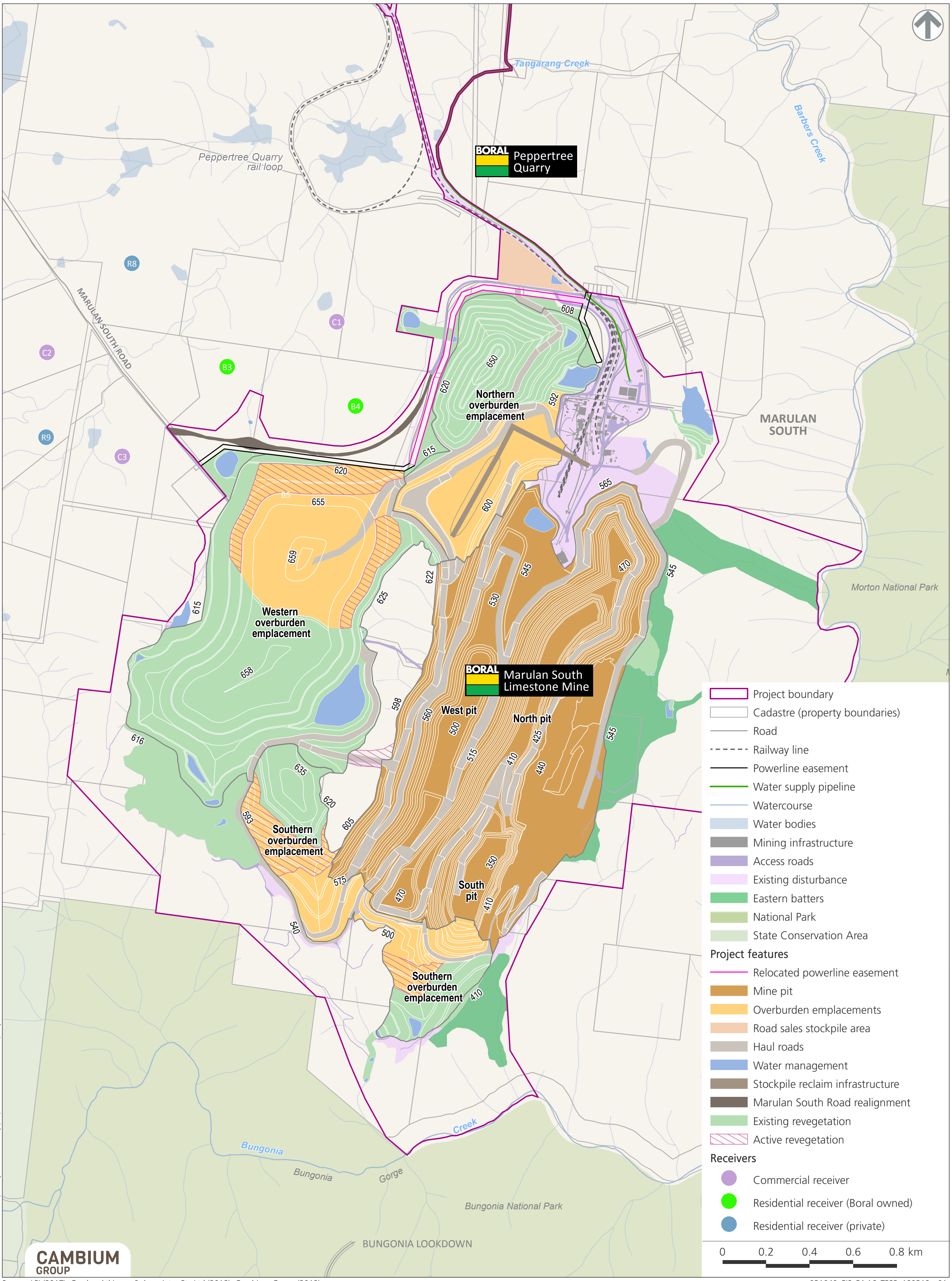
Stage 3 rehabilitation activities over a 6-year period will include:

- establishment of a further 50.6 ha of WOE rehabilitation to complete the southern section of this emplacement to 658 m AHD together with a section of western and northern lower slopes in the north-western corner adjacent to the proposed W1 sediment basin;
- commencement of revegetation of an additional 13.9 ha of upper slopes and northern batters of this northern extension to the WOE;
- establishment a further 8.1 ha of rehabilitation along the 1 in 3 outer slopes of the in-pit SOE up to approximately 460 m AHD elevation and commence a further 3.8 ha of active revegetation directly above; and
- maintenance of established 11.8 ha of western out-of-pit SOE revegetation between 615 m AHD and the domed 635 m top and commence revegetation of a further 7.1 ha directly below.

In the 6-year Stage 3 period 24.8 ha of new, active revegetation is targeted with 162.3 ha of existing revegetation established and subject to ongoing maintenance.

Figure 4.16
The Project - Stage 3 (6 years)

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

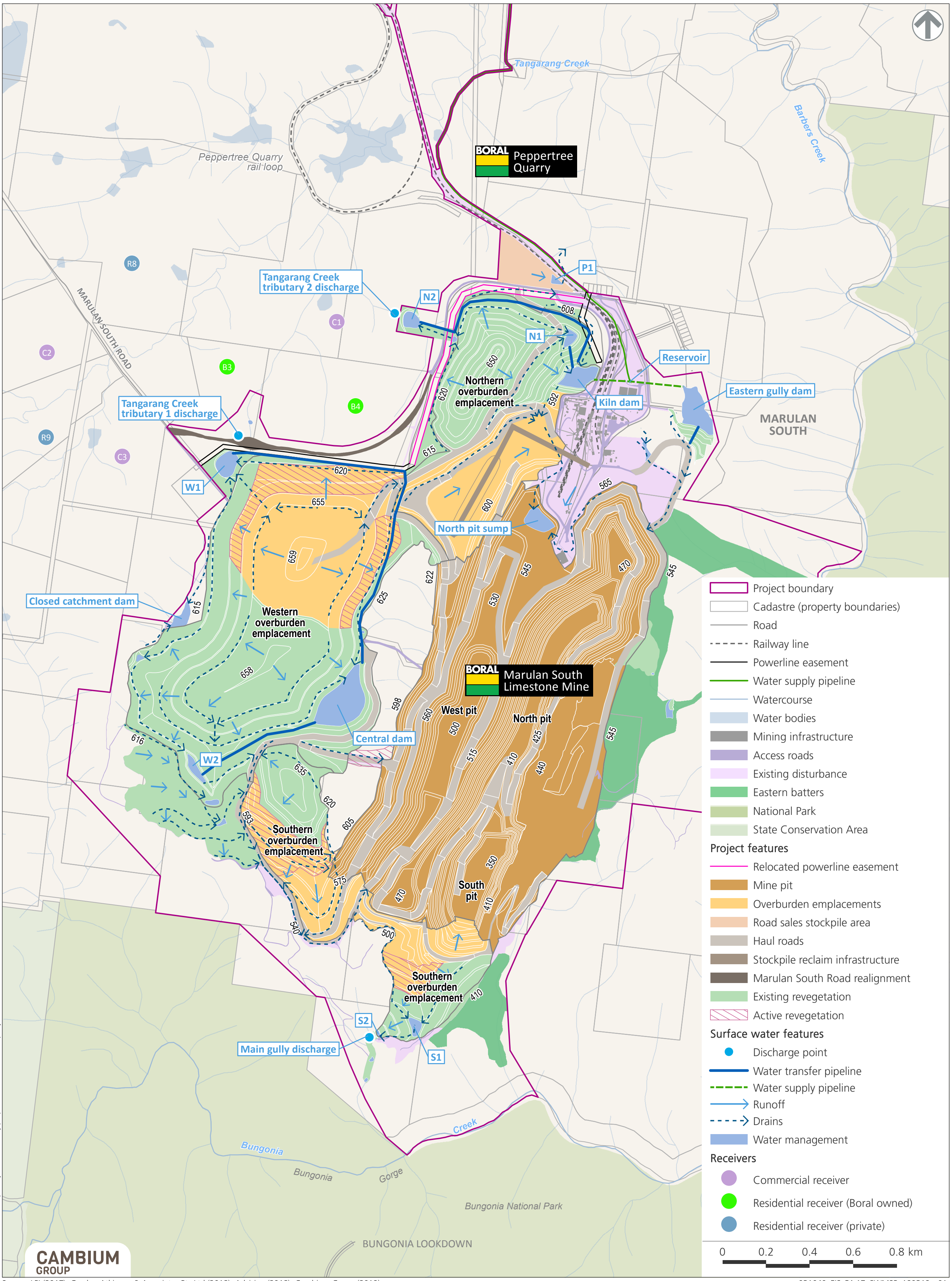


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-16_TPS3_190319_v01

Figure 4.17
Surface water management - Stage 3

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

031040_EIS_F4-17_SWMS3_190319_v01

4.5.5 Stage 4

Mining

Stage 4 will likely occur over 11 years and will involve the removal and emplacement of approximately 29.7 Mt of overburden material from the western part of the mine pit, to provide access to approximately 41.8 Mt of limestone resource (**Figure 4.18**). Approximately 1.43 Mt of shale will also be extracted.

Overburden emplacement during stage 4 will involve 31.97 Mt emplaced in the in-pit part of the SOE to between 496-520 m.

Surface water management

Surface water management during Stage 4 will involve (**Figure 4.19**):

- Sediment basins W1 and W2 to be decommissioned as actively managed sediment basins once rehabilitation of the northern section of the WOE is well established, but would likely to be retained for water storage and transfer as required for ongoing land management.
- Once rehabilitation has been well established on the outer slopes of the SOE, the drainage arrangements would be modified so that all runoff from the western part of the emplacement would be allowed to drain directly off site via Main Gully. Drainage from sediment basin S1 would also be directed to Main Gully via the existing S2 series of sediment basins.
- Assuming limestone mining did not continue beyond the proposed 30-year mine plan period the final mine pit floor configuration includes two large sediment retention basins, a northern basin at 365-355m AHD and southern basin at about 350-335 m AHD. These basins will provide an estimated storage capacity of 70 ML and 400 ML respectively.

Rehabilitation

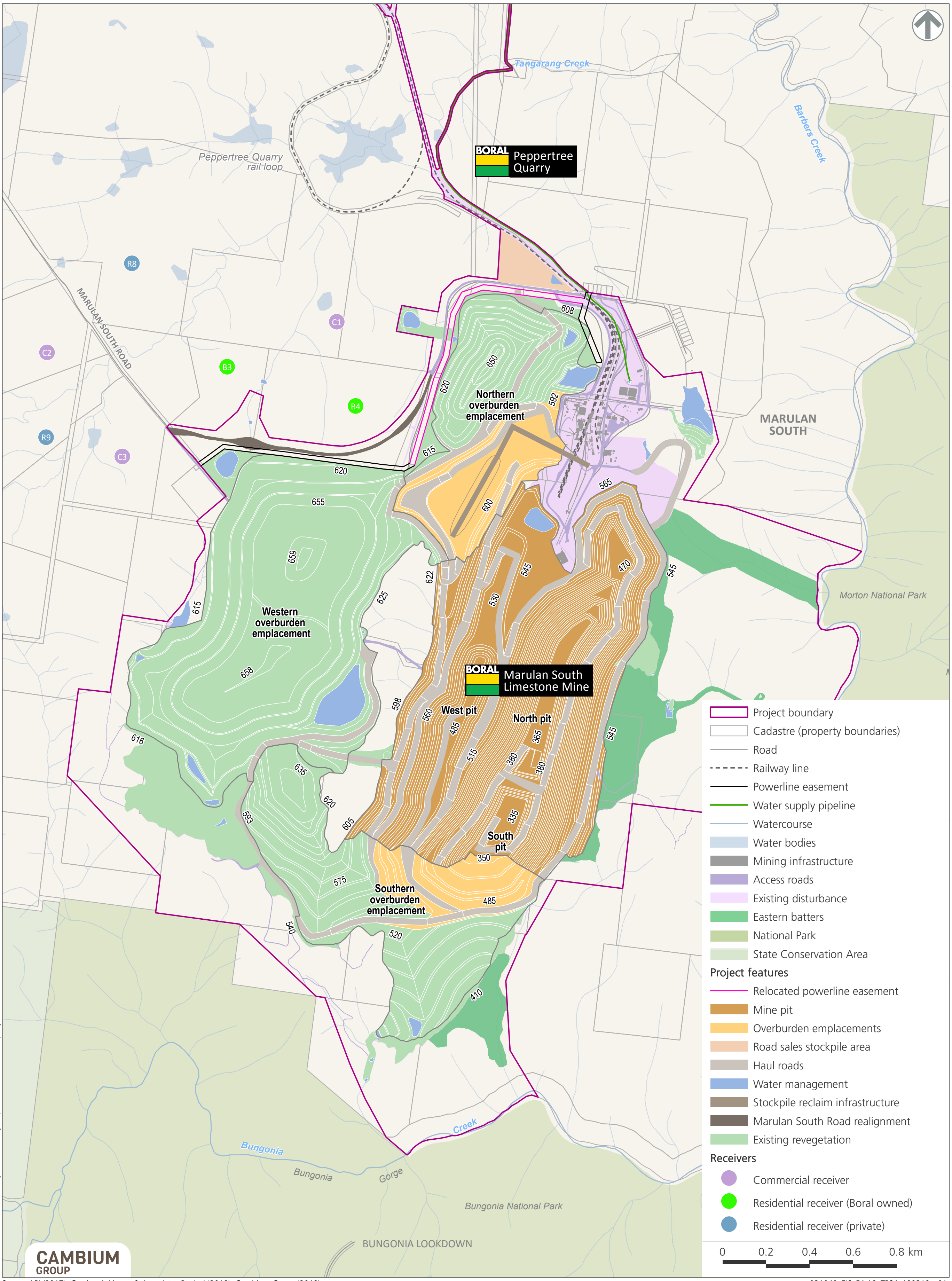
Stage 4 rehabilitation activities proposed over 11 years will include:

- Complete rehabilitation over the total 146.7 ha WOE including the northern section to 659 m.
- Complete rehabilitation of the out-of-pit (western) and in-pit SOE totalling 56.4 ha but leaving in-pit batters covering approximately 16.8 ha active. Note that further stabilisation by revegetation of some 6 ha of in-pit slopes and berms is possible if mining were to cease.
- Complete rehabilitation on remaining minor and miscellaneous areas of the NOE (0.8 ha), dams and high voltage power line easement totalling approximately 11 ha.

During the final 11-year Stage 4 period 91.9 ha of both active revegetation and remaining emplacement disturbance is targeted for completion.

Figure 4.18
The Project - Stage 4 (11 years)

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



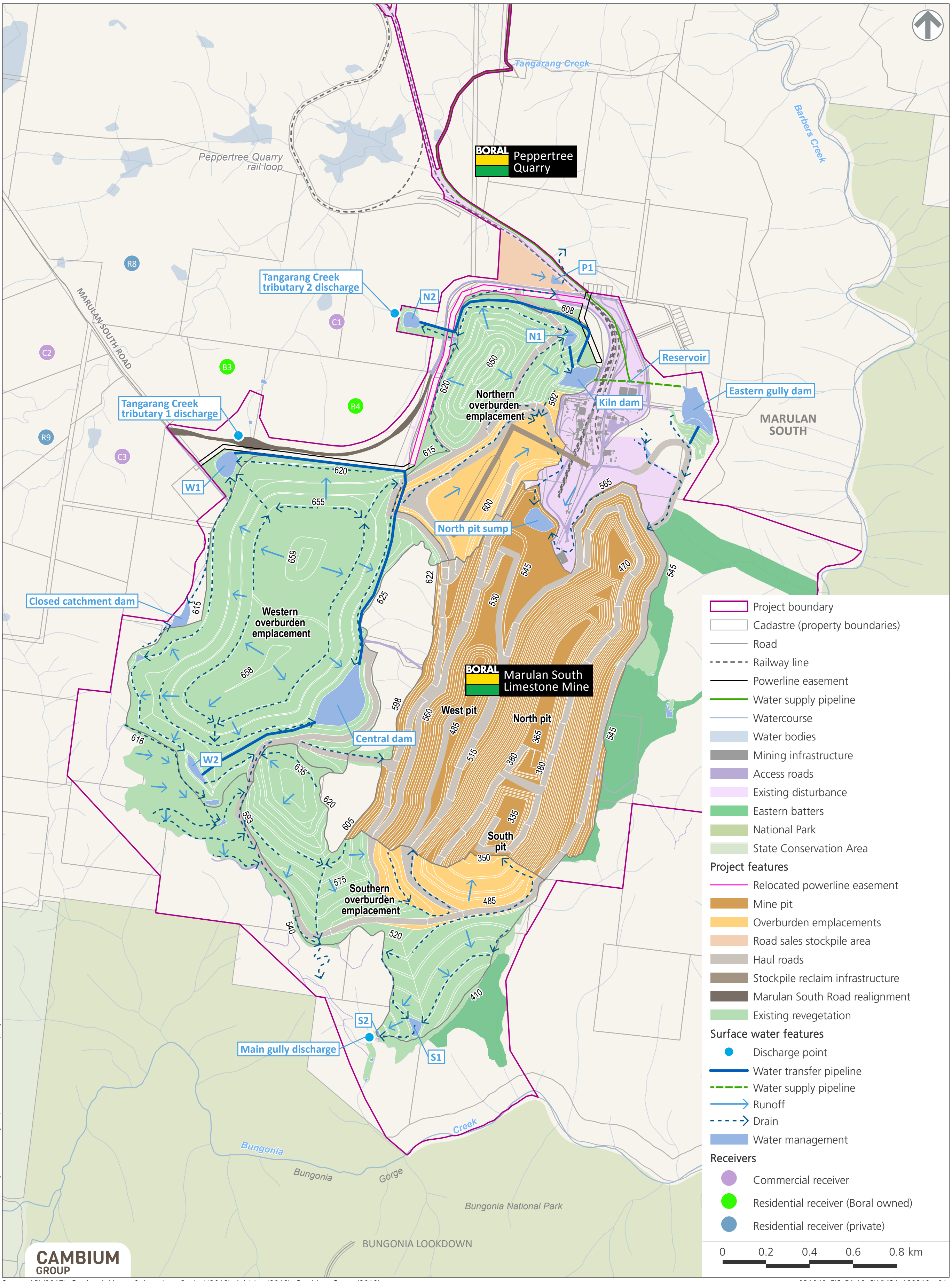
CAMBIUM GROUP

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-18_TPS4_190319_v01

Figure 4.19
Surface water management - Stage 4

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

031040_EIS_F4-19_SWMS4_190319_v01

4.6 Transport

Most limestone products will continue to be transported to customers by rail for cement, steel, commercial and agricultural uses. Boral seeks no limitation on the volume of products transported by rail.

Manufactured sand will continue to be transported by truck along a dedicated internal road, across Marulan South Road and into Peppertree Quarry for blending and dispatch by rail.

Agricultural lime, quick lime and fine limestone products will continue to be transported by powder tanker, bulk bags on trucks or open tipper trucks along Marulan South Road.

Shale, limestone aggregates, sand and tertiary crushed products will be transported by predominantly truck and dog along Marulan South Road.

Peppertree Quarry is approved to transport all products by rail. Boral will seek to transport approximately 150,000 tpa of Peppertree Quarry's products from the mine to customers via Marulan South Road. This could be achieved by back loading to the shared road sales stockpile area by the trucks carrying the limestone sand to Peppertree Quarry.

In total, Boral is seeking to 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.

Approximate road transport volumes associated with the Project are outlined in Table 4.2.

Table 4.2: Proposed annual road transport volumes

Product	Volume (tpa)	Vehicle type	Loaded from	Destination
Limestone aggregates/sand	105,000	Truck and dog	Shared road sales stockpile area	Hume Highway
Limestone filler	60,000	Tanker	Limestone plant area	Hume Highway
Limestone filler	60,000	1m^3 bulk bag on flat bed	Limestone plant area	Hume Highway
Lime products	120,000	Tanker	Limestone plant area	Hume Highway
Clay shale	90,000	Truck and dog	Limestone plant area	Hume Highway
White clay	15,000	Truck and dog	Limestone plant area	Hume Highway
Hard rock aggregates/sand	150,000	Truck and dog	Shared road sales stockpile area	Hume Highway
Sub-total	600,000			Hume Highway via Marulan South Road
Limestone products	120,000	Truck and dog	Limestone plant area	Agricultural lime manufacturing facility via Marulan South Road
Total	**720,000**			

Note: approximately 1 Mtpa of crushed and air classified limestone sand will be transported by truck and dog from the limestone plant to the Peppertree Quarry via internal roads crossing Marulan South Road.

The Project will result in an additional 68 heavy vehicle movements (two way trips) or 34 truckloads (one way trips) per average day which equates to an additional 4–6 heavy vehicle movements (two way trips) or 2–3 truckloads (one way trips) per average hour.

The Project will result in an additional 116 heavy vehicle movements (two way trips) or 58 truckloads (one way trips) per worst case day, which equates to an additional 10 heavy vehicle movements (two way trips) or 5 truckloads (one way trips) per worst case hour.

Therefore, existing and proposed vehicle movements with the Project include 266 heavy vehicle movements (two way trips) or 133 truckloads (one way trips) per worst case day and 20 heavy vehicle movements (two way trips) or 10 truckloads (one way trips) per worst case hour.

Light vehicle movements will not change as employee numbers will remain the same.

4.7 Interaction with Peppertree Quarry Modification 5

4.7.1 Overburden emplacement and associated infrastructure

Overburden emplacement at Peppertree Quarry is approved in a number of above ground overburden emplacements surrounding the quarry pit. Peppertree Quarry's development consent allows for remaining overburden that cannot be accommodated in the approved overburden emplacements, to be trucked to and emplaced in the mine's south pit.

Mine planning for the mine has ruled out emplacement of Peppertree Quarry's remaining overburden in the south pit in the required timeframes. There is some limestone remaining in the south pit and extraction of this will continue beyond Peppertree Quarry's need for additional overburden emplacement space. Additionally, as much in-pit space as possible needs to be created in the south pit to minimise the need for future out of pit emplacements at the mine. The mine is proposing to emplace approximately 30 Mt of the mine's overburden in the south pit.

Therefore, the mine is seeking to hold up to 15 Mt of overburden for Peppertree Quarry, in the northern part of the NOE with the southern part of the NOE being a flattened platform for the relocated stockpile and reclaim area. However, the mine's SSD application is unlikely to be determined before Peppertree Quarry runs out of overburden emplacement space. Therefore, Boral Resources (NSW) Pty Ltd (owner of Peppertree Quarry) is seeking earlier approval to emplace their overburden in the mine's NOE under Modification 5 to their development consent. For spatial orientation reasons, Peppertree Quarry are referring to the northern part of the NOE as their proposed South-west Overburden Emplacement (SWOE).

The mine staging plan shows the NOE being completed over approximately 5 years in Stage 1. If Peppertree Quarry obtain approval to commence emplacement of their overburden in the Northern part of the NOE before the mine receives development consent for their continued operations and associated 30-year mine plan, then some of the northern part of the NOE would likely be constructed in Stage 0 (pre SSD approval) and the remainder within Stage 1 of the 30-year mine plan.

Other activities required to enable the development of the NOE/SWOE that have been included in both the Peppertree Quarry Modification 5 and this EIS include:

- realignment of a section of the mine's high voltage supply power line (refer to **Section 4.4.9**);
- construction of the intersection on Marulan South Road, north of the NOE/SWOE (refer to **Section 4.4.6**); and
- Construction of sediment basins N1, N2 and P1 and the Kiln water storage dam (refer to **Section 4.5.2**).

These activities would also need to be constructed in Stage 0 (pre SSD approval) of the 30-year mine plan if Peppertree Quarry obtain approval for Modification 5 before the mine receives SSD approval.

All potential impacts of developing the entire NOE and associated infrastructure realignment and construction have been fully assessed in this EIS. All potential impacts of developing the northern part of the NOE (or SWOE as referred to in the Peppertree Quarry Modification 5) and associated infrastructure realignment and construction have also been fully assessed in the Peppertree Quarry Modification 5 environmental assessment.

Cumulative impacts of Peppertree Quarry have been fully considered in all relevant impact assessments for the mine's SSD application, particularly air quality, noise and visual impacts, as discussed in **chapters 17**, **19** and **20**.

4.7.2 Road sales stockpile area

As outlined in **Section 4.4.7** a new road sales stockpile area is proposed to store up to 50,000 t of limestone aggregates/sand per annum from the mine and 150,000 of Peppertree Quarry aggregates/blended products per annum. The aggregates/blended products from Peppertree Quarry, to be stockpiled in the mine's road sales stockpile area, will be transported along internal roads within the Peppertree Quarry site, to the north of the stockpile area. The mine will then transport both Peppertree aggregates/blended products and limestone aggregates/sand by truck along Marulan South Road. As the proposed road sales stockpile area and associated heavy vehicle transport volumes are included in the mine's SSD application and have been assessed in this EIS, Peppertree Quarry would not be required to modify their development consent to allow the storage of hard rock aggregates/blended products in the proposed road sales stockpile area or its transportation via road.

4.7.3 Manufactured sand

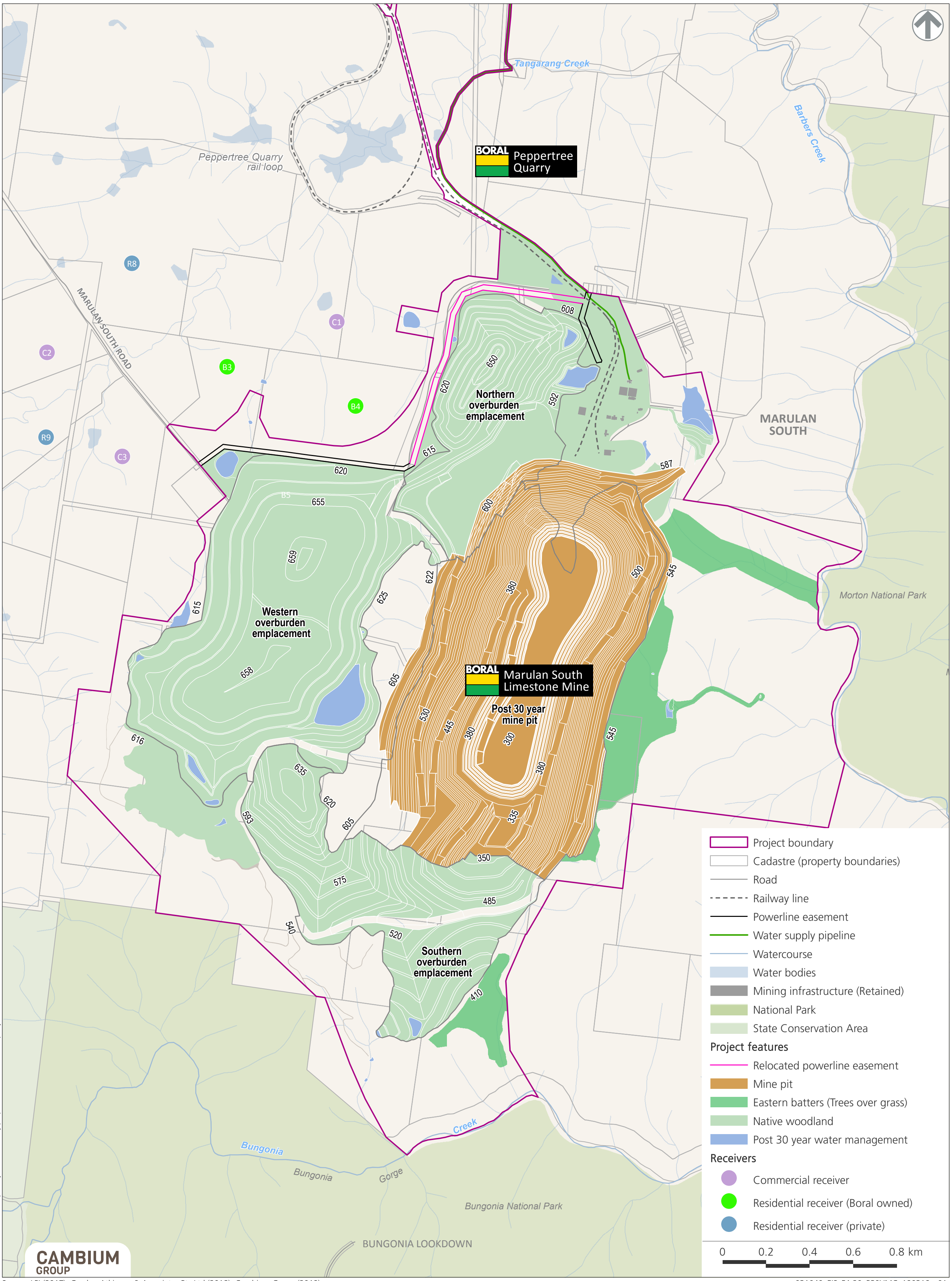
As outlined in sections 4.3 and 4.6 the mine currently produces approximately 500,000 tpa of manufactured limestone sand for Peppertree Quarry and transports the sand by truck along a dedicated internal road from the mine, that crosses Marulan South Road into Peppertree Quarry. The mine proposes to increase production of manufactured sand to 1 Mtpa and transport this additional 500,000 tpa to Peppertree Quarry along the same haul route. The proposed traffic impacts of these additional trucks crossing Marulan South Road have been assessed in the traffic impact assessment (**Chapter 20** and **Appendix T**) and the cumulative air quality and noise assessments in chapters 17 and 19 and appendices P and R respectively. In addition, it is likely that the section of Marulan South Road, east of the agricultural lime manufacturing facility driveway will be deproclaimed and will become a private road, prior to Boral increasing manufactured sand production and hauling. Therefore, as the proposed additional manufactured limestone sand production and haulage is included in the mine's SSD application and is assessed in this EIS, Peppertree Quarry would not be required to modify their development consent to allow for the receival of additional manufactured sand from the mine.

4.8 Post 30-year mine concept

The 120 Mt to be mined is only part of a much larger limestone deposit identified and estimated by GeoRes (2018) to be 640 Mt. Of the estimated 640 Mt limestone resource approximately 438 Mt is available for mining as approximately 143 Mt is located to the south of the south pit toward Bungonia Gorge and is unavailable for mining due to environmental constraints and a further 72 Mt is estimated to also be unavailable for mining as it is buried when backfilling the south pit to create the SOE. Although complete extraction of this large limestone deposit is unlikely when considering environmental impacts, it is anticipated that operations will continue well beyond the initial 30-year Project period with a further 110 Mt of limestone available for mining by extending the mine pit north, north-west and to a depth and elevation of 300 m AHD as shown in the post 30-year mining concept (**Figure 4.20**). This post 30-year mine development would require additional infrastructure relocation and the removal of some 141 Mt of overburden. An estimated 60 Mt of the 141 Mt to be removed can be emplaced by extending the in-pit SOE backfill northwards as shown in **Figure 4.20** before impacting upon the extended mine development down to 300 m AHD.

Figure 4.20
Post 30 year mine concept

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



CAMBIUM GROUP

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

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4.9 Mine closure strategy

The rehabilitation of land disturbed by mining activities is a standard requirement of mining project approvals and mining leases issued by the NSW government. There is also a community expectation that once mining has finished, a safe, useful and non-polluting landscape will be left behind. Given the location of the Project site, with agricultural properties to the west and conservation land to the south and east, it is important that effective rehabilitation processes are integrated into mine operational and closure planning.

The following sections outline Boral’s conceptual rehabilitation and mine closure strategy for the orderly transition from a mining land use to a stable and beneficial post mining use. This conceptual strategy adopts the rehabilitation methods recommended and presented in **Appendix I** for the proposed 30-year mine development and includes the likely option of continued post 30-year mine operations.

4.9.1 Post mining land use

Continued mine operation following this 30-year mine development is a likely option as outlined in **Section 4.8**. Post mining land use at this point in time is being considered at greater than 30-years into the future and therefore is conceptual, particularly regarding the mine void.

The 30-year mine development includes both ‘out-of-pit’ (‘above ground’) and ‘in-pit’ overburden emplacements to achieve a balance between resource utilisation and long term environmental considerations especially the visual impact of the rehabilitated landform. Overburden emplacements developed or expanded during Project operations, including the WOE, NOE, western and southern sections of the SOE, and existing eastern batter slopes will occupy approximately 242 ha of the total 598 ha disturbance footprint at the end of the 30-year Project life. The end of Project reshaped emplacements, as shown on **Figure 4.21**, will be the likely final landforms.

The post mining land use goal for the overburden emplacements is the re-establishment and development of native woodland vegetation communities that reflect the existing ecological communities identified in **Appendix K** and outlined in **Section 12.2**. Specifically, overburden emplacement rehabilitation will incorporate the:

- re-establishment of native woodland communities that reflect the structure and composition of the federally listed critical endangered ecological community (CEEC), Blakely's Red Gum - Yellow Box - Grassy open woodland particularly in the NOE and WOE areas, by incorporating key tree species of this community into the proposed seed mix for emplacement rehabilitation;
- establishment of woodland communities in the vicinity of the WOE that will also improve movement corridors for native fauna species, including Koalas and Yellow-bellied Gliders; and
- selection of species from the Coast Grey Box – stringybark dry woodland community, (commonly found on the upper slopes of adjacent steep gorges) for the rehabilitation of steep slopes of the SOE.

In addition, the re-establishment of native woodland communities within the nominated overburden emplacement domains is compatible with the proposed rehabilitation objectives of the adjacent Peppertree Quarry, which are to rehabilitate disturbed areas to Blakely's Red Gum - Yellow Box - Grassy open woodland, increase native wildlife habitat and re-establish movement corridors across the site.

If mining were to cease toward the end of the proposed 30-year Project life, other potential post-mining use options would need to be considered by Boral as discussed further in **Section 4.8**.

A conceptual final landform design has been developed as detailed in **Section 4.8** to guide the post mining land use planning process and assist in the development of rehabilitation objectives.

4.9.2 Conceptual final landform design

If operations were to cease at the end of the proposed 30-year Project life, detailed closure planning would commence at approximately the midway point of Stage 4 (five to six years prior to closure). This would allow sufficient time to complete limestone mining, including the removal and emplacement of overburden in accordance with final land use and closure planning commitments. Until confirmation of closure timing triggers the requirement for detailed closure planning, the proposed 30-year mine development and overburden emplacement schedule allows for some final land use flexibility, while maintaining public safety, providing guidance for rehabilitation design and minimising potential environmental impacts.

Figure 4.21 provides a 'snap shot' of a conceptual final landform design, including rehabilitated areas and retained infrastructure, approximately five years after the proposed 30-year mine Project life. This conceptual final landform design is also presented as 3D visualisations in **Figure 20.10** and Figure 20.11 and the cross sections in Figure 4.24, Figure 4.25 and Figure 4.26. Features of the conceptual final landform design, based on the 30-year mine development and progressive rehabilitation schedule, are outlined below.

Safety

Development of a nominally 30 m wide haul road access around the mine void at an elevation (AHD) of between 560 m and 590 m (western side) and 545 m (eastern side), permitting the installation of security fencing (typically 2.1 m in height) and earth/rock safety berms to physically restrict access to the mine void. The location of proposed and existing security fences is indicated by the black dashed line on Figure 4.21.

Approximately 10 m to 13 m of the former haul road can be planted/seeded with trees, forming a visual barrier whilst still providing safe road/track access around the approximate 7.1 km perimeter of the final mine void.

Visual

To improve visual amenity, additional tree planting/seeding may be established on the 9 m wide berms of the upper 15 m bench and 50-degree face slope, down to the approximately 500 m elevation. Possible bench planting locations (4 m to 5 m wide) are shown on Figure 4.21 as darker green shaded areas from 600 m down to 530 m elevations on the mine pits western rim and from 560 m to 500 m around the eastern perimeter.

Wider areas, from 60 m to 140 m wide are available for planting at the 530 m and 545 m elevations (western side), with safe road/track access being maintained for revegetation monitoring and maintenance.

The upper in-pit slopes of the SOE would, where practical, be battered to achieve 1:2 to 1:3 slope gradients down to 485 m AHD and revegetated to improve visual amenity from the south. If the lower in-pit slopes, concealed from view by the southern rim of the SOE, were not battered to approximately 1:3 in the final closure planning period then plantings along the three, 9 m wide berms (at approximately 455 m, 440 m and 395 m AHD) could be undertaken to assist with slope stabilisation, as indicated in Figure 4.21.

In total, approximately 30 ha of additional "visual screening" rehabilitation has been identified within the mine void as shown on Figure 4.21, assuming no further mining was to be undertaken. This rehabilitation comprises 24 ha of planting/seeding over the remaining 9 m wide mine benches, and 6 ha of the SOE in-pit slopes and berms.

If final mine closure did occur at the end of the 30-year Project life, the majority of the infrastructure area would also be subject to final rehabilitation. An estimated 70 ha of the infrastructure area (comprising existing processing plant, relocated stockpile reclaim area and the shared road sales stockpile area) would be decommissioned and rehabilitated.

The existing eastern batter rehabilitated areas (east of the mine pit) would also be well advanced towards the post mining land use objective of a stable landform with established native woodland vegetation, following a further 30 years of progressive rehabilitation, monitoring and maintenance.

Water Management

Some sediment basins and all of the water storage dams proposed as part of the Project development, together with water supply pipelines are likely to be retained for continued sediment and erosion control, and to facilitate water supply in support of the post-mining land use. Any sediment basins no longer required for final land use requirements will be decommissioned.

Surface water runoff from the SOE and the southern sections of the WOE will drain to the mine void via sediment basins during earlier stages of mine development. Once mining is complete and the emplacements are sufficiently rehabilitated, surface drainage from the WOE and western section of the SOE would be allowed to drain directly off site via Main Gully to Bungonia Creek. Drainage from the eastern in-pit section of the SOE would be allowed to drain off site to Main Gully and Bungonia Creek via Sediment Basin S1 and the S2 series of sediment basins. The northern sections of the NOE and WOE will report to Tangarang Creek during and after emplacement operations. The southern section of the NOE, and adjacent areas will drain to the north pit during and after mining operations. The two large sediment retention basins established on the mine pit floor would be retained to capture sediment from post-mining in-pit weathering and erosion. Bryces and Barbers overburden emplacements (the eastern batters) will continue to drain to Barbers Creek.

Services and Infrastructure

Subject to landholder agreement (Boral being the landholder for the majority of land titles), and in accordance with any development consent conditions, services including rail and road access, and electricity supply would be retained to service post-mining land uses. Maintaining partial road and rail access to, and around the Project site is considered necessary for ongoing land access and management, including bush fire prevention. Certain haul roads and light vehicle access tracks will be retained.

As with services, various buildings (e.g. workshops, stores, production and administration offices) may be retained, where agreed, to support post-mining land uses. Processing plant and equipment is likely to be decommissioned, removed from site and the remaining area rehabilitated in accordance with final land use requirements. Proposed infrastructure to remain at end of Project is shown in Figure 4.21.

Infrastructure that is no longer required will be decommissioned and removed as follows:

- The bitumen roadways, car parks and hardstand areas will be removed and inert waste material placed in the open cut voids and buried. Bitumen material would be removed from site and disposed.
- All sumps would be de-watered and de-silted prior to the commencement of demolition. In addition, all items of equipment will be de-oiled, de-gassed, de-pressurised and isolated, and all hazardous materials removed from the site.
- All buildings no longer required including dispatch, crushers and screens, lime plant, and other fixed plant (conveyors and gantries, transfer points, thickener tank, vehicle wash, etc) will be demolished and removed from the site. Where possible, assets may be re-used on other sites or sold.

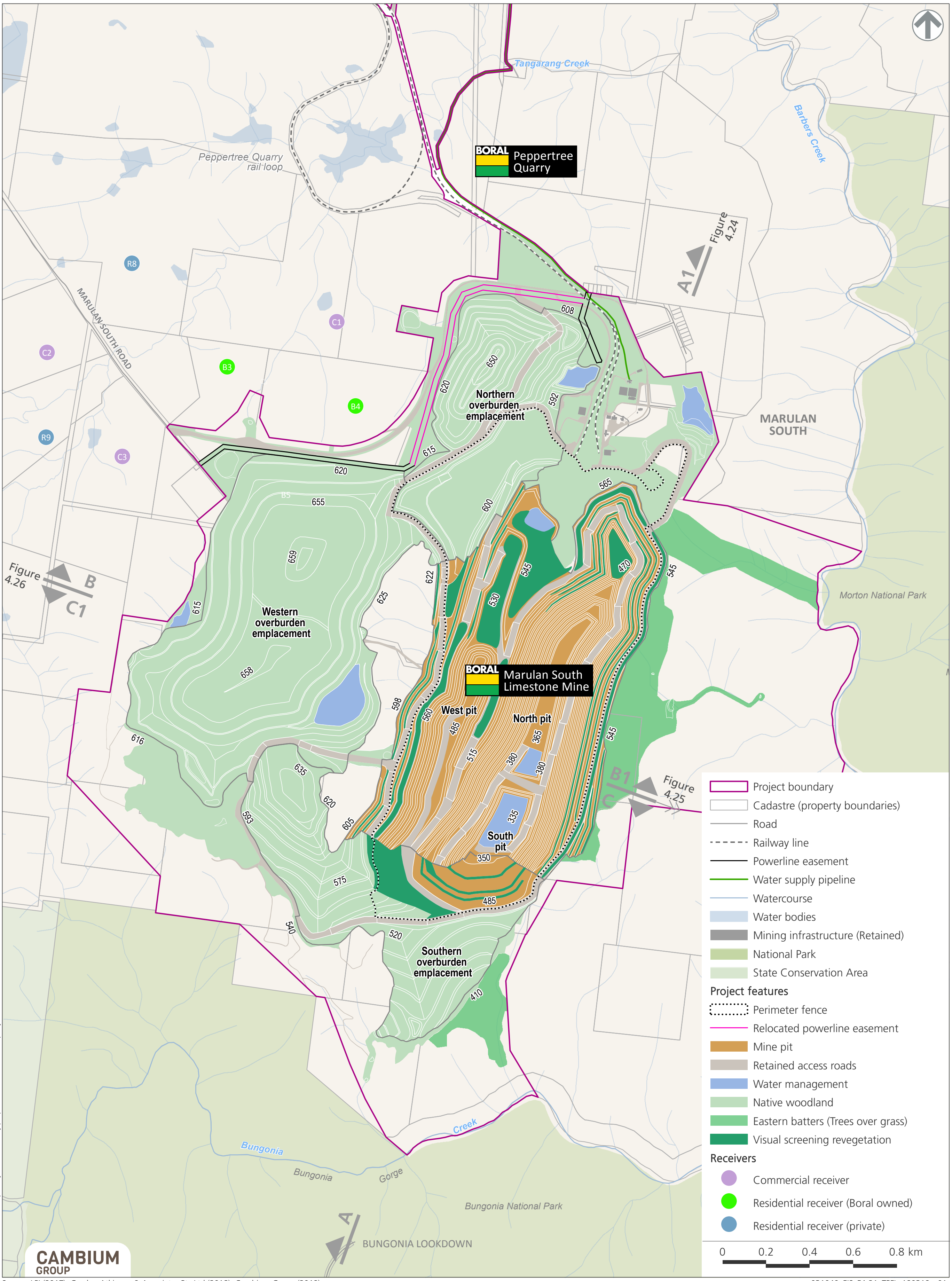
- The remaining items will be demolished, removed or transported from the site. All recoverable scrap steel will be sold and recycled, with the remaining non-recyclable wastes disposed to a licensed waste management facility.
- Prior to disposal, all wastes will be assessed and classified in accordance with the Environmental Guidelines: Assessment, Classification & Management of Liquid and Non-liquid Wastes (a combination of the Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes (1997) and the product of consultation on Draft Environmental Guidelines for Assessment, Classification and Management of Liquid Wastes (1998)).
- All concrete footings and pads will be broken up to at least 1.5 metres below the ground surface. The waste concrete, where practical, will be recycled to produce an aggregate that can either be used on the site, or sold for other beneficial use.
- All areas will then be reshaped, deep ripped, topsoiled and seeded in accordance with rehabilitation strategies outlined in **Chapter 26**.

Project rehabilitation objectives and completion criteria for the mine are presented in **Section 26.1.2** of this EIS and **Section 4.4** of **Appendix I**. Project rehabilitation methodology is described in **Section 26.1.2** of this EIS and **Section 4.5** of **Appendix I**. Monitoring and research and post-closure maintenance is discussed in **Section 26.2.6** of this EIS and section 4.4 and 4.5 of **Appendix I**.

An updated rehabilitation strategy and all relevant detail outlined in this EIS will be incorporated into a subsequent integrated MOP/rehabilitation plan, to be developed in consultation with, and approved by the Department of Resources and Geosciences in accordance with the MOP guidelines.

Figure 4.21
The Project - Final landform

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

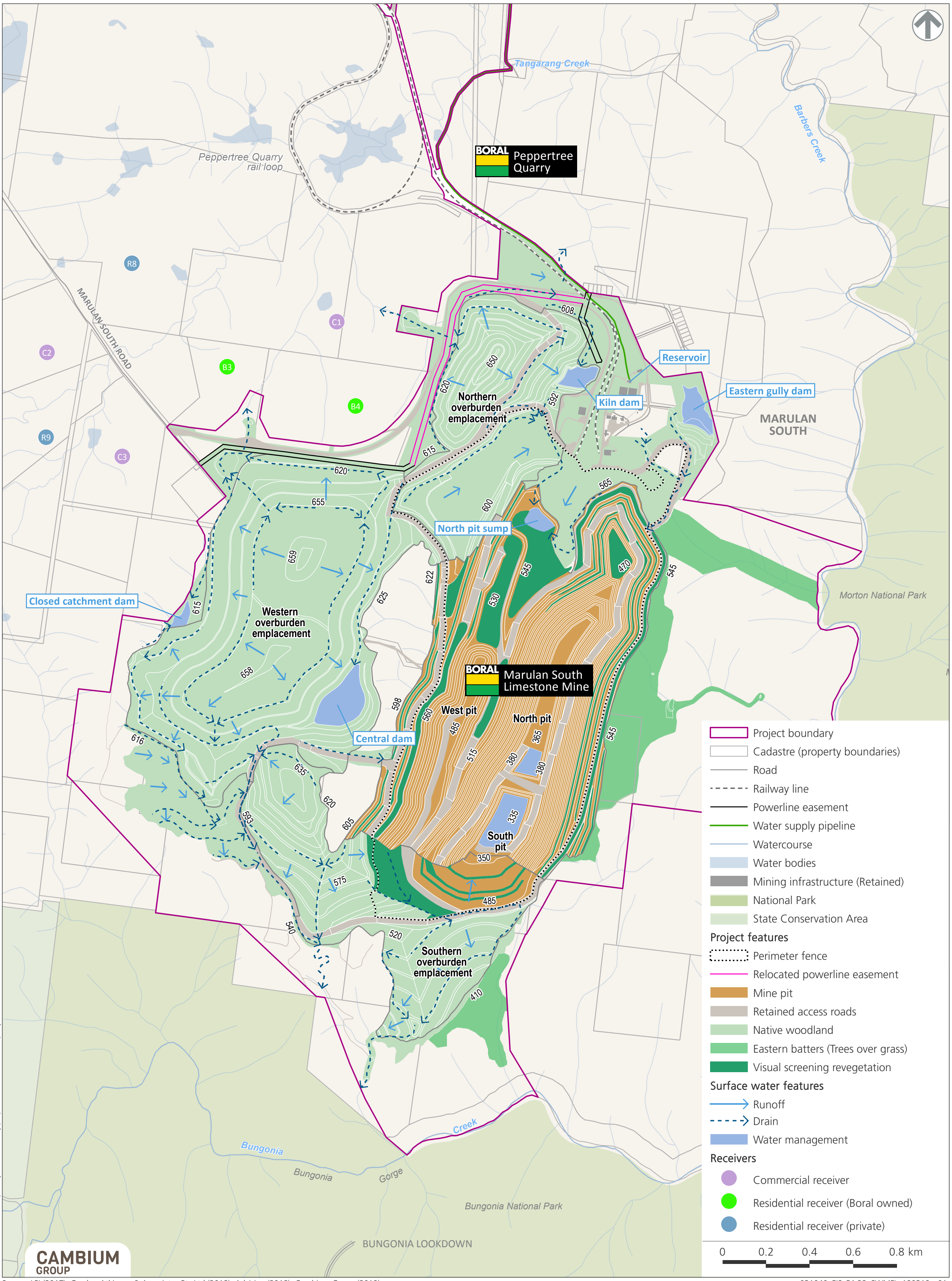


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-21_TPFL_190319_v01

Figure 4.22
Surface water management - Final landform

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

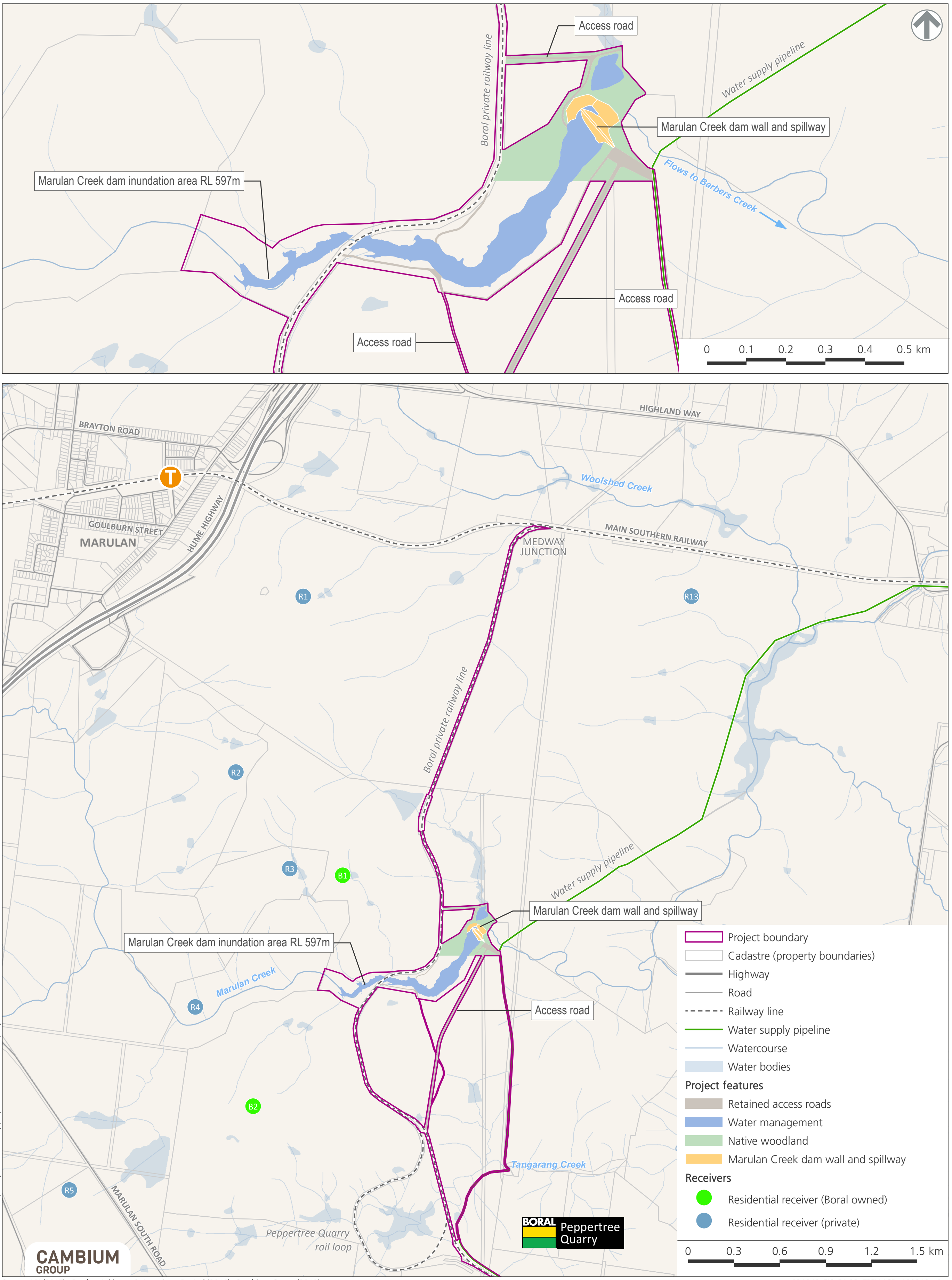


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Advisian (2018), Cambium Group (2019).

031040_EIS_F4-22_SWMFL_190319_v01

Figure 4.23
The Project - Final landform (Marulan Creek Dam)

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

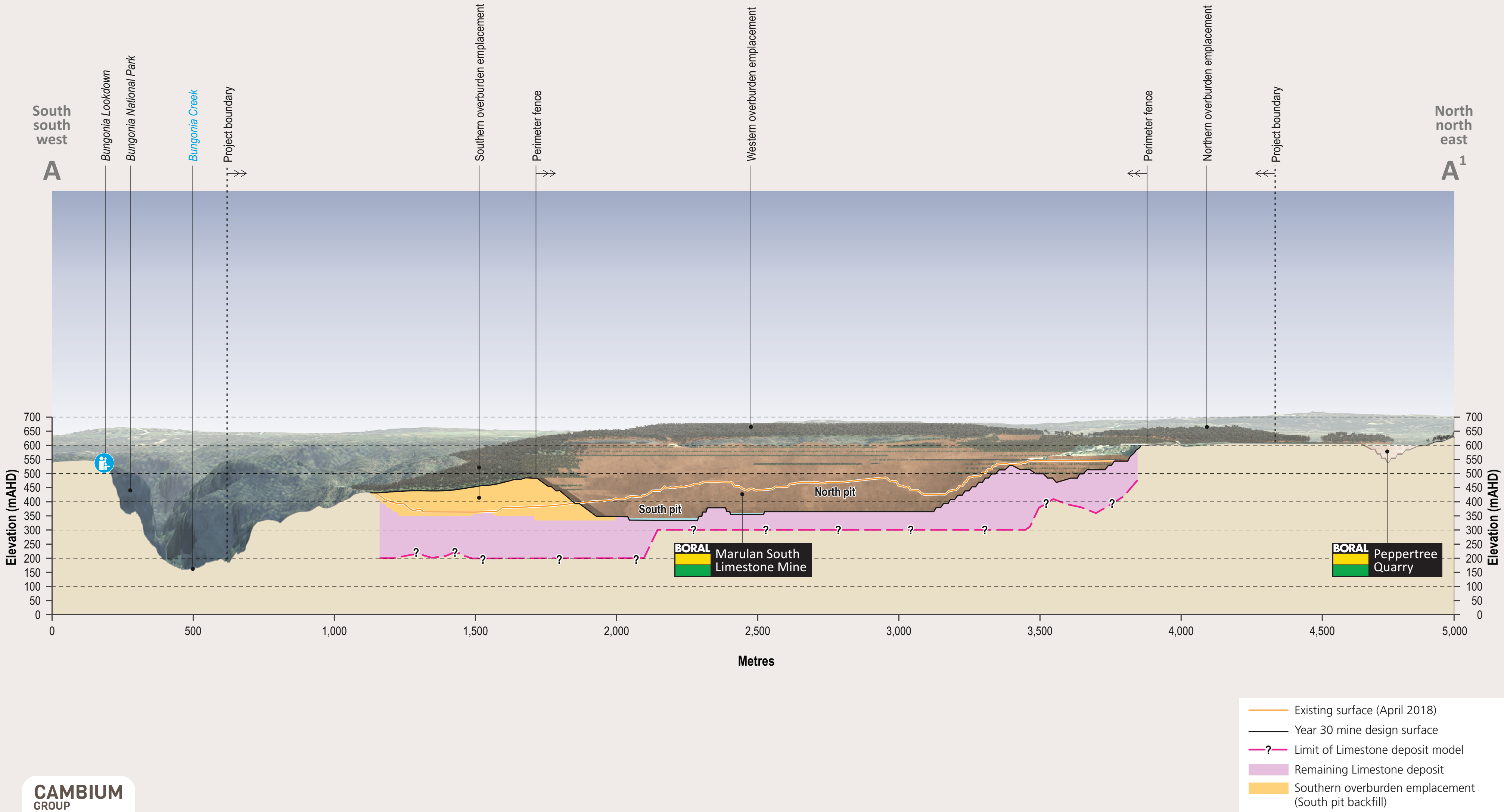


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-23_TPFLMCD_190319_v01

Figure 4.24
Pit cross section A-A[1]

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



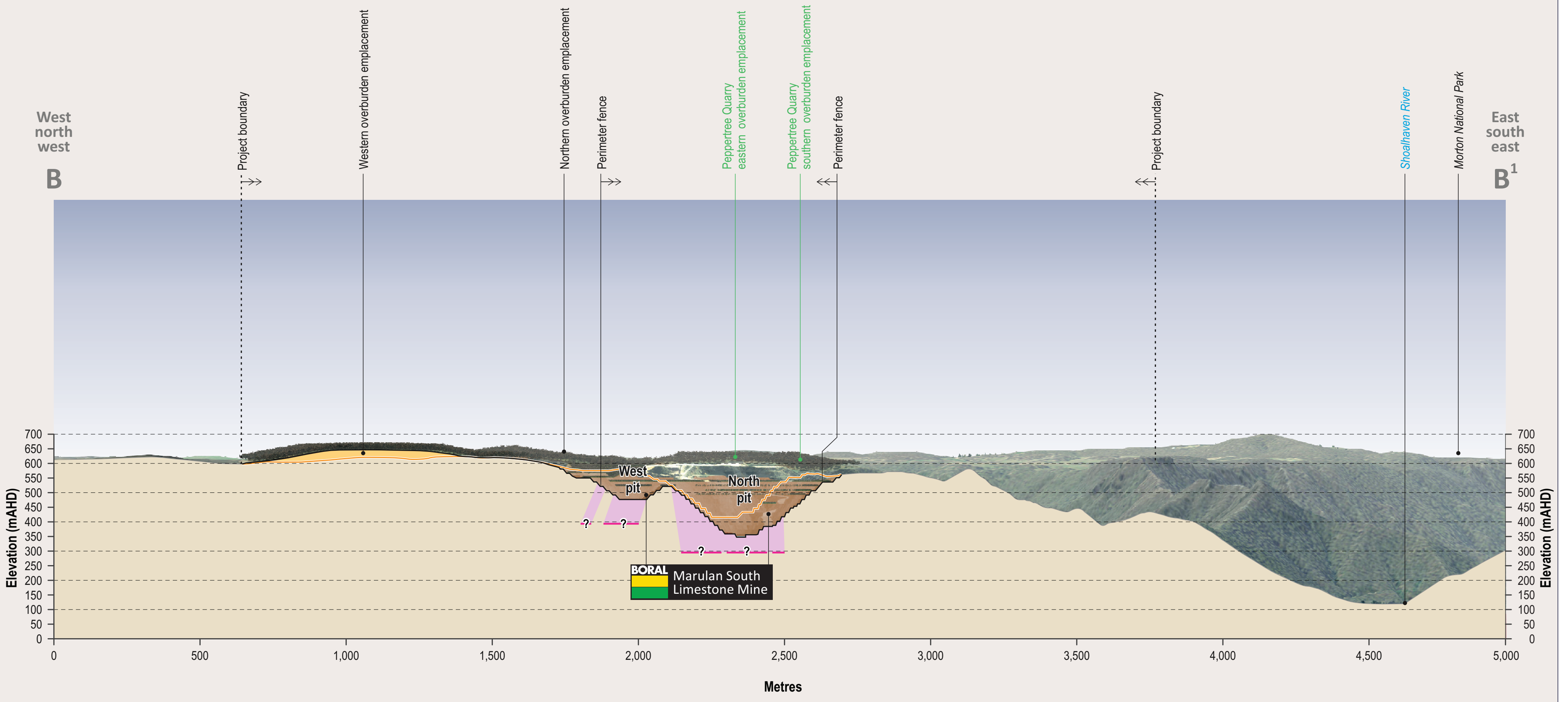
CAMBIUM GROUP

Source: GeoRes (2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-24_PCSAA1_190318_v01

Figure 4.25
Pit cross section B-B[1]

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



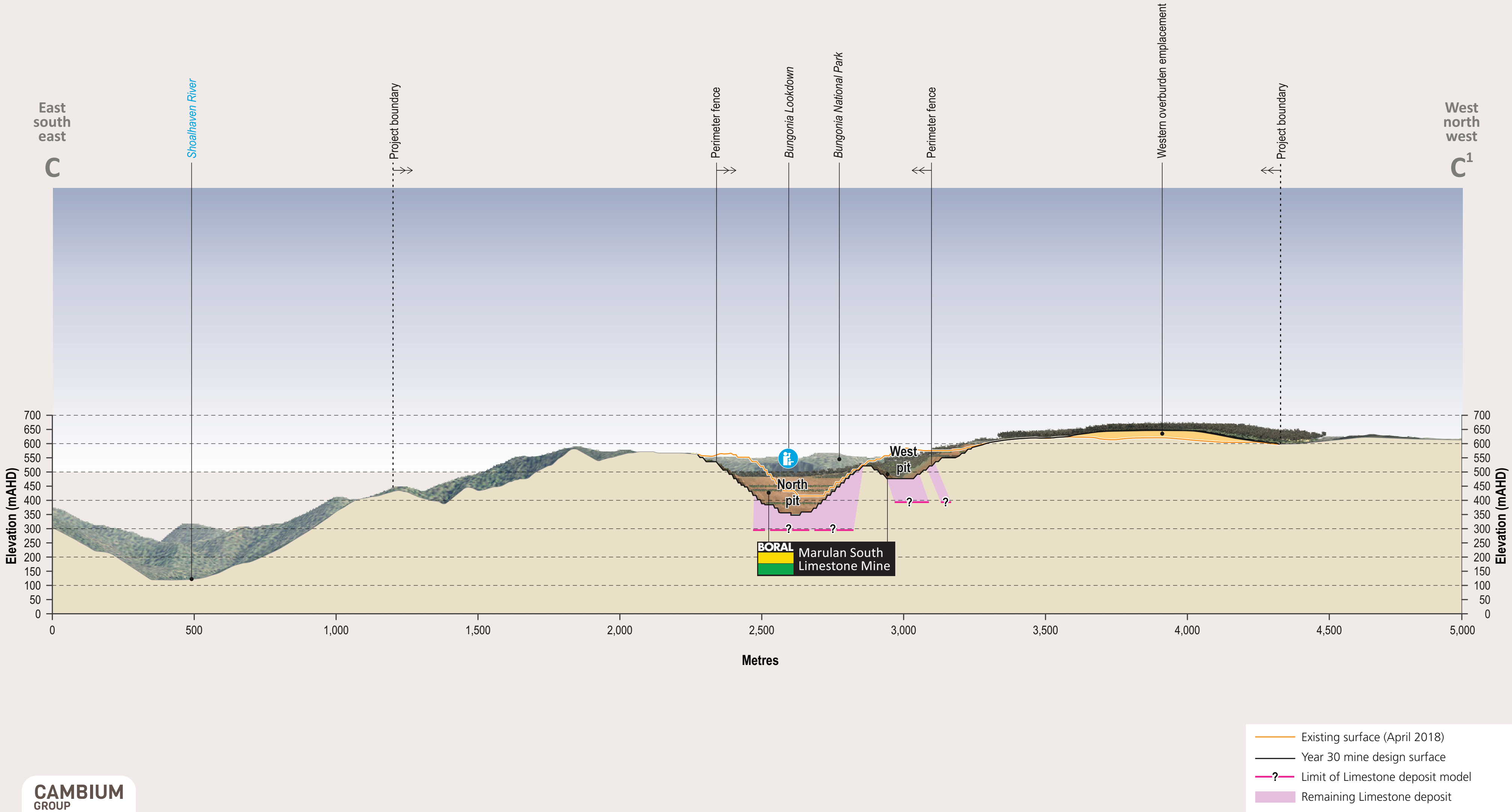
CAMBIUM GROUP

Source: GeoRes (2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-25_PCSBB1_190318_v01

Figure 4.26
Pit cross section C-C[1]

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



CAMBIUM GROUP

Source: GeoRes (2018), Gordon Atkinson & Associates Pty Ltd (2018), Cambium Group (2019).

031040_EIS_F4-26_PCSCC1_190318_v01

4.10 Post 30-year alternative land use options

If mining operations were to cease at the end of the proposed 30-year Project life, detailed closure planning would commence at approximately the midway point of Stage 4 (five to six years prior to closure) to ensure the successful implementation of the rehabilitation and mine closure strategy outlined in **Section 4.9**.

During closure planning other potential post-mining use options would be considered taking into account:

- strategic and local planning initiatives for the area at the time;
- key stakeholder requirements;
- community feedback and social impacts;
- environmental impacts; and
- economic viability.

Potential post-mining use options that could be considered further are outlined in the following sections.

4.10.1 Pit backfilling

Overburden material sourced from possible future expansion of the adjacent Peppertree Quarry extraction area and other virgin excavated natural material (VENM) or excavated natural material (ENM) sourced from external development projects could be used to backfill the mine pit. Overburden from Peppertree Quarry could be hauled to the site by truck and surplus VENM/ENM from major infrastructure projects in Sydney and possibly other regional areas could be imported to the site via the mine's rail infrastructure. If sufficient fill material became available over time, this could allow the backfilling of the mine pit to a 'natural ground level', re-instatement of pre-mining drainage regimes and revegetation with native vegetation communities as outlined in **Section 4.9**.

4.10.2 Environmental conservation

As outlined in **Section 4.9.1**, the post mining land use goal for the overburden emplacements is the re-establishment and development of native woodland vegetation communities that reflect the ecological communities that occur naturally in the locality. When the mine pit is backfilled with overburden/VENM/ENM to an elevation that allows for the creation of a free draining landform, then the backfilled pit area could also be rehabilitated to native woodland vegetation communities that align with the natural transitions between natural plateau type vegetation communities and the native vegetation of the Barbers and Bungonia Creek gorges. If the overburden emplacements and mine pit can be successfully rehabilitated to a stable, free draining landform vegetated with native woodland communities that requires little maintenance, then there is the possibility the land could be incorporated into adjacent conservation lands of either the Bungonia NP, Bungonia SCA or Morton NP. If the mine site was incorporated into one of these conservation areas, then much of the remaining infrastructure, except for possibly a few access tracks, would need to be removed and rehabilitated.

4.10.3 Tourism, sport and recreation

In 30 years time, the mine would have been operating for 180 years. It is one of the oldest and largest limestone mines in the world and is integral to the history of Marulan South and the Marulan area in general. With good rail and road access and views over the adjoining conservation lands to the south and east, the site could be developed into a tourism destination. Tourism, sport and recreation opportunities at the site could include:

- Retaining certain mining infrastructure in place and made safe for public access to allow visitors to learn about the history of limestone mining at the site and mining practices in general;
- Existing administration buildings at the site could be used for education and school groups and an interpretive centre;
- Sporting and adventure activities could be established on the site such as mountain biking, rock climbing, abseiling and flying foxes;
- Cabins could be erected on site to provide accommodation for eco tourism, schools and visitors; and
- The existing Marulan South Village cricket oval could be used as a training facility for teams seeking a mixture of training and team building activities.

4.11 Comparison of existing and proposed operations

A comparison of the existing/approved operations at the site and the proposed 30-year continued operations is set out in Table 4.3.

Table 4.3: Comparison of existing and proposed operations

Project component	Existing	Proposed
Mining method	Overburden including clay shale is removed using excavators and front-end loaders. Limestone is extracted using open-cut drill and blast techniques. Limestone is loaded using excavators and front-end loaders and hauled either to stockpiles or the primary processing plant using haul trucks. Oversized material is stockpiled and reduced in size using a hydraulic hammer attached to an excavator, before being introduced to the processing plant.	No change.
Resource	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 rising almost to the original land surface divided the two pits. The north and south pits were recently joined in 2016/2017 by mining the centre ridge to form a single contiguous pit, approximately 2 km in length. However, the areas are still referred to as north pit/south pit.	The proposed 30-year mine plan accesses approximately 120 Mt of limestone down to a depth of 335 m AHD. The mine footprint focuses on an expansion of the north pit westwards to mine the Middle Limestone and to mine deeper into the Eastern Limestone. As the Middle Limestone lies approximately 70 m to 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

Project component	Existing	Proposed
		part of the south pit, leaving the remainder of the south pit for overburden emplacement and a visual barrier.
Project site and disturbance area	CML 16 (which encompasses ML 1716), covers an area of 616.5 ha. Existing mining has disturbed approximately 341.5 ha.	The Project site is approximately 846.4 ha. The Project would result in an additional disturbance footprint of approximately 256.5 ha.
Annual production	Subject to market demand the mine has typically produced up to 3.38 Million tonnes of limestone and up to 200,000 tonnes of shale per annum.	Limestone will be extracted at a rate of up to 4 Mtpa for a period of 30 years. Clay shale will also continue to be extracted at a rate of up to 200,000 tpa.
Mine life	Mining commenced around 1830.	Project life 30 years.
Total Resource recovered	Extraction to date is unknown as records were not regularly kept in early years of mining.	Up to 120 Mt of limestone and up to 5 Mt of shale resource extracted over 30 years.
Beneficiation	Processing of 3.38 Mtpa of limestone to create various limestone and lime products including limestone aggregates and sand, hydrated lime and quick lime.	Processing of 4 Mtpa of limestone to create various limestone and lime products including limestone aggregates and sand, hydrated lime and quick lime.
Management of mining waste (overburden)	Overburden from stripping operations is emplaced in the WOE, west of the open cut pits.	The proposed 30-year mine plan will generate approximately 108 Mt of overburden. Overburden will be emplaced both within 'in-pit' and 'out-of-pit' overburden emplacements.
General infrastructure	The existing mine includes access and haul roads, limestone handling and processing equipment, limestone product stockpiling and reclaim areas, conveyor network, lime production and processing plant, limestone sand plant, rail loading and despatch infrastructure, administration offices and visitor/employee car parking facilities, electricity supply and distribution, utility infrastructure, workshop, stores and ablution buildings, underground diesel storage, heavy vehicle servicing, parking and washdown facilities.	The Project will require the following key infrastructure changes: ▪ relocation of a section of high voltage power line to accommodate the NOE; ▪ realignment of a section of Marulan South Road, to accommodate the WOE; ▪ 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; and ▪ development of a shared Road Sales Stockpile Area including a weighbridge and wheel wash to service both the mine and Peppertree Quarry.

Project component	Existing	Proposed
Product transport	A single line rail track owned and maintained by Boral links the Project site to the Great Southern Railway at Medway Junction. A 1.2 km long passing line was constructed at Medway Junction as part of construction of the Peppertree Quarry. This line will also be used by the mine to enhance access to the Main Southern Railway. Boral currently transports most finished products by rail, with up to six trains departing the mine per day. Annual road transport volumes along Marulan South Road to the Hume Highway are approximately: ▪ lime products – 130,000 tpa. ▪ Limestone aggregates – 50,000 tpa. ▪ Clay shale – 80,000 tpa. ▪ Fine limestone – 70,000 tpa. Annual road transport volumes along Marulan South Road to the agricultural lime manufacturing facility are approximately 120,000 tpa. Annual road transport volumes of crushed and air classified limestone sand along internal roads to Peppertree Quarry are approximately 500,000 tpa.	The majority of limestone products will continue to be transported to customers by rail for cement, steel, commercial and agricultural uses. Boral seeks to maintain the approved rail transportation limit of six trains departing the mine per day. Manufactured sand will continue to be transported by truck along a dedicated internal road, across Marulan South Road and into Peppertree Quarry for blending and dispatch by rail. The mine currently produces approximately 500,000 tpa for Peppertree Quarry and proposes to increase production of manufactured sand to approximately 1 Mtpa. Agricultural lime, quick lime and fine limestone products will continue to be transported by powder tanker, bulk bags on trucks or open tipper trucks along Marulan South Road. Shale, limestone aggregates, sand and tertiary crushed products will be transported by predominantly truck and dog along Marulan South Road. The adjoining Peppertree Quarry is currently approved to transport all products by rail. Boral will seek to transport approximately 150,000 tpa of Peppertree Quarry's products from the mine to customers via Marulan South Road. This could be achieved by back loading to the new shared road sales product stockpile area by the trucks carrying the limestone sand to Peppertree Quarry. In total, Boral is seeking to 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, which is approximately 1 km west along Marulan South Road.
Vehicle movements	Approximately 278 light vehicle movements (two way trips) per day and 150 heavy vehicle movements (two way trips) per day and 8-10 heavy vehicle movements (two way trips) or 4-5	An additional 68 heavy vehicle movements (two way trips) or 34 truckloads (one way trips) per average day, which equates to an additional 4–6 heavy vehicle movements (two way

Project component	Existing	Proposed
	truckloads (one way trips) per hour.	trips) or 2 – 3 truckloads (one way trips) per average hour. An additional 116 heavy vehicle movements (two way trips) or 58 truckloads (one way trips) per worst case day, which equates to an additional 10 heavy vehicle movements (two way trips) or 5 truckloads (one way trips) per worst case hour. Therefore, existing and proposed vehicle movements will total 266 heavy vehicle movements (two way trips) or 133 truckloads (one way trips) per worst case day and 20 heavy vehicle movements (two way trips) or 10 truckloads (one way trips) per worst case hour. Light vehicle movements won't change as employee numbers will remain the same.
Water management	The main clean water source for the mine is the 'external' source of Tallong dam, an 85 ML water storage dam leased from the State Rail Authority and located 10 km to the north. Water is transferred to the mine from Tallong Weir via a pipeline. Mine water supply is supplemented by surface runoff collected in water storage dams that is used for dust suppression and two on-site groundwater bores. An agreement was also in place with a local landholder to supply water from a large farm dam, Glenrock dam, should the site ever reach a minimum onsite supply level. This agreement has never been implemented. Potable water supply is provided in 15 L water bottles issued to the mine by the store.	Water supply for the Project, including dust suppression, processing activities and some non-potable amenities will be from existing and new on-site dams and a proposed new 118 ML water storage dam on Marulan Creek. This dam will be on Boral owned land north of Peppertree Quarry and will use Boral's adjoining Tallong water pipeline to transfer water to the mine. This dam will require the purchase of water entitlements. Mine water demand in the earlier stages of the 30-year mine operations will also be supplemented by Tallong dam via the Tallong water pipeline and the groundwater production wells (WP16 and 17) north of the pit. Surface water runoff from active mining areas will drain to a network of sediment basins. Water captured in sediment basins will be pumped to the water storage dams to service the mine's water demand and to restore capacity in the sediment basins.
Operational workforce	Approximately 191 full time personnel are currently employed by Boral in connection with the mine, including lime manufacturing, administration and logistics. This includes 118 personnel on-site (excluding contractor personnel) and another 73 that are employed at other locations e.g. Berrima and	The Project will provide continued direct employment for 118 people on the mine site and 73 offsite.

Project component	Existing	Proposed
	Maldon Cement Works and North Ryde that would otherwise not be employed if it weren't for the mine.	
Hours of operation	24-hours per day, 7 days per week. Blasting is conducted during daylight hours on weekdays, excluding public holidays.	No change.
Blasting frequency	One blast per day on weekdays, excluding public holidays, totalling five blasts per week.	No change.
Key environmental impacts and mitigation measures	Key environmental impacts assessed in the most recent development application for the site, which was a statement of environmental effects for the sand plant, were: ▪ air quality; ▪ water management; ▪ flora and fauna; ▪ visual amenity; and ▪ noise and vibration. Other environmental aspects which received less detailed assessment were: ▪ traffic; ▪ heritage; ▪ bushfire; ▪ waste management; and ▪ hazards.	The following key environmental impacts have been assessed through specialist technical assessments: ▪ surface water and hydrology; ▪ groundwater; ▪ air quality; ▪ noise and blasting; ▪ soils and rehabilitation; ▪ aboriginal heritage; ▪ historic heritage ▪ biodiversity; ▪ traffic; ▪ visual amenity; ▪ economics; ▪ social; and ▪ contamination. These technical specialist assessments have identified environmental management and mitigation measures which are to be implemented during construction and operational phases of the Project, to minimise environmental, social and economic impacts associated with the Project.
Capital investment value	Historical capital investment is unknown as records were not regularly kept during the Mine's lifetime.	$111 million.

Chapter 5

Stakeholder engagement

VOLUME 1

5 STAKEHOLDER ENGAGEMENT

5.1 Introduction

Successful completion of the EIS required consultation with a number of key stakeholders. This chapter provides a summary of the stakeholder engagement undertaken for the Project. **Appendix A** provides a comprehensive compilation of the SEARs along with all Commonwealth and State government agency requirements which have been formulated for the Project.

5.1.1 Assessment requirements

The SEARs in Table 5.1 require consultation with relevant stakeholders during the preparation of the EIS and documentation of the outcomes of the stakeholder engagement process.

Table 5.1: Stakeholder engagement related SEARs

Requirement	Section and appendix where addressed
▪ During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners.	**Chapter 5**; **Chapter 25**; **Appendix A**; **Appendix V**
▪ The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	**Chapter 5** ; **Chapter 25**; **Appendix A**; **Appendix V**

5.1.2 Stakeholder engagement strategy

Having operated at Marulan South for a long time, Boral has a sound understanding of the key stakeholders that have an interest in the mine. A detailed stakeholder engagement strategy and program was developed at the start of the SSD process to guide stakeholder engagement activities.

The focus of the stakeholder engagement program was to identify any relevant concerns stakeholders may have about the Project, ensure these concerns are appropriately considered by the Project team, and where necessary, address these through changes or refinements to the 30-year mine plan and associated infrastructure.

5.1.3 Social Impact Assessment

The SEARs also require an "assessment of the likely social impacts of the development" in accordance with the *Social impact assessment guideline – For State significant mining, petroleum production and extractive industry development* (NSW Department of Planning and Environment, 2017).

To inform the social impact assessment (SIA) for the Project thorough engagement was required with fenceline neighbours, landowners along Marulan South Road, non-government organisations, government agencies, Council and the general public. The SIA report in **Appendix V** and **Chapter 25** of the EIS, provide a summary of all key stakeholder engagement including:

- who was consulted;
- when they were consulted;
- what they were consulted about;
- what issues were raised;

- where follow up consultation or additional research was required to further investigate any issues raised; and
- how these issues were considered in the Project design, and development of impact avoidance, minimisation and management measures.

Therefore, the following sections only summarise engagement with government agencies and Aboriginal community groups that did not raise any specific matters that required further consideration from a SIA perspective and was therefore not presented in **Chapter 25** and/or **Appendix V**.

5.2 Government agency consultation

Table 5.2 provides a summary of government agency consultation and any key issues raised and provides a reference to where in the EIS these issues have been addressed. It captures key outputs from government agency consultation. Where no key outputs arose from government agency consultation, consultation with that government agency has not been captured.

5.3 Continuation of stakeholder engagement

The EIS will be placed on public exhibition to allow for government agencies, organisations, interest groups, stakeholders and community members to review the EIS, seek clarification with Boral on the content of the EIS and provide written submissions if required.

Once the EIS has been exhibited, Boral will prepare a Response to Submissions Report, if required, to address any written submissions, prior to determination of the SSD application.

All relevant stakeholders and the local community will be advised of the public exhibition of the EIS and will continue to be engaged with during the remainder of the SSD process in accordance with the stakeholder engagement strategy and to achieve recommendations from the SIA outlined in **Chapter 25** and/or **Appendix V**.

Table 5.2: Summary of government agency consultation

Stakeholder	Consultation Details	Comments	Response/EIS Section Reference
Department of Planning and Environment (DPE)	DPE has been consulted with throughout the SSD process. Key consultation includes: ▪ Meeting to introduce the Project around the time of lodgement o the PEA and request for SEARs; ▪ Receipt of SEARs and clarification on certain SEARs; ▪ Receipt of supplementary SEARs from DoEE; ▪ Request for extension of SEARs; ▪ Receipt of Site Verification Certificate (SVC); ▪ Meeting to discuss the revised mine plan; and ▪ Adequacy review of the technical studies and lodgement of the EIS.	Other than ongoing consultation with DPE on the status of the SSD process, key formal correspondence from DPE that required consideration in the EIS includes: ▪ SEARs dated 10 June 2015; ▪ Supplementary SEARs from DoEE dated 27 October 2015; and ▪ DPE extension of SEARs timeframe letters dated 8 September 2017 and 25 June 2018 which requested consideration of: - changes to the BC Act and the relevance to biodiversity assessment; - changes to the 'Approved Methods' for air quality assessments and implications for the air quality impact assessment; and - the need to conduct a SIA.	▪ How SEARs have been addressed is outlined in **Section 1.7**, **Appendix A** and the start of chapters of the EIS. ▪ The biodiversity assessment has been prepared in accordance with the biodiversity assessment methodology under the BC Act (**Chapter 12** and **Appendix K**); ▪ The air quality assessment has been prepared in accordance with the revised 'approved methods' (**Chapter 17** and **Appendix P**); and ▪ An SIA has been conducted in accordance with the SIA guidelines (**Chapter 25** and **Appendix V**).
Commonwealth Department of Environment and Energy (DoEE	DoEE has been consulted with throughout the SSD process. Key consultation includes: ▪ Meeting to introduce the Project prior to the lodgement of the EPBC Referral; ▪ Lodgement of the EPBC Referral; ▪ Receipt of confirmation of controlled action; ▪ Receipt of supplementary SEARs; and ▪ Teleconference to discuss how to deal with the overlap of impacts on critically endangered ecological communities associated with the Peppertree Quarry Modification 5 and the mine's SSD application.	Other than regular consultation with DoEE on the EPBC referral process, controlled action determination and status of the SSD process, key formal correspondence from DoEE that required consideration in the EIS is in the supplementary SEARs from DoEE dated 27 October 2015. In a teleconference held with DoEE on 11 February 2019, Boral explained that they had spoken to DP&E about the intention to keep the overlapping overburden emplacement area (SWOE in the Peppertree Quarry Modification 5 and NOE in the mine's SSD application) in both the Peppertree Quarry Modification 5 application and the mine's SSD application as it was unknown which one would be approved first. Boral explained that whichever project was approved first would be required to offset the impacts associated with the disturbance footprint of the overlapping overburden emplacement area and the same amount of credits would be removed from the project approved second	The only Matter of National Environmental Significance that will be impacted by the Project is a critically endangered ecological community which is assessed in **Chapter 12** and **Appendix K**.

Stakeholder	Consultation Details	Comments	Response/EIS Section Reference
		so that there wasn't double counting of biodiversity offset liabilities. DoEE agreed to this approach in principle but wanted to speak to DP&E to discuss the approach further.	
NSW Department of Primary Industries (Office of Water (NoW)) (a division of NSW Trade and Investment)	A meeting was held on-site in December 2015. The purpose of the meeting was to discuss the preliminary findings of the surface water and groundwater assessments conducted for the EIS, undertake a site inspection of the mine site and proposed Marulan Creek dam location, and discuss any key concerns of DPI in regards to assessment or licencing of the Project. Further correspondence with DPI-Water between 2015 and 2018 included telephone and email correspondence as well as a meeting at DPI-Water's offices in Nowra on 16 June 2017 to present the revised mine plan and discuss the proposed surface water management approach.	Key points from correspondence with DPI Water include: ▪ DPI advised the following in terms of proposed storage dams: - Harvesting catchment runoff (clean water) dams need to be within harvestable rights for both the existing and proposed dams. If the total dams exceed the harvestable rights limit, then licensing would be required for the storage of water. - Dams to be used to capture sediment laden runoff, that is then used to pump out and suppress dust, do not need to be included in the harvestable rights calculations. ▪ DPI advised that in-river dams are not supported in the area, however as the Project is State Significant Development, in-stream dams may be considered, but would be bound by the water sharing plan rules, and a Water Access Licence is required. Boral would therefore be required to purchase enough entitlements to cover the water usage proposed from the Marulan Creek dam. ▪ DPI advised that there are 1175.5 ML of licensed entitlements in the Barbers Creek catchment under 11 licences. ▪ DPI confirmed that Boral must explore all feasible options for mine water supply as an alternative to the proposed Marulan Creek dam. There needs to be a strong justification for the proposed dam. ▪ DPI advised that any groundwater take needs to be accounted for by purchasing the appropriate allocations. ▪ DPI advised that the agency do not have a process within their licensing regime for accounting for returning flows/groundwater recharge on mine sites, and it is currently unclear how this would be considered by DPI in terms of licensing. DPI would investigate further and advise Boral accordingly.	Surface water is assessed in **Chapter 8** and **Appendix G** and groundwater is assessed in **Chapter 9** and **Appendix H**.

Stakeholder	Consultation Details	Comments	Response/EIS Section Reference
		▪ DPI advised that there are large quantities of water in the Goulburn Fractured Rock Groundwater Source and that: - Boral can trade allocations, as is the case with surface water; and - From time to time there are controlled allocations, which are allocated through a tender process, usually at the end of each year.	
Department of Planning and Environment – Division of Resources and Geoscience (DPE-DRG)	DPE-DRG has been consulted with throughout the SSD process which has included numerous phone calls and meetings to discuss: ▪ the MoP; ▪ the Project mine plan; ▪ the approach to maximising limestone extraction and resource sterilisation; ▪ the approach to rehabilitation; and ▪ the approach to surface water management.	DPE-DRG did not raise any further specific requirements not already covered by their requirements in the SEARs.	**Chapter 4** presents the mine plan and approach to rehabilitation and water management for each stage; **Chapter 26** presents the rehabilitation strategy; **Appendix D** includes the geological report that specifically addresses DPE-DRG SEARs; and **Appendix I** contains the soils, land resources and rehabilitation assessment.
Environment Protection Authority (EPA)	**NSW EPA Air Technical Advisory Services Unit** Todoroski Air Sciences Pty Ltd contacted EPA on 11 November 2015 to discuss the methodology for the air assessment in general terms.	▪ Todoroski advised EPA that a standard methodology, per the EPA's Approved Methods and also the CALPUFF modelling guidelines are being followed for the Air Quality Impact Assessment. ▪ Todoroski advised that total cumulative impacts, including proposed modifications to the adjoining Peppertree Quarry were included in the assessment, and that both projects have been planned/optimised to reduce net impacts to the surrounding community. ▪ Todoroski offered to provide additional details upon request of the EPA. ▪ The EPA advised they encourage the application of its guidelines in such assessments, and would be able to provide any detailed comments upon review of the submitted Air Quality Impact Assessment. ▪ No specific issues that the mine would not be aware of are known by EPA.	Air quality is assessed in **Chapter 17** and **Appendix P**

Stakeholder	Consultation Details	Comments	Response/EIS Section Reference
	A meeting was held at EPA's offices in Queanbeyan on 15 June 2017 to present the revised mine plan and discuss the preliminary results of the noise and air quality assessments as well as the proposed surface water management approach.	No key issues were raised that required specific consideration outside of those already included in EPA's requirements in the SEARs.	Air quality is assessed in **Chapter 17** and **Appendix P**, noise and blasting are assessed in **Chapter 19** and **Appendix R** and Surface water is assessed in **Chapter 8** and **Appendix G**.
Office of Environment and Heritage (OEH)	**NSW OEH Assessment Team – Ecosystem Management Science** As part of the Assessment of Biophysical Strategic Agricultural Land (BSAL), undertaken to support application for a Site Validation Certificate (SVC) for the Project, LAMAC Management Pty Ltd exchanged email correspondence with members of the OEH between the 28 April and 28 October 2015. In these emails, the scope of ground disturbance associated with the Project was discussed, along with the assessment requirements outlined in the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land*.	As well as providing general advice on the BSAL assessment process, OEH advised on: ▪ The area that should be included in the BSAL assessment; ▪ Soil analysis requirements, and suitability of the proposed analytical laboratory; and ▪ Reporting requirements, such as the inclusion of suitable quality soil profile photos and completion of BSAL site cards.	All comments and recommendations provided by the OEH Assessment Team, Ecosystem Management Science, were incorporated into the Project BSAL Assessment Report, as part of the Site Verification Certificate application. These comments are also integrated into Section 3 of the soil, land resources and rehabilitation assessment (**Appendix I**).
	NSW OEH - South Branch Regional Office As part of the Aboriginal Cultural Heritage Assessment (ACHA), EMM Consulting Pty Ltd undertook substantial and ongoing consultation with the OEH archaeologist via phone and email throughout the ACHA process.	Key points from correspondence with OEH on the ACHA include: ▪ OEH considered the proposed survey, consultation and test excavation methods to be sound and appreciated the opportunity to discuss the Project prior to reporting; ▪ Aboriginal group opposition to the test excavation method was noted and OEH advised a change to the excavation method in order to accommodate the wishes of the Aboriginal groups; ▪ The OEH archaeologist noted that the potential impacts on an identified cultural site will be the	▪ The method for the test excavation was altered. ▪ Registered Aboriginal Parties (RAP) for the Project were updated on the change to the methodology. ▪ Further investigation was completed on the cultural site and the potential impacts. The ACHA is summarised in **Chapter 15** and included in **Appendix N**.

Stakeholder	Consultation Details	Comments	Response/EIS Section Reference
		determining factor in the analysis required. Should the site be impacted, further analysis was considered a necessity to provide OEH and DPE with the required information to make an appropriate decision.	
	NSW OEH – South East Branch, Queanbeyan Boral held a teleconference with OEH on 21 February 2019 to discuss the approach that had been taken in preparing the Biodiversity Development Assessment Report (BDAR).	Boral advised in the teleconference with OEH that the BDAR for the Project had been prepared in accordance with the Biodiversity Assessment Methodology (BAM) and had also considered the comments made by OEH on the Peppertree Quarry Modification 5 BDAR. OEH confirmed that they were satisfied with this approach.	Terrestrial Biodiversity is assessed in **Chapter 12** and in **Appendix K**.

5.4 Aboriginal community groups

The Aboriginal heritage specialists (EMM Consulting Pty Limited – EMM) consulted the Aboriginal community in accordance with:

- Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010); and
- Interim Community Consultation Requirements for Applicants (DEC, 2005).

Each private Aboriginal organisation or individual who responded with a written request to be registered for consultation is referred to as a 'registered aboriginal party' (RAP). Government agencies who registered interest were also consulted in parallel with RAPs.

Details of consultation are provided in Appendix A of the ACHA.

5.4.1 Stage 1 – notification and registration of Aboriginal parties

Agency contact

A letter requesting advice on which Aboriginal parties to invite for consultation and all known heritage matters to be taken into consideration was posted to the following groups on 2 February 2014:

- OEH – South East Region;
- Pejar Local Aboriginal Land Council (PLALC);
- Council;
- South East Local Land Service (replacing the Catchment Management Agency);
- National Native Title Tribunal;
- The office of the Registrar of Aboriginal Owners; and
- NTSCorp.

Responses were received from all agencies and are in Appendix A of the ACHA.

Press advertisement

A public notice was placed in the *Goulburn Post* newspaper on 2 February 2015 seeking registrations of interest from Aboriginal parties. A copy of the notice is in Appendix A of the ACHA. No responses to the public notice were received.

Invitation to register to Aboriginal stakeholder groups

Letters were sent via post and email to the parties listed by the government agencies, inviting written registration on 19 February 2015. Those letters which did not receive a response were followed up with a phone call and email where these details were provided.

Registered Aboriginal Parties

The RAPs who registered an interest in being consulted for the Project are in Table 5.3.

Table 5.3: List of RAPs for the Project

Organisation	Contact Name
Pejar Local Aboriginal Land Council	Delise Freeman
Mr Peter Falk Consultancy	Peter Falk
Buru Ngunawal Aboriginal Corporation	Walter Bell
Gundungurra Aboriginal Heritage Association Inc	Sharyn Halls

Organisation	Contact Name
King Brown Tribal Group	Carl Brown
Koomurri Ngunawal Aboriginal Corporation	Donna Dobson
Corroboree Aboriginal Corporation	Steve Johnson
Murri Bidgee Mullangari Aboriginal Corporation	Darleen Johnson
Nundagurri Aboriginal Corporation	Aaron Broad
Walbunja Aboriginal Corporation	Hike Tekowhai
Wullung	Leeroy Bota
Badu	Karia Bond
Yerramurra	Nicholas Glover
Merrigarn Aboriginal Corporation	Shaun Carroll
Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman
Duncan Falk Consultancy	Duncan Falk
Thunderstone Aboriginal Cultural and Land Management Services	Tyronne Bell
Ngunawal Heritage Aboriginal Corporation	Dean Delponte
Gunyuu	Darlene Hoskins-Mackenzie

5.4.2 Stages 2 and 3 – presentation of information and request for cultural information

Distribution of information

A letter presenting information about the Project and describing the proposed assessment method was issued on 13 March 2015 via email to all RAPs. No comments were received on Project and method information.

Consultation meeting 1

A meeting was held on 25 March 2015 at the mine office and was attended by EMM, Boral and RAP representatives. Project information, survey strategy and the possibility of test excavation for the Project was presented.

Test excavation

After the site survey, the need for test excavation was confirmed. It was identified that due to the number of test pits required, controlled machine excavation would be needed in some areas and was added to the test excavation method. RAPs were sent a letter on 8 May 2015 detailing the updated method and requesting comment. The following comments were received:

- Gundungurra Aboriginal Heritage Association Inc noted agreement with the test excavation method;
- Badu noted their opposition to machine excavation and dry sieving;
- Gulgunya Ngunawal Heritage Aboriginal Consultancy expressed their opposition to the use of a machine for excavation;
- Koomuri Ngunawal Aboriginal Corporation expressed their opposition to the use of a machine for excavation;
- Murra Bidgee Mullangari Aboriginal Corporation expressed their opposition to the use of a machine for excavation; and
- Peter Falk Consultancy expressed their opposition to the use of a machine for excavation.

As a result of the comments and in consultation with OEH, the test excavation method was revised to include excavation of the first test pit in each landscape area by hand to record stratigraphy, prior to continuing with machine excavation.

5.4.3 Stage 4 – review of draft Aboriginal cultural heritage report

Distribution of draft report

The draft ACHA has undergone two RAP review periods. The first draft report and summary cover letter was issued to RAPs by email on 27 November 2015, with a four week review period. Towards the end of the review period telephone calls were made to the RAPs to request a response, answer questions and offer more time if required.

A second draft review period was offered to account for the changes to the Project and impact assessment between early 2016 and December 2017. This version of the draft report and a summary cover letter was issued to RAPs by email on 13 August 2018, with a 28 day review timeframe.

Consultation meeting 2

A meeting to discuss and review the first draft ACHA was held at the mine administration building on 10 December 2015. The purpose of the meeting was to:

- present the results of field survey completed to date;
- present updated project information;
- invite feedback from Aboriginal stakeholders on Aboriginal heritage places, stories, or traditions relevant to the assessment;
- present draft management and mitigation strategies for potential impacts to Aboriginal heritage values; and
- provide the opportunity to discuss the proposed management and mitigation strategies.

Present at the meeting were Rebecca Newell (EMM), Pamela Chauvel (EMM), Rod Wallace (Boral), Vince Scarella (Boral), Kate Waters (Waters Consultancy), Korey Moon (Waters Consultancy), Tyronne Bell (Thunderstone), Tammy Muscat (NHAC), Glen Freeman (KNAC/GNHAC).

Attendees were updated on the test excavation method and results, followed by an outline of the proposed management strategies.

During the consultation process, an Aboriginal stakeholder identified an area of Marulan Creek as a site of Aboriginal cultural significance.

Kate Waters of Waters Consulting, who was engaged to assess the cultural site explained her approach in assessing intangible heritage. She advised that her process begins by asking stakeholders to identify knowledge holders. She acknowledged that this is a sensitive issue and it is important to find out who can speak for country. Her process then involved examining the whole cultural landscape in order to contextualise and understand the site under investigation including looking at documentary and other evidence. Other issues raised by the RAPs at the meeting are included in **Appendix N**.

Response to comments

The issues raised in response to the draft report are provided in the RAP letters and consultant's responses in Appendix A of the ACHA. Comments from RAPs were only provided during the first ACHA review period in 2015. No comments were received for the draft ACHA review period in 2018.

Consultation during Project re-design

The RAPs were kept informed of the revision of the mine plan via written communications. EMM sent letters to all RAPs on 28 October 2016 and again on 9 November 2017 informing them that the Project was still in progress. All were invited to contact EMM if they required clarification. The letters explained that the revised mine plan would not extend into areas not previously considered as part of the survey and test excavation program completed for the Project and therefore additional fieldwork was not required.

In February 2018, RAPs were notified about the proposed Peppertree Quarry Modification 5.

Chapter 6

Planning framework

VOLUME 1

6 PLANNING FRAMEWORK

6.1 Introduction

This chapter summarises the Commonwealth and NSW regulatory and policy framework for state significant development. Several approvals are require including; Commonwealth approval under the EPBC Act and development consent is required under Division 4.7 of the EP&A Act. This chapter describes the assessment pathway under these pieces of legislation and identifies other approvals under State and Commonwealth legislation which are required.

6.1.1 Assessment requirements

The SEARs require the EIS to address legislative and policy requirements, which are listed in **Table 6.1**.

Table 6.1: Legislation and policy related SEARs

Requirement	Section and appendix where addressed
▪ The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000.	**Section 6.3.6**
▪ a list of any approvals that must be obtained before the development may commence;	**Section 6.5**
▪ consideration of the development against all relevant environmental planning instruments (including Part 3 of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007);	**Section 6.4**

6.2 Commonwealth legislation

6.2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides the legal basis to protect and manage internationally and nationally important flora, fauna, ecological communities, heritage places and water resources which are deemed to be matters of national environmental significance (MNES). MNES, as defined under the EPBC Act, are:

- world heritage properties;
- places listed on the National Heritage Register;
- wetlands of international significance listed under the Ramsar Convention;
- threatened flora and fauna species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining); and
- water resources, in relation to coal seam gas or large coal mining development.

Under the EPBC Act, actions that will, or are likely to, have a significant impact on a MNES are deemed to be controlled actions and can only proceed with the approval of the Commonwealth Minister for the Environment. An action that may potentially affect a MNES has to be referred to the DoEE for determination as to whether it is a controlled action.

The Project was referred to the Department of the Environment and Energy (then DoE, now DoEE) in July 2015 for consideration as a controlled action, based on potential impacts to listed threatened species and communities. The Project was deemed a controlled action by DoEE on 14 September 2015 on the basis that it may impact listed threatened species and communities (sections 18 and 18A of the EPBC Act).

The DoEE accredited the NSW SSD assessment process for the Project, and its assessment requirements were provided as supplementary SEARs from DPE on 27 October 2015. The DoEE's requirements are reproduced in **Appendix A**.

The potential impacts on listed threatened species and communities are addressed in detail in **Appendix K** and summarised in **Chapter 12**.

6.2.2 Native Title Act 1993

The Commonwealth *Native Title Act 1993* recognises and protects native title rights in Australia. It allows a native title determination application (native title claim) to be made for land or waters where native title has not been validly extinguished, for example, extinguished by the grant of freehold title to land.

Applications for compensation for extinguishment or impairment of native title rights can also be made. All native title claims are subjected to a registration test and will only be registered if claimants satisfy a number of conditions. A register of native title claims is maintained by the National Native Title Tribunal.

Proposed activities or development that may affect native title are called 'future acts'. Claimants whose native title claims have been registered have the right to negotiate about some future acts, including mining and granting of a mining lease over the land covered by their native title claim. Where a native title claim is not registered, a development can proceed through mediation and determination processes, though claimants will not be able to participate in future act negotiations.

Native Title matters will be considered during the mining lease application covering new mining areas.

6.2.3 National Greenhouse and Energy Reporting Act 2007

The Commonwealth *National Greenhouse and Energy Reporting Act 2007* (NGER Act) provides a single national framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas projects, and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds.

Boral triggers the threshold for reporting under the NGER Act, and reports energy use and greenhouse gas emissions from its operations, including the mine.

Boral will continue to monitor and report energy use and greenhouse gas emissions associated with the Project under its obligations under the NGER Act.

6.3 Environmental Planning and Assessment Act 1979

6.3.1 Overview

The EP&A Act and NSW Environmental Planning and Assessment Regulation 2000 (EP&A Regulation) form the statutory framework for planning approval and environmental assessment in NSW. Implementation of the EP&A Act is the responsibility of the Minister for Planning, statutory authorities and local councils. It contains three parts that impose requirements for planning approval:

- Part 4, which provides for control of 'development' that requires development consent from the relevant consent authority. A division of Part 4 (Division 4.7) provides for the assessment of SSD where the Minister for Planning (or delegate) or the Independent Planning Commission is the consent authority.
- Part 5, which provides for control of 'activities' that do not require approval or development consent under Part 4.
- Division 5.2, which provides for control of State significant infrastructure that does not require approval or development consent under Part 4.

The requirement for development consent is set out in environmental planning instruments (EPIs), being SEPPs or local environmental plans (LEPs).

6.3.2 State significant development

Part 4, Division 4.7 of the EP&A Act relates to the assessment of development deemed to be significant to the State (ie SSD). Under Section 4.36(2) a development is SSD if it is declared by a SEPP. The relevant SEPP to the Project is the State Environmental Planning Policy (State and Regional Development) 2011 (the SRD SEPP). In relation to SSD, Clause 8(1) of the SRD SEPP states the following:

8 Declaration of State significant development: 8C

1. Development is declared to be State significant development for the purposes of the Act if:
   a. the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and
   b. the development is specified in Schedule 1 or 2.

Schedule 1 of the SRD SEPP identifies development for the purpose of mining with a capital investment value (CIV) over $30 million as SSD. In addition, development for the purposes of mining is permissible with development consent in the Project site, as discussed in **Section 6.3.3**. Accordingly, the Project is SSD and will be subject to the provisions of Division 4.7 of Part 4 of the EP&A Act.

Under Section 4.5(a) of the EP&A Act, the Minister for Planning is the consent authority for SSD. However, pursuant to clause 8A(1), the Independent Planning Commission (IPC) will be the consent authority if:

- Council objects to the Project; and/or
- at least 25 persons (not including Council) object to the Project; and /or
- Boral have made a reportable political donation in connection with the Project.

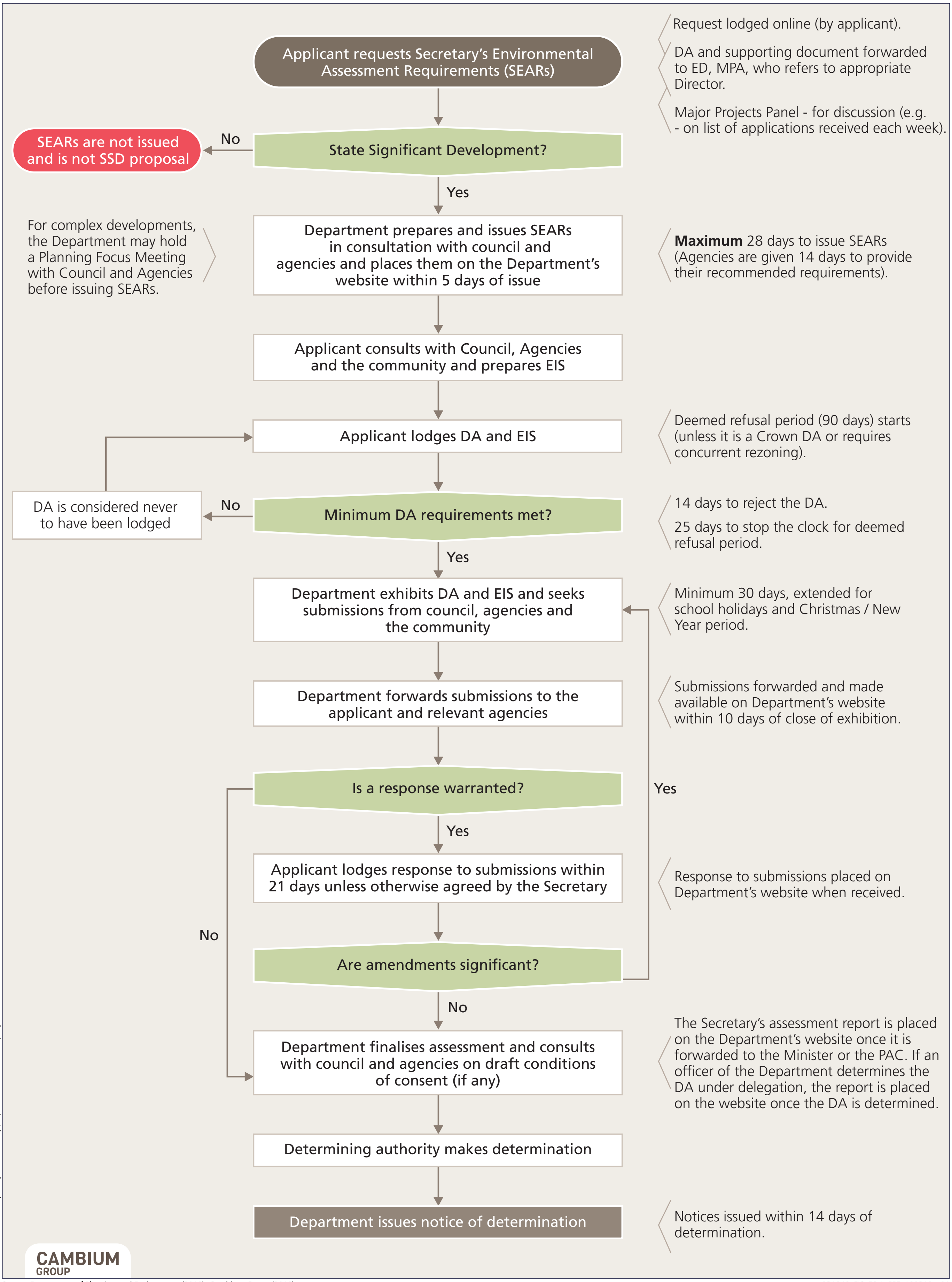
A development application (DA) for SSD must be accompanied by an EIS in accordance with Section 4.12(8) of the EP&A Act and the EIS must be prepared in accordance with the EP&A Regulation. Before preparing an EIS, an applicant must request the Secretary's environmental assessment requirements (SEARs), which specify the issues to be addressed in the EIS. The

SEARs for the Project were issued by DPE on 10 June 2015 and are provided in **Appendix A**. The Project was also declared a controlled action on 14 September 2015 by the DoE. Accordingly, the DoE issued supplementary SEARs to address MNES relevant to the Project. The supplementary SEARs are also included in **Appendix A**. Appendix A also identifies the sections of the EIS where the SEARs have been addressed.

The planning assessment process for SSD under Division 4.7 of Part 4 of the EP&A Act is shown in **Figure 6.1**.

The relevant factors in the assessment and determination of the Project are addressed in the following sections.

Figure 6.1
State Significant Development planning process flowchart



Source: Department of Planning and Environment (2018), Cambium Group (2019).

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6.3.3 Permissibility

Most of the Project site is zoned RU1 Primary Production under the Goulburn-Mulwaree Local Environmental Plan 2009 (LEP) and two small areas in the south-east of the Project area are zoned E3 Environmental Management, as shown on Figure 2.3.

Development for the purposes of mining is permitted with consent in the RU1 zone. However, mining is not permitted in the E3 zone.

Permissibility of mining developments is also governed by State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP), which prevails over any inconsistencies with a LEP. Clause 7 of the Mining SEPP defines mining development that can be undertaken with development consent. Clause 7(1) of the Mining SEPP states the following:

1. Mining

   Development for any of the following purposes may be carried out only with development consent:

   a. mining carried out:

      i. on land where development for the purposes of agriculture or industry may be carried out (with or without development consent), or

Under clause 3 of the Mining SEPP, 'mining' is defined as:

Mining means the winning or removal of materials by methods such as excavating, dredging, or tunnelling for the purpose of obtaining minerals, and includes:

a. the construction, operation and decommissioning of associated works, and
b. the stockpiling, processing, treatment and transportation of materials extracted, and
c. the rehabilitation of land affected by mining.

As agriculture is permitted in the E3 zone with consent, mining is also permitted in this zone under the Mining SEPP with consent.

6.3.4 Objects of the Act

The objects of the EP&A Act are specified in Section 1.3 of the Act, and seek to promote the management and conservation of natural and artificial resources, while also permitting appropriate development to occur. The consistency of the Project with the objects of the Act is considered in **Table 6.2**.

Table 6.2: Objectives of the EP&A Act

Objectives of the EP&A Act	Consistency of the Project
1) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,	Specialist consultants have been engaged to assess and report on the potential for the Project to impact upon the natural and artificial resources of the Project area. Notably: ▪ impacts on the natural environment have been addressed in **chapters 8** to **26** of this EIS; and ▪ social and economic implications have been addressed in **chapters 24** and **25**.
2) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about	The Project is consistent with the principles of ecological sustainable development (ESD) as outlined in **Section 6.3.5**.

Objectives of the EP&A Act	Consistency of the Project
environmental planning and assessment,	
3) to promote the orderly and economic use and development of land,	The orderly and economic use of land is best served by development which is permissible under the relevant planning regime and predominantly in accordance with the prevailing planning controls. The Project comprises a permissible development which is consistent with the statutory and strategic planning controls. As detailed in this EIS, the Project will result in positive economic impacts, with appropriate mitigation measures and management strategy being proposed to reduce any adverse environmental and social impacts.
4) to promote the delivery and maintenance of affordable housing,	Not applicable to the Project.
5) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,	Specialist consultants have been engaged to assess and report on the potential for the Project to impact upon the local environment. Notably, the impacts on flora and fauna have been addressed in **Appendix K** and **chapters 12, 13** and **14**.
6) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),	Specialist consultants have been engaged to assess potential impacts on historic and Aboriginal cultural heritage, as described in **chapters 15** and **16**. The Project has been designed to avoid impacts on historic and Aboriginal cultural heritage where possible. Management measures will be implemented to minimise and mitigate impacts where unavoidable.
7) to promote good design and amenity of the built environment,	A polycentric decision making approach has been adopted in the design of the 30-year mine plan and associated infrastructure as outlined in **Section 7.1**. Specialist consultants have been engaged to assess potential noise, air quality and visual impacts on sensitive receivers, as described in **chapters 19**, **18** and **20**. Design changes have occurred to avoid impacts in the first instance and management measures proposed to minimise and mitigate residual impacts.
8) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,	Not applicable as the Project does not involve the construction of buildings. However, existing buildings will be maintained and any potentially hazardous substances managed in accordance with relevant legislation as described in **chapters 11** and **23**.
9) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,	As outlined in **Section 6.3**, the Project is subject to the provisions of Part 4 of the EP&A Act, and the Minister for Planning or Independent Planning Commission will be the consent authority. Despite this, Goulburn Mulwaree Council, as local government authority, have been regularly consulted throughout the planning phase of the Project and preparation of this EIS (refer to **Chapter 5**). As such, it is deemed that both local and state levels of government have been provided with sufficient opportunities to share in responsible environmental planning of the Project.
10) to provide increased opportunity for community participation in environmental planning and assessment.	As outlined in **Chapter 5** and **Chapter 25**, Boral has undertaken significant consultation in relation to the Project with government agencies, the local community and other stakeholders. This consultation process is ongoing. Any relevant public representations will need to be considered by DPE during the assessment of the development application.

6.3.5 Ecologically sustainable development

One of the objects in Section 1.3 of the EP&A Act is "to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment". Section 1.4 (Definitions) of the EP&A Act defers to the NSW *Protection of the Environment Administration Act 1991* (POEA Act) for a definition of ESD. Section 6.2(2) of the POEA Act defines ESD as:

> …ecologically sustainable development requires the effective integration of social, economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following principles and programs:

a. the precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

   In the application of the precautionary principle, public and private decisions should be guided by:

   i. careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
   ii. an assessment of the risk-weighted consequences of various options,

b. inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,
c. conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,
d. improved valuation, pricing and incentive mechanisms—namely, that environmental factors should be included in the valuation of assets and services, such as:

   i. polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,
   ii. the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,
   iii. environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The following sections consider the relation of the Project to ESD.

Precautionary principle

Where there are threats of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage.

As described in **Section 2.2.1**, baseline environmental characteristics have been monitored since 2012 to understand the condition of the existing environment at and around the mine, and to understand the environmental impacts of existing operations. This extensive baseline data has been used by the technical specialists to predict the environmental impacts of continued mining.

As described in **Chapter 7**, environment aspects requiring assessment and weightings apportioned to them in terms of size and duration of impact were considered during a risk workshop attended by senior Boral personnel and technical specialists. Potential Project risks to the environment were rated as described in **Section 7.1.1**, and the level of assessment detail for each risk was proportional to the risk rating.

Proposed Project options were discussed during the risk assessment workshop, which resulted in optimisation of Project elements based on the interactions of the Project's profitability, location of target resources and environmental constraints. This 'polycentric' approach to Project and EIS technical study optimisation is described in **Section 7.1**.

Where serious or irreversible damage to the environment is likely to be unavoidable, management measures and/or compensatory measures (for example the biodiversity offset strategy in **Section 12.5.1**) have been proposed.

Inter-generational equity

Inter-generational equity is the concept that the present generation should ensure the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

As described in **Section 4.5**, the 30-year mine plan will target approximately 120 Mt of limestone, out of a total approximate resource of 600 Mt. Therefore, there will be resource available for future generations to economically exploit assuming a suitable market into the future. As described in **Section 4.5**, elements of mine infrastructure will be moved so that any sterilisation of the resource is minimised.

As described in **chapters 8**, **9**, **17**, and **10**, the mine will not have significant impacts on surface and ground water availability or quality, air quality or agricultural land. Therefore, the Project will not detract from future generation's access to and equal enjoyment of water, air and agricultural resources.

As described in **Chapter 12**, the Project will have a significant impact on threatened species and an ecological community. However, biodiversity offsets will be provided to compensate for these impacts, which protect other areas of native vegetation into perpetuity for the enjoyment of future generations.

Conservation of biological diversity and ecological integrity

This is the concept that conservation of biological diversity and ecological integrity should be a fundamental consideration.

As described in **Chapter 12**, the Project will have a significant impact on threatened species and an ecological community, with the biodiversity specialist predicting a significant impact on Koala and Large-eared Pied Bat habitat; and Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands threatened ecological community (TEC).

As described in **Section 12.5.1**, Boral will offset these impacts by purchasing properties that contain similar habitat and vegetation to the impacted areas. The vegetation on these properties will be protected into perpetuity, which will have the net benefit of increasing the area of protected biodiversity in NSW.

Improved valuation, pricing and incentive mechanisms

This is the concept that environmental factors should be included in the valuation of assets and services.

Cost benefit analysis (CBA) was used to estimate the economic benefit of the Project to Australia and NSW, which is in Appendix U and summarised in **Section 24.2**. It subtracted the production and environmental costs from the production benefits of the Project to determine the net cost/benefit to society. The costs of water extraction, road upgrades and purchase and maintenance of biodiversity stewardship sites were included in the capital and operating costs of the Project.

The costs associated with greenhouse gas generation, using a shadow price per tonne of CO_2 equivalent, and the values of the directly impacted heritage items, were included as costs on the CBA. Other environmental aspects such as noise, air quality and visual impacts to sensitive receivers were not costed as there will not be any residual impacts related to these aspects.

The CBA determined the Project will have a maximum net benefit of $643 million to Australia and $321 million to NSW. Any unquantified residual impacts of the Project after mitigation, offset and compensation would need to be valued at greater than these amounts for the Project to be questionable from an economic efficiency perspective.

6.3.6 Environmental Planning and Assessment Regulation 2000

Section 4.39 of the EP&A Act refers to the EIS form and content provisions of the Environmental Planning and Assessment Regulation 2000 (EP&A Regulation). Schedule 2, clauses 6 and 7, of the EP&A Regulation describes the requirements for the form and content of an EIS, which are considered in **Table 6.3**.

Table 6.3: EIS requirements

Details	Commentary
Clause 6 - Form of environmental impact statement: An environmental impact statement must contain the following information:	
1) The name, address and professional qualifications of the person by whom the statement is prepared;	Certification page
2) The name and address of the responsible person;	Certification page
3) The address of the land: a) in respect of which the development application is to be made, or b) on which the activity or infrastructure to which the statement relates is to be carried out,	**Appendix C**
4) A description of the development, activity or infrastructure to which the statement relates;	**Section 1.3**, **Chapter 4**
5) An assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule; and	**Chapters 8-26**
6) A declaration by the person by whom the statement is prepared to the effect that: a) the statement has been prepared in accordance with this Schedule, b) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and c) that the information contained in the statement is neither false nor misleading.	Certification page
Clause 7 – Content of environmental impact statement 1) An environmental impact statement must also include each of the following:	
a) a summary of the environmental impact statement;	Executive summary
b) a statement of the objectives of the development, activity or infrastructure;	**Section 1.4**

Details	Commentary
c) an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure;	**Chapter 28**
d) an analysis of the development, activity or infrastructure, including: i) a full description of the development, activity or infrastructure;	**Chapter 4**
ii) a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected;	**Chapter 2**, **Chapters 8-26**
iii) the likely impact on the environment of the development, activity or infrastructure;	**Chapters 8-26**
iv) a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment; and	**Chapters 8-26**, **Chapter 29**
v) a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out.	**Section 6.5**
e) a compilation (in a single section of the environmental impact statement) of the measures referred to in item (d) (iv),	**Chapter 29**
f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4).	**Section 1.2**, **Section 6.3.5**, **Section 7.1**, **Chapter 28**
2) Not applicable to the Project. 3) Not applicable to the Project.	
4) The principles of ecologically sustainable development [ESD] are as follows:	**Section 6.3.5**
a) the **precautionary principle,** namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and ii) an assessment of the risk-weighted consequences of various options.	As above
b) **Inter-generational equity**, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,	As above
c) **conservation of biological diversity and ecological integrity**, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,	As above
d) **improved valuation, pricing and incentive mechanisms**, namely, that environmental factors should be included in the valuation of assets and services, such as:	As above

Details	Commentary
i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, ii) the users of goods and services should pay prices based on the full lifecycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.	

Clause 50A of the EP&A Regulation refers to the need for a site verification certificate (SVC) where mining is proposed on biophysical strategic agricultural land (BSAL). It refers to the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007, which outlines the process to secure a SVC. Refer to **Section 6.4.1** for additional context regarding the application of a SVC to the Project.

6.3.7 Section 4.15 matters for consideration

The consent authority is required to consider the matters in Section 4.15 of the EP&A Act when determining a DA for SSD. Matters relating to the Project are considered in the following pages.

Environmental planning instruments

The LEP and Mining SEPP are addressed in **Section 6.3.3**, the SRD SEPP is considered in **Section 6.3.2** and other EPIs are considered in **Section 6.4**.

The regulations

Requirements of the EP&A Regulation are considered in **Section 6.3.6**.

Likely impacts of the development

The technical assessments have assessed impacts to the natural and built environments, and social and economic impacts, which are in **appendices G** to **V** and summarised in **chapters 8** to **26**. The technical assessments were prepared using the most recent and accurate scientific data relevant to the Project. The technical assessments adopted conservative assumptions so the upper limit of likely impacts could be assessed.

Suitability of the site

The site is suitable for the proposed development as it contains a limestone resource as described in **Section 2.2.4** and is the site of an existing mine that has been in operation since 1830, with infrastructure that will continue to be used for the Project as described in **chapters 3** and **4**.

Submissions

This EIS will be placed on public exhibition by DPE and submissions will be sought from Council, government agencies and the community. Any submissions received by DPE will be reviewed and forwarded to Boral for consideration in the response to submissions report (RTS).

Following receipt of the RTS, DPE will prepare its assessment report having regard tothe matters raised in this EIS, all submissions received during the exhibition process and the RTS.

Public interest

This EIS includes a justification for the Project in **Section 1.2**, which considers the potential environment, social and economic impacts of the Project to assist the consent authority to determine if the Project is in the public interest. The EIS also considers the principles of ESD in **Section 6.3.5**.

Compliance with non-discretionary development standards

The Project's compliance with the non-discretionary standards in clause 12AB of the Mining SEPP are considered in **Section 6.4.1**.

6.3.8 Legislation to be applied consistently with an approval

The Project will require other authorisations under NSW legislation, some of which cannot be refused under Section 4.42 of the EP&A Act provided the project is consistent with an approval for SSD granted under the EP&A Act. Authorisations relevant to the Project are considered in the following pages.

Mining Act 1992

As described in **Section 3.3**, CML 16, held by Boral, covers an area of approximately 616.5 ha, which includes land owned by Boral, Crown Land (adjoining to the south and east) and five privately owned titles. CML 16 was granted for the purpose of prospecting and mining for agricultural lime, clay/shale, iron minerals, limestone, marble, and structural clay.

The Project will extend into areas currently outside the boundary of CML 16. As such, a new mining lease application would be lodged for Boral to develop and mine these lands.

In accordance with Clause 65 of the Mining Act, a mining lease cannot be granted until such a time that appropriate development consent is in force with respect to the carrying out of permitted activities on the land in question.

This EIS has been prepared to facilitate the granting of development consent under Part 4 of the EP&A Act. If development consent is granted Boral would commence application for a new mining lease in accordance with Part 5 of the Mining Act, to cover additional lands to be disturbed as part of the Project.

Protection of the Environment Operations Act 1997

Under Section 48 of the POEO Act, an EPL is required for premises-based activities listed in Schedule 1 of the Act.

Crushing, grinding or separating activities with a capacity to process more than 150 t of materials per day or 30,000 tpa, and land based extractive activities involving the extraction, processing or storage of more than 30,000 tpa of extractive materials, are scheduled activities under the Act.

Environment Protection Licence 944 applies to existing operations at the mine. The need for a new licence or variation to the existing EPL for the existing operations would be discussed with the EPA. The EPL variation is likely to be required to address conditions for water quality monitoring and discharge at sediment basins W1, N2 and S2.

Roads Act 1993

Consent is required from the relevant roads authority under Section 138 of the NSW *Roads Act 1993* (Roads Act) for any work in, on or over a public road. As described in **Section 4.4.4**, a section of Marulan South Road is proposed to be realigned. These works will require a Section 138 approval under the Roads Act. Potential impacts on the existing road network are discussed in further detail in **Chapter 21**.

6.3.9 Exemptions from NSW authorisations

Under Section 4.41 of the EP&A Act, the following authorisations are not required for SSD that is authorised by a development consent:

- a permit under section 201, 205 or 219 of the NSW *Fisheries Management Act 1994*;
- an approval under Part 4, or an excavation permit under Section 139 of the NSW *Heritage Act 1977*;
- an Aboriginal heritage impact permit under Section 90 of the NSW *National Parks and Wildlife Act 1974* (NPW Act);
- a bushfire safety authority under Section 100B of the NSW *Rural Fires Act 1997*; and
- a water use approval under Section 89, a water management work approval under Section 90 or an activity approval (other than an aquifer interference approval) under Section 91 of the NSW *Water Management Act 2000* (WM Act).

Notwithstanding the above, potential impacts on aquatic biodiversity (**chapters 13** and **14**), historic heritage (**Chapter 16**), Aboriginal heritage (**Chapter 15**) and surface water (**Chapter 8**) have been assessed as required by the SEARs for the Project.

6.3.10 Other State legislation

In addition to the requirements under Part 4 of the EP&A Act, the Project will require additional approvals, licences and/or authorisation under various other pieces of NSW legislation, which are summarised in this section.

Crown Lands Act 1989

The NSW *Crown Lands Act 1989* provides for the administration and management of Crown land in the eastern and central divisions of NSW. Crown land may not be occupied, used, sold, leased, dedicated, reserved, or otherwise dealt with unless authorised by this act or the NSW *Crown Land (Continued Tenured) Act 1989*.

Crown Land adjoins the eastern boundary of the site along the western side of Barbers Creek Gorge and the northern side of Bungonia Creek Gorge, with various parcels of Crown land located within the existing pit (refer to Figure 2.9). The Project will continue to extract limestone and emplace overburden in those parcels of Crown land already impacted by mining activities. The Project will also impact on a number of Crown roads. Boral does not propose to purchase Crown land within the mine pit or close Crown roads.

Water Act 1912 and Water Management Act 2000

The NSW *Water Act 1912* (Water Act) and WM Act regulate the management of water by granting licences, approvals for taking and using water, and trading groundwater and surface water. The WM Act applies to those areas where a water sharing plan has commenced. Alternatively, if a water sharing plan has not yet commenced, the Water Act applies. The WM Act is progressively replacing the Water Act as relevant water sharing plans are introduced across the State.

Water sharing plans (WSPs) have commenced for most of NSW. Licensing of monitoring bores continues under the Water Act until a regulation for aquifer interference gives a mechanism to approve these activities. Licensing of reinjection into groundwater systems is also still currently managed under the Water Act.

Surface water

The Project is in the area of the Greater Metropolitan Region Unregulated Area WSP and the following three surface water sources within the WSP:

- Bungonia Creek Management Zone (commenced July 2011);
- Barbers Creek Management Zone (commenced July 2011); and
- Shoalhaven River Gorge Management Zone (commenced July 2011).

Boral's existing entitlements in these WALs are summarised in **Table 3.4**. Total water entitlements in the management zones and their access rules are summarised in **Table 6.4**.

Table 6.4: Surface water entitlements and access rules

Entitlements/rules	Management zone		
	Bungonia Creek	**Barbers Creek**	**Shoalhaven River Gorge**
Licensed water entitlements			
Total surface water entitlement (ML/year)	43	1,176	5
Numbers of water licenses	7	11	1
Peak daily demand (ML/day)	1.54	2.8	N/A
Access rules			
A Class	Cease to pump flow <0.2 ML/day	N/A	Cease to pump flow <40 ML/day
Commence to pump (A Class)	Flow exceeds 0.2 ML/day for 24 hours	N/A	Flow exceeds 77 ML/day
Environmental flow protection rule	N/A	Pumping prohibited when there is no visible flow	N/A
Reference point	Bungonia Creek gauge (215014)	Pump site	Shoalhaven River at Fossikers Flat (215207)
Trading rules			
Trading into management zone	Not permitted	Not permitted	Permitted up to a maximum entitlement of 2,198 ML
Trading within management zone	Permitted	Permitted subject to assessment	Permitted subject to assessment
Conversion to high flow access licence	Not permitted	Not permitted	Not permitted

The proposed Marulan Creek dam will be in the Barbers Creek Management Zone. The surface water assessment (**Appendix G**, summarised in **Chapter 8**) identified a total annual surface water entitlement of up to 183 ML/year would be required. As summarised in **Table 6.4**, water licence trading is permitted in the Barbers Creek Management Zone, and sufficient surface water entitlements exist for the Marulan Creek dam. Boral would seek to acquire additional entitlements in the Barbers Creek Management Zone to account for water extracted from the Marulan Creek dam.

Groundwater

Groundwater in the Project site is managed under the Goulburn Fractured Rock Groundwater Source zone of the 2011 Greater Metropolitan Region Groundwater Sources Water Sharing Plan (the plan).

Groundwater extraction requires an authorisation under the plan via a water access licence or some form of exemption. Boral holds entitlement to extract 12 ML/year (WAL24697) from two bores (10WA116142) for water supply on site. Boral also owns groundwater Water Access Licence 41976 for 838 ML, which was issued in September 2017.

Other approvals

As described in **Section 6.3.9**, Section 4.41 of the EP&A Act removes the need for a number of approvals under the WM Act when development consent has been granted for SSD. Required authorisations include water access licences under the WM Act and bore licences under the Water Act.

The water licensing requirements identified for the Project are discussed in detail in **Section 8.3**.

Biodiversity Conservation Act 2016

The NSW *Biodiversity Conservation Act 2016* (BC Act) replaced the *NSW Threatened Species Conservation Act 1995*, *NSW Native Vegetation Act 2003* and the flora and fauna provisions of the NP&W Act.

As the Project is SSD, it is required to consider biodiversity impacts in accordance with the Biodiversity Offset Scheme of the BC Act, that requires impacts to first be avoided and then mitigated before being offset in accordance with the scheme. The preliminary biodiversity offset strategy described in **Appendix K** and summarised in **Section 12.5.1** will be finalised and the necessary offsetting credits secured in accordance with the Biodiversity Offset Strategy if development consent is granted.

Dam Safety Act 1978

The NSW *Dam Safety Act 1978* requires that the NSW Dams Safety Committee (DSC) periodically review large dams that may constitute a hazard to human life and property. These dams are known as prescribed dams and are listed in Schedule 1 of the act. Any new prescribed dams are to be designed to the satisfaction of the DSC.

The Project will require construction and operation of the Marulan Creek dam and various other water storage dams for the security of water supply to the mine.

The detailed design process for the Marulan Creek dam and other water storage dams would include an assessment process in regards to potential safety implications to human life and property. Additionally, consultation with the DSC would be undertaken by Boral to determine if the Marulan Creek dam or other water storage dams are to be considered a prescribed dam to be regulated under the Act.

Contaminated Land Management Act 1997

The phase 1 and 2 environmental assessment of the Project site (**Appendix J**) concluded there is no duty to report contamination to the EPA under Section 60 of the NSW *Contaminated Land Management Act 1997* (CLM Act).

If previously unidentified contamination is identified during construction or operation of the Project, additional assessment will be undertaken, and depending on the conclusions of the assessment, the contaminated area may be required to be notified to the EPA under Section 60 the CLM Act, and potentially remediated if required by the regulatory authority.

6.4 Environmental planning instruments

Environmental planning instruments (SEPPs and local environmental plans) are legal documents that regulate land use and development.

6.4.1 State environmental planning policies

SEPPs deal with issues significant to the State and people of NSW. They are made by the Governor on the recommendation of the Minister for Planning and may be exhibited in draft form for public comment before being gazetted as a legal document.

The relevant SEPPs which have been considered in relation to the Project are summarised below.

State Environmental Planning Policy (State and Regional Development) 2011

The SRD SEPP, amongst other matters, defines whether a development is SSD. The applicability of the SEPP is considered in **Section 6.3.2**.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

The Mining SEPP regulates the permissibility of mining, extractive industries and related development and specifies matters that must be considered in assessing extractive industry developments requiring consent under Part 4 of the EP&A Act. The Mining SEPP outlines various activities that are permissible both with and without development consent and defines developments that are prohibited, exempt or complying development.

The Project is not exempt or complying development under Part 2 of the SEPP and, therefore, requires consent in accordance with clause 7.

Part 3 (clauses 12 to 17) of the Mining SEPP stipulates matters for consideration by the consent authority before determining a mining application, which are addressed below.

Clause 12AB

Clause 12AB of the Mining SEPP sets out non-discretionary development standards for the purposes of sections 4.15(2) and (3) of the EP&A Act. These standards relate to cumulative noise and vibration levels, cumulative air quality and Aquifer interference. These standards are addressed in **chapters 19, 17** and **9** respectively.

Clause 12

Land uses near the mine are described in **Section 2.3.2**, and include extractive industry, grazing, rural residential, commercial/industrial and conservation. Potential impacts on these land uses have been assessed in this EIS, demonstrating that the Project will not have a significant impact on existing and approved land uses around the Project.

Clause 12A

The Mining SEPP requires consent authorities to consider applicable provisions of the Voluntary Land Acquisition and Mitigation Policy (VLAMP) before determining a mining application.

The VLAMP establishes a framework for ensuring that when noise or dust impacts from a proposal exceed the relevant assessment criteria, land owners are provided with:

- a negotiated agreement between the land owner and the proponent; or
- obligations on the proponent to offer mitigation of impacts on the land, or acquisition of the land, in accordance with conditions of a project approval.

As described in **chapters 17** and **19**, there will not be any residual air quality or noise impacts at receivers and further consideration of the VLAMP is not required.

Clause 13

Clause 13 of the Mining SEPP relates to matters a consent authority must take into consideration when determining applications for development that is:

- near an existing mine, petroleum production facility or extractive industry;
- identified on a map as being the location of State or regionally significant resources of minerals, petroleum or extractive materials; or
- identified by an environmental planning instrument as being the location of significant resources of minerals, petroleum or extractive materials.

Land surrounding the mine is used for extractive industry, grazing, rural residential, commercial/industrial and environmental conservation.

Peppertree Quarry, owned by Boral Resources (NSW) Pty Limited, borders the mine to the north. There are no additional mining, petroleum production or extractive industries near the mine (Lynwood Quarry is approximately 8.5 km north-west and Gunlake Quarry is approximately 10 km north-west of the mine). The independent continued operation of the mine would not impact operations of Peppertree Quarry, nor impede access to geological resources extracted at Peppertree Quarry. As Boral manages both facilities and they share common infrastructure such as rail despatch facilities, ensures that both entities are operated in a manner which minimises the disturbance footprint and impact of two large mining and extractive land uses working immediately adjacent to each other.

There are no geological deposits covered under third party exploration licences issued under the NSW *Mining Act 1992* near the mine.

Clause 14

Clause 14(1) of the Mining SEPP requires that before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:

- that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable;
- that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable; and
- that greenhouse gas emissions are minimised to the greatest extent practicable.

The assessments of water resources, biodiversity and greenhouse gases are summarised in **chapters 8**, **9**, **12** and **18** respectively.

Clause 15

Clause 15 of the Mining SEPP requires the consent authority to consider the efficiency of resource recovery.

As outlined in **section 3.1.14** and **Chapter 22**, the construction and operation of the Project has been designed to maximise the efficiency of resource recovery.

The principles of waste hierarchy in the NSW *Waste Avoidance and Resource Recovery Act 2001* will continue to be implemented during the Project by:

- purchasing recycled products where appropriate;
- developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site;
- recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and
- where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licenced facility.

Additionally, Boral is investigating incorporating overburden material into the limestone products, which could substantially reduce overburden emplacement volumes over 30 years.

Clause 16

Clause 16 of the Mining SEPP requires the consent authority to consider the implications of transport of materials from the development on public roads.

The Project involves the transport of up to 600,000 tpa of materials along Marulan South Road, and the wider public road network including the Hume Highway. Traffic impacts from road transportation are addressed in **Chapter 21**, and demonstrate that the Project would not have a significant impact on the road network.

Clause 17

Clause 17 of the Mining SEPP requires that before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development.

The Project will be rehabilitated as described in **sections 4.5**, **4.9** and **26**.

Part 4AA

In 2013, the NSW government introduced a gateway process to protect high value agricultural land from potential mining development impacts. The gateway process requires BSAL to be identified, and potential impacts assessed before a development application can be lodged for mining and petroleum projects.

Under the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment (Resource Significance) 2013 (Mining SEPP amendment), the gateway process applies to the following SSD located wholly or partially on BSAL:

- state significant mining development that requires a new mining lease;
- extraction of a bulk sample of more than 20,000 t of coal or any mineral ore (i.e. State significant mining exploration activity);
- state significant petroleum development that requires a new petroleum production lease;
- state significant petroleum exploration activity; and
- excluding any associated development, such as linear infrastructure, outside the area of a proposed mining or production lease.

The NSW government has mapped BSAL at a regional scale to assist with preliminary identification of BSAL during project planning. Regardless of whether a project area has been regionally mapped as BSAL or not, proponents may apply for a SVC, which certifies that a project area does not meet BSAL criteria and is, therefore, exempt from the gateway process.

Applications for SVC must be accompanied by a BSAL assessment report completed in accordance with the Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (NSW Government 2013).

Under Part 4AA, Clause 17A of the Mining SEPP amendment, only those parts of a project area requiring a new mining lease (under the Mining Act 1992) are subject to the gateway process. Project development on existing mining leases, or on land not proposed for a mining lease, is not subject to BSAL assessment or the gateway process.

As described in **Section 10.2.4**, The soil survey data show there is no BSAL in or adjacent to the Project site. While there is no requirement to obtain a gateway certificate for the Project, a SVC application was submitted to confirm the absence of BSAL on the site. The SVC was issued by DPE on 17 November 2015.

Refer to **Section 6.4.3** for information regarding the NSW Government's Strategic Regional Land Use Policy (NSW Government, 2012a).

State Environmental Planning Policy No 33 – Hazardous and Offensive Development

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33) requires the consent authority to consider whether a development proposal is a potentially hazardous industry or a potentially offensive industry.

As described in **Section 23.2** the Project is not classified as hazardous or offensive industry under SEPP 33. As such, the preparation of a preliminary hazard analysis (PHA) report is not required.

State Environmental Planning Policy No 44 – Koala Habitat Protection

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) provides for the protection of koala habitat by ensuring that areas subject to development proposals are considered for their value as habitat or potential habitat for koalas. The former Mulwaree LGA (now merged with Goulburn LGA) is listed under Schedule 1 of SEPP 44 as an area to which the SEPP applies.

The Project site contains potential Koala habitat as defined under SEPP44, given Schedule 2 tree species meet at least 15% of the total number of trees within portions of the Project site. The Project site does not constitute core Koala habitat given the absence of a resident population of koalas in the Project site.

Notwithstanding, potential impacts on Koalas are assessed in detail in **Appendix K** and summarised in **Section 12.3**.

State Environmental Planning Policy No 55 – Remediation of Land

State Environmental Planning Policy No 55 – Remediation of Land (SEPP 55) aims to provide a state-wide planning approach to the remediation of contaminated land and to reduce the risk of harm to human health and the environment by consideration of contaminated land as part of the planning process. Under SEPP 55 a consent authority must not consent to the carrying out of development on land unless it has considered potential contamination issues.

As described under the CLM Act above, there is no duty to report identified contamination to the EPA under Section 60(3) of the CLM Act. If previously unidentified contaminated land is identified during construction or operation of the Project, the requirements of SEPP 55 will be complied with.

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (Drinking Water SEPP) aims to provide for healthy water catchments that will deliver high quality water while permitting development that is compatible with that goal.

The mine is in Sydney's drinking water catchment. Under clause 10 of the SEPP, a consent authority must not grant consent to the carrying out of development on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect NorBE on water quality.

It is considered that the Project can be managed to provide at least a neutral effect on water quality in the Shoalhaven River catchment as discussed further in **Section 8.2.2**.

6.4.2 Goulburn Mulwaree Local Environmental Plan

The Project will be on land zoned E3 Environmental Management and RU1 Primary Production under the LEP. The proposed activities are prohibited in the E3 zone and permitted in the RU1 zone with consent. As described in **Section 6.3.3**, the Project is permissible under the Mining SEPP, which prevails over any inconsistencies with a LEP.

6.4.3 Other considerations

Strategic Regional Land Use Policy

The (NSW Government, 2012a) sets out a range of initiatives to better balance growth in the mining industry with the need to protect agricultural land and water resources. The Policy includes a package of measures including the following key elements:

- the preparation of strategic regional land use plans (SRLUPs) for both the Upper Hunter and the New England North West regions of NSW which identify and map strategic agricultural land (SAL) and critical industry clusters (equine and viticulture land uses) within these areas;
- the introduction of the *NSW Aquifer Interference Policy* (AIP) (NSW Government, 2012b) (see below); and
- the requirement for agricultural impact statements (AIS) to accompany SSD applications for mining projects that have the potential to affect agricultural resources.

The key policy response for resolving land use conflict between mining and coal seam gas proposals and agricultural land is the new 'gateway process'. Under this process, a panel of independent experts will assess proposals involving mining or coal seam gas development on mapped SAL at an early stage before the lodgement of a development application. The outcome of the gateway process will be that the proposal either meets the gateway criteria relating to agricultural and water impacts, or the proposal does not meet the criteria and therefore stringent requirements will be imposed that must be addressed at the development application stage.

The existing SRLUPs do not apply to the Project site. Notwithstanding, matters relating to soil landscapes, land use impacts, land capability and agricultural suitability have been addressed within this EIS.

As described in **Section 10.2.4** the Project site does not contain any land that has the characteristics of BSAL. Furthermore, there is no land area in or adjoining the Project site that is used for commercial horse breeding or contains vineyards.

Aquifer Interference Policy

The AIP was released by the NSW Office of Water in 2012. It defines the regime for protecting and managing the impacts of aquifer interference activities (such as underground mining) on water resources. The AIP seeks to strike a balance between the water needs of towns, farmers, industry and the environment.

The AIP clarifies water licensing and impact assessment requirements for aquifer interference activities under NSW legislation, principally the Water Act and WM Act. This includes defining criteria or 'minimal impact considerations' for water table, pressure and quality that are to be applied in assessing the potential impacts of aquifer interference activities on water resources. That is, to evaluate whether or not more than minimal impacts might occur to a water-dependent asset as defined in the AIP, for example a water supply work or high priority groundwater dependent ecosystem.

The AIP also sets out the information that must be provided by the applicant to enable appropriate assessment of the activity by the Minister for Lands and Water.

The Project has been assessed in accordance with the AIP, as described in **Chapter 9**.

Sydney to Canberra Corridor Regional Strategy

The Sydney to Canberra Corridor Regional Strategy outlines the future strategic planning direction of the region extending between Sydney and Canberra. This region is experiencing steady growth, and has important economic and environmental values for NSW. The Strategy aims to manage sustainable housing and job growth, while protecting the local environment.

The mine is located within the corridor and as such, the objectives of the Strategy should be considered.

The Strategy specifically identifies the economic importance of extractive and mineral resources to areas within the corridor. This EIS highlights that the mine contributes to economic growth in the region and provides opportunities for employment for the local community. The mine has historically been operated in a manner that minimises adverse impacts on surrounding land uses and the local community. Additionally, with the environmental management strategies proposed to be implemented in accordance with the findings of this EIS, it is considered that continued operation of the mine would be conducted in an environmentally responsible manner which minimises unavoidable impacts to the surrounding environment. As a result, it is considered that the Project is consistent with the objectives of the Strategy in promoting economic growth whilst protecting the local environment.

Goulburn Mulwaree Strategy 2020

The Goulburn Mulwaree Strategy 2020 is a strategic planning document for the future growth and development of the LGA until 2020. The Strategy was formed to promote the sustainable land management and guide land use decisions within the LGA to 2020.

The Strategy identifies Marulan as a centre for future population and economic growth. This will require employment generating activities in the surrounding area. To support such employment growth, the Strategy promotes implementation of industrial land uses to the south and west of the town, which would support mining and extractive industries in the region.

The mine is located approximately 10 km south-east of Marulan and as highlighted in this EIS, generates local, regional, state and national economic activity, and provides employment opportunities for the Marulan district and beyond. As a result, it is considered that the Project is consistent with the objectives of the Strategy.

Goulburn Mulwaree Section 94 Development Contributions Plan 2009

The Goulburn Mulwaree Section 94 Development Contributions Plan 2009 applies to all 'extractive industries, mines and like development' in the LGA. The plan requires these developments to contribute to a road maintenance levy for the upgrade and maintenance of roads within the LGA. The Plan outlines a method to calculate the contribution for each tonne of material transported.

Boral currently pays a Section 94 contribution levy to Council for transportation of its product along Marulan South Road. As provided by Council, the current rate is $0.0462 per tonne, per kilometre.

As detailed in **Chapter 21**, the Project will result in an increase in daily heavy vehicle movements along Marulan South Road and the wider road network. Boral would continue to pay the Section 94 contribution, with future increases in total contributions potentially required by Council in response to the increase in vehicle movements.

Goulburn Mulwaree Community Strategic Plan 2030

The Goulburn Mulwaree Community Strategic Plan 2030 outlines the community's priorities and expectations for the LGA for the long-term. The Plan provides six key directions identified by the local community, namely:

- Infrastructure;
- Business and industry;
- Community needs;
- Environment;
- Culture and leisure; and
- Image influence.

The Plan identifies the promotion of a healthy and strong economy, which will enhance the general wealth of the community, as a key objective. As outlined by this EIS, the mine is an important economic entity in the region, contributing to the local economy and providing employment opportunities. As a result, it is considered that the Project is consistent with the objectives of the Strategy.

NSW Long Term Transport Master Plan and Southern Regional Transport Plan

The NSW Long Term Transport Master Plan identifies a range of actions for the southern region to address the challenges and meet the transport planning objectives for the region.

The Southern Regional Transport Plan has developed actions around the three key themes of:

- providing better transport services;
- ensuring effective regulation; and
- improving transport infrastructure over the short, medium and long term.

The Project will improve the road infrastructure in Marulan South Road, will assist in providing better transport services by improving school bus pick-up and drop-off areas and is therefore consistent with objectives and actions of these NSW transport plans.

6.5 Summary of approval requirements

Licences, approvals and permits that are likely to be required for the Project are summarised in Table 6.5.

Table 6.5: Summary of approval requirements

Legislation	Authorisation	Consent of approving authority
EP&A Act	Development consent	Minister or IPC
POEO Act	Amended EPL for mining and processing operations	EPA
Roads Act	Section 138 permit for road improvements	RMS/ Council
WM Act	Water access licences	DPI–Water
Dams Safety Act	Listing of water storage dams*	Dams Safety Committee
EPBC Act	Approval to undertake controlled action	DoEE

*Potentially required

Chapter 7

Environmental assessment approach

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7 ENVIRONMENTAL ASSESSMENT APPROACH

7.1 Polycentric approach

On 7 April 2014, the NSW Court of Appeal dismissed the appeal against the judgement handed down by the Chief Judge of the NSW Land and Environment Court in relation to the refusal of a Project Application under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) lodged by Warkworth Mining Limited to expand an open cut coal mine near the village of Broke. This case is arguably the most important ruling by the courts in the past decade, as it clearly sets out how a major project such as a mine must be assessed.

The implications for developments like the Marulan South Limestone Mine Continued Operations are profound. The Chief Judge has explained that when grappling with the task of assessing a major project, we are dealing with a polycentric problem. An extract from paragraph 31 of his judgement is provided below and explains what this means:

"The range of interests affected, the complexity of the issues and the interdependence of the issues, means that decision making involves a polycentric problem. A polycentric problem involves a complex network of relationships, with interacting points of influence. Each decision made communicates itself to other centres of decision, changing the conditions, so that a new basis must be found for the next decision."

An analogy of a web is provided in the judgement, where it is explained that a pull on one strand will distribute tensions and after a complicated pattern of adjustment throughout the whole web a new equilibrium will be established. Polycentric problems cannot be resolved by simply dealing with individual key issues.

The Chief Judge concluded at paragraph 483 of his judgement:

"a polycentric problem such as determining whether to approve or disapprove a mining project, cannot be resolved by identifying each issue and sequentially resolving it; the resolution of one issue has repercussions on other issues."

With 17 environmental issues each requiring specialist consideration, the Project's planning and assessment team, agreed from the beginning that this Project requires a polycentric approach, to ensure that the mine planning, community and stakeholder engagement, technical studies and environmental impact assessment process is conducted in a truly integrated manner. The polycentric approach taken for this Project is outlined in the following sections.

This chapter should be read in conjunction with the alternatives evaluation process presented in **Chapter 28** to develop a full picture of the thought, planning, evaluation and decision making process adopted during the four year SSD planning and assessment process for the Project.

7.1.1 Risk, project definition and constraints workshop

Two all-day risk, project definition and constraints workshops were attended by Boral's mining and planning teams, all technical study leads, the EIS delivery team and an independent 'Challenger' – a mining approvals specialist appointed to challenge the Project team.

At the workshops, the Project team of over 30 experts, were introduced to Boral's broad objective of "continuing mining limestone at the site", then they considered key issues associated with their fields of expertise, and developed an environmental, social and economic values and constraints framework to inform development of the 30-year mine plan and associated infrastructure.

This workshop approach to defining the Project scope at the commencement of the SSD approval process, allowed the implications of one decision, influenced by a certain issue to be considered by the other 14 technical specialists, the 'Challenger' and Boral's mining and planning teams, in order to ascertain the impacts on the other issues. This facilitated in-depth discussion and consideration of why one issue should be attributed greater value than another issue. Below is an example of some of the dialog between the Project team that provides insight into how the polycentric decision making approach played out in this Project's planning.

Boral mine manager: "The mine needs to be expanded to extract an additional 120 million tonnes of limestone over 30 years and needs space to emplace approximately 108 million tonnes of overburden."

Mine planner: "To maximise extraction of the highest grade limestone, we need to focus extraction on the 'eastern limestone'. As the limestone body is vertically dipping we would need to not only widen the pit westwards, but also eastwards, mining out the eastern batters, reducing the eastern and south-eastern rim of the pit by 230 m, daylighting the mine pit to the east and south.

We can't backfill the pit with overburden as it will get in the way of extraction and will prohibit future mining beyond the 30 year mine plan, so we would need to find space out-of-pit to place the overburden."

Biodiversity lead: "We have undertaken some preliminary vegetation mapping of Boral lands on the mine site and have identified the presence of a threatened ecological community as well as other native vegetation communities and threatened fauna habitat. Even though this land has all been disturbed in the past through tree clearing for kiln fuel, these native vegetation communities are of biodiversity value and if they can't be avoided, would need to be offset."

Visual lead: "Mining the eastern batters and lowering the rim of the pit will significantly increase the visibility of the mine from viewpoints in the adjoining conservation lands to the east and south."

Surface water lead: "Mining the eastern batters and undisturbed, wooded bushland on the very steep outer slopes of the current pit, within the Barbers and Badgerys creek gorges would make it extremely difficult to manage sediment and runoff during high rainfall events and would risk impacting water quality in the receiving waters which are part of a drinking water catchment."

Biodiversity lead: "There are also relatively undisturbed native vegetation communities on the outer slopes of the current pit that would need to be cleared and would likely result in a significant risk to water quality through the difficulty in managing sediment runoff from these outer slopes and the potential impacts this could have on aquatic ecology".

Mine planner: "To avoid mining the eastern batters we are going to have to expand the pit further west to access the eastern limestone at depth, but to also mine the lower, middle and upper limestone bodies."

Boral mine manager: "We going to have to put the overburden as close to the pit as possible as we need to minimise the haul distance for trucks. Long haul roads mean more fuel, longer roads to build and maintain."

Mine planner: "But if you put the overburden immediately west of the proposed future mine pit then you are going to have to move millions of tonnes of overburden if you ever want to continue mining after 30 years, which would require extending the pit to the west."

Boral commercial manager: "To entirely avoid the native vegetation to the west of the pit, would require the purchase of between 250 to 500 ha of land outside of Boral's current landholdings for the emplacement of overburden as well as substantial additional buffer land, to mitigate noise and air quality emissions."

Boral community engagement manager: "But, as the mine couldn't expand its operations south or east as it is flanked by the steep Barbers and Bungonia Creek gorges and the Bungonia and

Morton NPs, while the Peppertree Quarry borders the mine immediately to the north, expansion westwards onto neighbouring properties would be the only option. However, the properties that border the mine to the west are successful commercial and agricultural operations such as Foti Fireworks, poultry farms and the agricultural lime manufacturing facility. These property owners are unlikely to want to sell their land, and even if they did we would be leap frogging our land, expanding our disturbance footprint significantly westward and would then also need to purchase additional buffer land even further west to mitigate potential noise and air quality impacts."

Boral mine manager: "We are then going to have to find a way to emplace all the overburden on Boral owned land but not in the pit and not too close to the western side of the pit to allow for future limestone extraction."

Mine planner: "You could steepen up the batter slopes of the overburden emplacements to make then a lot higher and fit in more overburden, but there is probably still going to be insufficient space for overburden emplacements."

Soils and rehabilitation lead: "But having read through the results of past rehabilitation trials at the site and the existing rehabilitation strategy for the site, steepening the overburden emplacement batters too much would risk batter failure, reduce revegetation success and increase erosion and sedimentation risk."

Visual lead: "If you make the overburden emplacements too high they are going to be visible from lots of private properties and public viewpoints which will be a key issue for the local community."

The risk, project definition and constraints workshop continued in this manner until all competing issues had been fully interrogated. With the attendance of Boral's mine planning and operations team and all technical study leads, an integrated approach was achieved whereby the whole Project team were fully aware of the other project issues and were therefore able to give due consideration to these issues in developing the 30-year mine plan, planning their site investigations and conducting their assessments.

7.1.2 Stakeholder and community engagement

Relevant stakeholder and local community input into the planning process for the continuation of a mine is essential to polycentric problem solving. Stakeholder's and the community may identify additional or different issues to the Project team or may attribute higher values to certain issues. As outlined in **chapters 5** and **25**, thorough stakeholder and community engagement has been undertaken over a four-year period and outcomes of this engagement process have been considered carefully in developing the proposed 30-year mine plan and in deciding which issues should be attributed greater value than others.

7.1.3 Ongoing Project team meetings and communication

Regular project team meetings have been held to update Boral's mine planning and operations team and all technical study leads on outcomes from other technical studies and issues raised through the stakeholder and community consultation process. Through this process, the weighting of the values assigned to each issue identified in the early project constraints and definition phase, and possibly changed due to early stakeholder and community input, is revisited and revaluated and a decision made as to whether further changes should be made. Below is an example of how the polycentric decision making approach played out in ongoing project team meetings, communications and Project refinements and finalisation.

Visual lead: "Using the latest 3D modelling software, we have developed 3D analytical views of the proposed 30-year mine plan from each of the neighbouring residences and local public viewpoints. The overburden emplacements are barely visible from all neighbouring residences and local public viewpoints if the bulk of the proposed WOE does not exceed approximately 655 m AHD and the NOE doesn't exceed approximately 650 m AHD. Also, to substantially reduce views up the centre of the mine pit from the Bungonia Lookdown in the Bungonia NP to the south, backfilling the southern end of the south pit to an elevation above 480 m AHD and revegetation on top should be considered."

Mine planner: "I have redesigned the 30-year mine plan taking into account all the feedback from the initial risk, project definition and constraints workshop, stakeholder and community engagement input, and recent feedback from the visual lead on recommended overburden emplacement heights and backfilling the south pit. In revising the mine plan I have:

- only expanded the mine to the west as not to mine the eastern batters or the southern rim of the pit;
- reserved an area of land to the west of the pit to allow for future limestone mining after 30 years if required;
- located the overburden emplacements out of the pit and restricted the height of the bulk of the WOE to 655 m AHD and the NOE to 650 m AHD; and
- designed an out-of-pit SOE that mimics the undulating ridges of the transitional landscape between the plateau and the steep Bungonia gorge.

However, I am still short of over 13.6 million m^3 (30 million tonnes) of overburden emplacement space. Although it will sterilise some limestone, I can design an in-pit section to the SOE which will also mimic the undulating ridges of the transitional landscape between the plateau and the steep Bungonia gorge, will take up approximately 13.6 million m^3 (30 million tonnes) of overburden and will created an elevated ridge from 485 m – 540 m AHD which will result in a significant reduction in the visibility of the mine from the Bungonia Lookdown, especially once it is revegetated and trees have reached a mature height. However, I am still short 9.3 million m^3 (20.5 million tonnes) of overburden emplacement space."

Groundwater lead: "We have completed modelling of the final 30-year mine pit including the western expansion and the modelling predicts that none of the identified registered groundwater users to the west of the mine will be impacted by groundwater drawdown associated with the Project."

Boral Mine Manager: "I have been speaking to Mr Ordasi who owns the property immediately north of the big bend in Marulan South Road. His property is an isolated privately owned property inside Boral's Marulan South landholdings and he is interested in downsizing and is interested in selling."

Mine Planner: "I have completed a design of the extension of the WOE to include the Ordasi property and at a maximum bulk height restriction of 655 m AHD. This extended WOE accommodates the surplus 20.5 million tonnes of overburden. This extended WOE will require the realignment of a section of Marulan South Road."

Traffic lead: "The large bend in Marulan South Road subsumed by the proposed northern extension of the WOE, will be replaced with a straight section of road and a more gradual curve, immediately north of the WOE, which will be safer for vehicles using the road, especially heavy vehicles."

Biodiversity lead: "It appears that if the mine is to continue operations, an unavoidable impact is the loss of native vegetation including a TEC. Where impacts on native vegetation, TECs and threatened fauna are unavoidable, Boral will need to offset these impacts by ensuring the protection in perpetuity of like vegetation communities or better, on other properties in the same bioregion. We have interrogated State vegetation mapping and satellite imagery and have identified various properties that may have suitable vegetation to offset the Projects unavoidable biodiversity impacts."

Boral Planning and Development Manager: "We have received commercial approval for the ecologists to survey the properties that could be suitable for offsetting the Project's biodiversity impacts."

Biodiversity lead: "Two of the properties that we have surveyed have enough similar native vegetation and the same TEC as well as threatened fauna habitat to offset a large portion of our Project's biodiversity impacts."

Boral Planning and Development Manager: "We have purchased a 1,000 ha property and are in negotiations to purchase the other property that will be used to offset most of our Project's biodiversity impacts. We will continue to seek further properties to satisfy the remaining biodiversity offsets we require or we may offset the remaining impacts by paying into the Biodiversity Conservation Trust Fund administered by OEH and used to manage conservation lands in NSW."

Aboriginal heritage lead: "A cultural heritage site has been identified by one of the registered Aboriginal parties in the location of the proposed Marulan Creek dam and consideration should be given to moving the dam wall further upstream."

Boral Mine Manager: "Our dam design engineers have redesigned the proposed Marulan Creek dam wall and relocated it upstream of the identified cultural site."

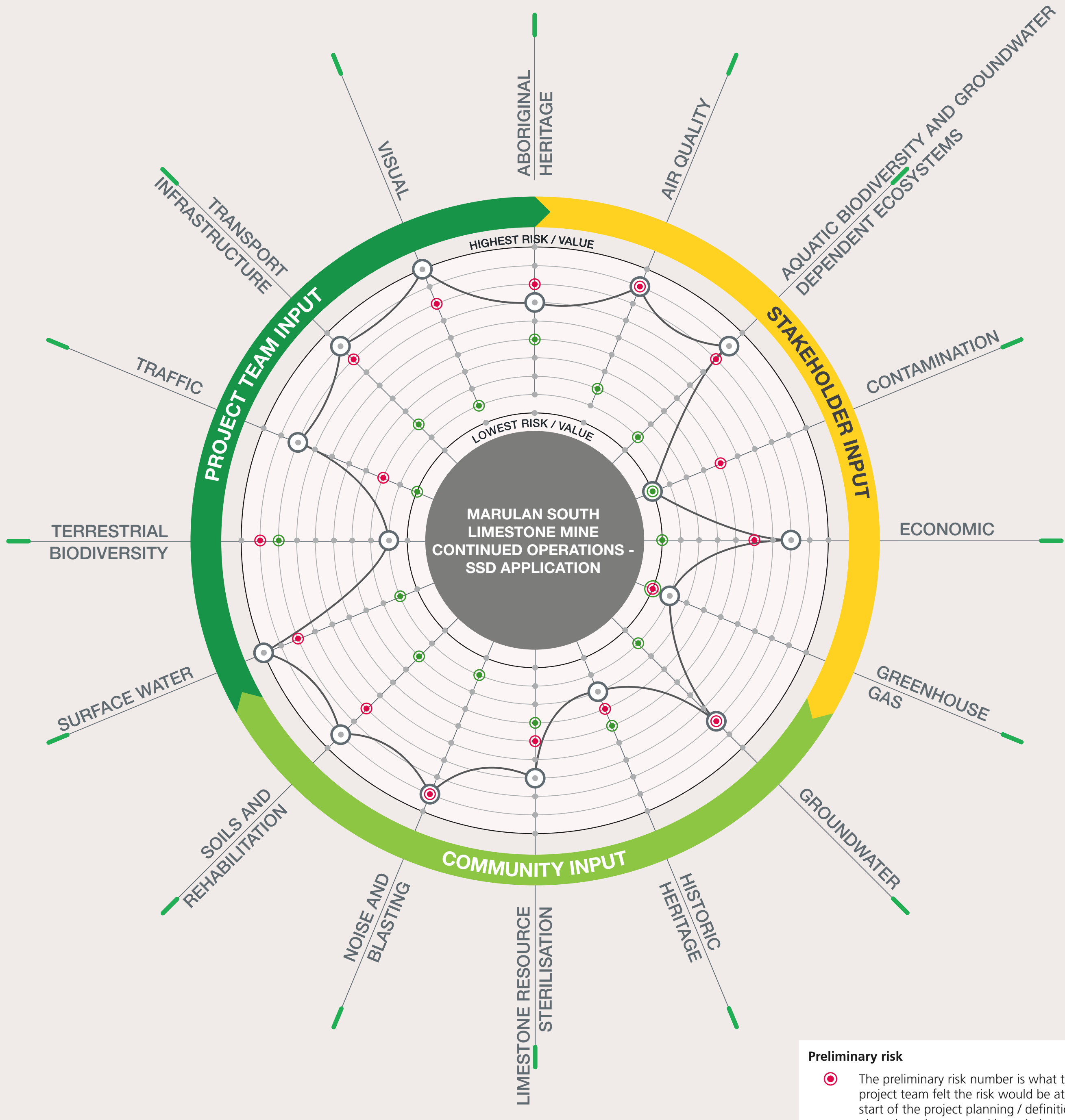
7.1.4 An optimum solution to a complex, polycentric problem

The outcomes of this polycentric approach to considering key issues and constraints at the start of the planning phase of the Project and assigning each of the issues a value, and refining these values during the stakeholder and community engagement process and ongoing team meetings and communication during technical study development, has informed the proposed mine plan presented in **Chapter 4**. The 30-year mine plan and the avoidance, minimisation, mitigation and offsetting of environmental and social impacts outlined in this EIS are considered an optimum solution to a complex, polycentric problem.

Figure 7.1 presents the ultimate 'value' assigned to each of the key issues in developing the preferred mine plan and associated Project features. It also presents the preliminary risk and residual risk ratings described in **Section 7.2.1** and **Chapter 27**.

Figure 7.1
Polycentric approach

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



Preliminary risk

The preliminary risk number is what the project team felt the risk would be at the start of the project planning / definition phase based on general knowledge of the site and supported by desktop investigations.

Residual risk

The residual risk number is the risk after all issues have been taken into account through the mine design process, have been assessed by technical specialists and avoidance, minimisation or mitigation applied. It does not account for offsetting in the case of biodiversity.

Value

The 'Value' is what attention / value the project team (particularly Boral and mine planner) gave to each issue in developing the mine plan.

CAMBIUM GROUP

Source: Boral (2018), Cambium Group (2019).

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7.2 Environmental risk assessment

It is integral to consider the environmental impacts of a proposed development early in the planning of the Project. Careful planning of the development can avoid, or reduce, the likelihood of a significant impact on the environment. Where possible and practicable, it is best to avoid impacts. If impacts cannot be avoided they should be minimised or mitigated as much as possible.

The purpose of the environmental impact assessments conducted as part of this EIS, was to determine whether the Project would result in significant impacts to the environment. Where a significant impact is likely, the Project needs to be planned to avoid, manage, mitigate or offset this impact.

As such, the approach for the environmental impact assessments have considered the hierarchy of avoid, manage, mitigate and offset. Specifically:

- During preliminary planning, where environmental features with high value and significance were identified that could be avoided, Boral revised the project design to avoid impacts to these areas by relocating infrastructure (such as internal roads, overburden emplacements and ancillary infrastructure); and
- Where environmental features could not be avoided and would be directly impacted, it was assumed that these areas would be impacted, and the EIS prepared on this basis with a view to identify best practice measures to manage, mitigate or offset the impact.

The preceding section outlined the polycentric decision making approach adopted for the Project and how decisions were made on which issues should be attributed greater value than others.

The following chapters (**chapters 8 – 26**) provide a summary of the key environmental issues considered for the Project, including the SEARs issued by DPE, assessment methodology employed, results of site surveys, potential construction and operational environmental impacts, and the proposed management and mitigation measures to be implemented for the Project in order to minimise the potential for adverse environmental impacts or risks.

7.2.1 Preliminary environmental risk analysis

A preliminary environmental risk analysis was undertaken as part of the *Preliminary Environmental Assessment* (Element Environment, 2015) to identify the key potential environmental factors or impacts associated with the Project, the results of which are outlined in **Section 7.2.1**. The preliminary environmental risk analysis was informed by the risk, project definition and constraints workshop, early stakeholder and community engagement, early mine planning and specialist study desktop research and site based investigations. For those environmental factors that achieved a high or medium risk rating, further assessment was proposed to be undertaken as part of this EIS, generally in the form of specialist technical investigations, as detailed in **chapters 8 – 26**. For those environmental factors that achieved a low risk rating, no further specialist technical assessment was required, as these non-key issues could largely be addressed using appropriate environmental safeguards and management measures, as detailed in this EIS.

The priority matrix illustrated in Table 7.3 provides a tool for the allocation of a risk rating to each environmental issue. Each environmental issue is ranked between one and three based on the likelihood of occurrence and for the perceived consequence of effects if left unmanaged.

Risk rating assessment criteria

The allocation of risk is based on the following considerations (see **Table 7.1, Table 7.2** and Table 7.3).

Table 7.1: Allocation of risk based on likelihood of occurrence

	Likelihood of Occurrence[1]
Definition	**Risk Rating**
High probability of occurring	High
Potential to occur	Medium
Unlikely to occur	Low

Table 7.2: Allocation of risk based on consequence of unmanaged effects

	Consequence of Unmanaged Effects
Definition	**Risk Rating**
Adverse environmental change; inter-regional implications; serious or long term cumulative impacts, offsets not readily available.	High
Moderate adverse environmental change; regional implications; modest or medium term cumulative impacts; offsets available	Medium
Minor environmental change; localised implications; imperceptible or short term cumulative impacts; offsets readily available.	Low

Table 7.3: Environmental issue priority matrix

	Consequence of Unmanaged Effects		
Likelihood of Occurrence	**3 High**	**2 Medium**	**1 Low**
1 Low	4 (Medium)	3 (Low)	2 (Low)
2 Medium	5 (High)	4 (Medium)	3 (Low)
3 High	6 (High)	5 (High)	4 (Medium)

Preliminary risk rating analysis for the Project

A preliminary environmental risk analysis was undertaken, with rankings allocated to each environmental issue being based on the likelihood of occurrence and the perceived consequence of effects if left unmanaged. The preliminary analysis did not consider the potential outcomes of specialist technical assessments and the application of mitigation measures to manage the environmental issue. In most cases, suitable mitigation measures are likely to minimise any potential impacts.

The information provided in Table 7.4 provides a summary of the environmental issues considered in the PEA, and their associated risk ratings.

Table 7.4: Preliminary risk rating for environmental issues

Environmental Issue	Risk Rating	Comments
Surface Water and Hydrology	High	Potential for impacts on the quality and quantity of receiving waters through the discharge of surface water containing sediment and pollutants, primarily from areas of disturbance

[1] Likelihood of occurrence risk rating is based on current understanding of risks without further technical assessment and implementation of environmental controls/mitigation measures.

Environmental Issue	Risk Rating	Comments
		including processing areas, overburden emplacement areas and haul roads. Receiving waters include Bungonia and Barbers Creeks, associated tributaries and the Shoalhaven River. Potential impacts associated with the construction of the proposed main mine water supply dam within Marulan Creek. Upstream flooding and reduction in downstream flows will be considered as part of the surface water and hydrological assessments.
Groundwater	High	Potential for impacts on local groundwater and neighbouring groundwater users through interception of the groundwater table and groundwater drawdown during open-cut mining and contamination of groundwater from mining activities.
Air Quality	High	Potential for air quality impacts associated with the 24 hour operation of an open-cut limestone mine, in moderate proximity (1 km) to residential and commercial receivers.
Noise and Blasting	High	Potential for operational noise and blasting impacts associated with the 24 hour operation of an open-cut limestone mine, in moderate proximity (1 km) to residential and commercial receivers.
Soils and Rehabilitation	High	Potential for long-term surface water pollution, visual impacts, biodiversity impacts, landform instability and community concern, if disturbed areas associated with mining activities are not suitably rehabilitated.
Aboriginal Heritage	High	Mine pit expansion, overburden emplacement, haul road construction and main mine water supply dam development on Marulan Creek has the potential to impact on Aboriginal sites especially in those areas not subject to previous surface disturbance.
Biodiversity	High	The 30-year mine plan requires the clearing of native vegetation to allow for the emplacement of overburden, construction of haul roads and expansion of the mine pit. These activities have the potential to impact on threatened species (flora and fauna) endangered ecological communities, aquatic ecology including stygofauna.
Visual	High	Although the existing mine is not visible from surrounding residential and commercial receivers the pit and part of the processing plant are highly visible from the Bungonia Lookdown to the south. The proposed 30-year mine plan involves the creation of new overburden emplacement areas which will be visible to varying extents from sensitive receivers to the west, south and northeast of the mine and has the potential to impact on the visual amenity and views of these local receivers.
Traffic and Transport	**Medium**	The Project will not result in a significant increase in the volume of finished products transported by road and therefore the number of heavy vehicles using Marulan South Road. A new grade separated intersection has been established at the Marulan South Road - Hume Highway intersection, which will provide safe access for heavy vehicles traveling to and from the mine. The Project will however require the realignment of a section of Marulan South Road to accommodate the western overburden emplacement area. As this realignment is close to the entrance to the mine, it is unlikely to result in a significant impact to the public use of this road.
Contamination	**Medium**	Potential to encounter or disturb areas of contamination are low with much of the land proposed for disturbance as part of the 30-year mine plan being regrowth woodland, which has not been subject to historic contaminating activities.

Environmental Issue	Risk Rating	Comments
		There is the potential for historical contamination around the existing processing plant primarily from the underground storage of fuel.
Historic Heritage	**Medium**	Due to the age of the mine, some of the old, disused infrastructure has potential historic heritage value and may fall within the proposed disturbance footprint of the Project.
Economics	**Medium**	The Project has the potential to result in positive economic benefits to the local area, region and State through the continued supply of jobs, engagement of local service contractors and the provision of essential construction products and manufacturing raw materials. If the Project was not to proceed, it would result in adverse economic impacts on the local area, region and State.
Greenhouse Gases	**Medium**	Although the Project will only result in a minor increase in overall production volumes and is unlikely to result in a significant increase in greenhouse gas (GHG) emissions, the mine currently consumes significant volumes of energy including, electricity, diesel and gas, which result in GHG emissions. Through a focus on energy efficiency at the site from procurement through to operations, there is the potential to for the Project to identify ways for a reduction in GHG emissions from the site.
Waste Management and Minimisation	**Low**	Other than overburden, the Project is unlikely to generate larger volumes of waste or new waste streams from that already produced at the site. Opportunities for the reduction, reuse and recycling of waste will be further explored through the Project planning.

A revised environmental risk analysis has been undertaken as part of the EIS (**Chapter 27**), which presents a revised risk rating after considering the outcomes of mine plan reiterations (outlined in **Section 7.1** and **Chapter 27**) specialist technical assessments (**chapters 8 – 26**) and the implementation of all recommended avoidance, management, mitigation and offset strategies for the Project.

7.3 Structure of Environmental Assessment

The SEARs issued by DPE for the Project state that an assessment of the likely impacts of the development on the environment, focussing on the key identified issues must be undertaken, and include:

- A description of the existing environment likely to be affected by the development, using sufficient baseline data;
- An assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice;
- A description of the measures that would be implemented to mitigate and/or offset the potential impacts of the development, and an assessment of:
  - whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented;
  - the likely effectiveness of these measures;
  - whether contingency plans would be necessary to manage any residual risks; and
- A description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved.

A description of the existing environment and baseline data for the Project site and surrounding areas is included in **Chapter 2**.

The environmental impact assessment chapters in this EIS have been formulated to provide a summary of the desktop and site investigations, an assessment of the potential construction and operational impacts of the Project, and a description of the management and mitigation measures that would be implemented by Boral to ensure residual environmental impacts are minimised, and where unavoidable consideration is given to whether offsetting is a viable option.

Where relevant, the chapter provides a summary of the relevant legislation, guidelines, policies and plans relevant to each key environmental aspect, and presents a summary of the technical specialist assessments prepared to address these requirements, and to investigate and minimise medium to high environmental risks.

Chapter 8

Surface water

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Surface water and hydrology

Surface water is managed in accordance with the water management system and is based on segregating ‘clean’ and ‘dirty’ water and capturing stormwater runoff for use in the mine processes, dust suppression and environmental controls.

The main water source for the Project will be runoff, which will be collected in the sediment basins and mine water storage dams. Collected runoff will be supplemented primarily by Marulan Creek dam, with Tallong dam and the groundwater bore providing further supplementation early in the mine life. Groundwater inflow to the pits would not provide significant water supply as most of it will evaporate.

Marulan Creek dam will be maintained near full capacity except during the constant riparian release and transfers to the water management system. There would be a significant water supply shortfall without the dam, which could supply up to 182 ML/year.

The water balance model demonstrated that the range of existing and proposed water sources will meet operational water demands.

In terms of flooding, an average of 583 ML/year of runoff from the pit catchment and overflows from the water storage dams and sediment basins S1 and W2 will drain to a sump at the base of the pit. The average water level in the pit will be 0.5 m for most of the time which will increase up to 7.9 m during heavy rain, which will quickly seep into the pit floor.

Marulan Creek dam will not significantly increase flooding risks at the railway bridge approximately 1 km upstream of the proposed dam wall or on private property further upstream.

The Project will increase the Tangarang Creek catchment area and alter the Marulan Creek catchment with construction of Marulan Creek dam. The dam will alter flows along Marulan Creek, so a riparian flow of 0.3 ML/day will be maintained via seepage from the base of the dam.

There will be approximately 1.6 days of overflows from sediment basins to natural receiving waters per year, which is within the guidelines for sediment basins designed to capture fine or dispersive sediments in runoff from a 95th percentile rainfall event.

The principal surface water management measure is design and implementation of the water management system. However, operation of the Project (including Marulan Creek dam) will be subject to a MOP, which will include a water management plan. The plan will include protocols for monitoring discharges from sediment basins and quarterly monitoring in waterways adjacent to the Project site, and a trigger action response plan if monitoring indicates water quality values have been exceeded.

The Project is in the area of the Greater Metropolitan Region Unregulated Area Water Sharing Plan and Boral will apply for transfers and entitlements to account for Marulan Creek dam and groundwater return flows/recharge.

8 SURFACE WATER

8.1 Introduction

This chapter summarises the surface water technical study report, which is in **Appendix G**. It summarises the simulation of the proposed water management system; potential impacts of the Project on water supply, stream flows, water quality and post-mining impacts; and management and monitoring measures.

8.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on surface water (**Table 8.1**).

Table 8.1: Surface water related SEARs

Requirement	Section and appendix where addressed
▪ an assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the EPA's, NSW Office of Water's and Water NSW's requirements and the NSW Aquifer Interference Policy	8.2.2, Appendix G
▪ an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users;	8.2.2, Appendix G
▪ a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;	8.2.1, Appendix G
▪ demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any Water Sharing Plan;	6.3.10, 8.3.4, Appendix G
▪ a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant Water Sharing Plan or water source embargo;	6.3.10, 8.3.4, Appendix G
▪ a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts;	3.1.8, 4.4.2, 4.6, 8.3.2, Appendix G

The following guidelines were used during the assessment:

- *Independent Inquiry into the Shoalhaven River System* (Healthy Rivers Commission, 1999);
- Neutral or Beneficial Effect on Water Quality Assessment Guideline (Sydney Catchment Authroity, 2015);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000);
- *Southern Rivers Catchment Action Plan* (NSW Southern Rivers Catchment Management Authority, 2013);
- Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (Department of Environment and Climate Change, 2008a); and
- The controlled activity guidelines for works on waterfront land (Department of Primary Industries – Water, 2012) (Natural Resources Access Regulator, 2018).

8.1.2 Overview of assessment methods

The objects of the surface water assessment were to address the SEARs by:

- Describing the existing catchment conditions and flow regime and water quality of waterways in and adjacent to the Project area, which are summarised in **Section 2.2.5**.
- Describing the proposed water management system including water supply and demand requirements and supplementary water supply via a dam on Marulan Creek, which is summarised in **sections 3.1.8** and **4.5**.
- Assessing the potential impacts of changes to flow and water quality from the Project and identifying measures to prevent or manage these impacts.
- Identifying a system to monitor Project impacts on surface and groundwater and initiate additional management measures if required.
- Identify water licensing and approval requirements for the Project, which are summarised in **Section 6.3.10**.

8.1.3 Simulation of water management system

The results of the simulated performance of the proposed water management system are summarised in **Section 8.2.1**. The simulation comprised a daily water balance model to demonstrate the impacts of climate on the water management system and identify potential for water shortages or discharges at the mine. It assumed water demand would be met by the water management system, supplemented with a licensed supply from the Marulan Creek dam after the first two or three years of the Project.

The model accounted for runoff from overburden areas and all inflows to, and losses from, storages over the life of the mine and accounting for rainfall and evaporation. It comprised 98 climate scenarios representing variation in rainfall over the previous 30 years plus a sensitivity analysis for potential climate change.

8.1.4 Water flows and quality

The water balance predicted the frequency of overflows from the water management system into the receiving environment, and the likely quality of the overflow water was considered against the water quality guidelines in **Section 8.1.1**.

The proposed changes to catchment sizes and potential impacts to stream flows were calculated.

8.2 Results

8.2.1 Simulated performance of water management system

Summary

- The water balance produced probability plots for water sources, use, losses and change in water storage for the 10th percentile to 90th percentile climate scenarios, including median for all climate scenarios. The annual median water use and average annual water supply are summarised in **Table 8.2** and the range of results representing wet and dry climate conditions are summarised in **Table 8.3**.
- The main water source for the Project will be runoff, which will be collected in the sediment basins and mine water dams as described in **sections 3.1** and **4.5**. A portion of the collected runoff will be used as supply for dust suppression and plant demands, which will be supplemented by Marulan Creek dam, Tallong dam and the groundwater bore when runoff cannot adequately meet demand (refer to **Section 6.3.10** for summary of extraction

licensing). Groundwater inflow to the pits would not provide significant water supply as most of it will evaporate.

- Dust suppression will account for approximately 60% of water use and will fluctuate depending on climate conditions (i.e. greater demand during dry weather). Process and plant demand will be constant and not influenced by climate.
- During extended drought and when there is a shortage of water in the on-site water storage dams there will be a deficit of up to 5 ML in the water balance (see total of water demand column in Table 8.2). Water use for dust suppression could be reduced to 50% of normal use with chemical dust suppressants. This would reduce the overall site demand in some years by 30% or about 65 ML. Therefore, the mine has an option to ensure that it does not risk running out of water during an extreme dry year or sequence of years.
- Water will mainly be lost from the water management system via seepage from the pits, followed by evaporation from storages and overflows from sediment basins when runoff exceeds their design capacities. Evaporation will be low until all sediment basins and storages have been constructed, then will increase to a maximum around Year 5 and stabilise after Year 7. The amount of evaporation is uncertain as it will be influenced by climate conditions.
- Eighteen to 25% of the runoff into the sediment basins will overflow after rainfall that exceeds the design capacities of the basins. Under median climate conditions there will be an average 1.6 days per year of overflows from the basins (one to two overflows per year) and a maximum of 2.9 days per year, which will be less than the expected frequency in Table 6.2 of (Department of Environment and Climate Change, 2008a).
- The mine water dams will receive water from Marulan Creek dam and balance the water supply when runoff does not meet demand. Water will mostly be supplied from the kiln dam and Eastern Gully dam. Supply from the kiln dam will increase from a median of 10 ML/year in Year 1 to a median of approximately 55 ML/year from Year 4. Supply from the Eastern Gully dam will increase from 0 ML/year in Year 2 to a constant median of 70 ML/year after Year 4.
- Water in the proposed Marulan Creek dam will be maintained near full capacity except during the constant riparian release and transfer of water to the water management system. There would be significant shortfall in water supply without Marulan Creek dam, which could supply a maximum of 183 ML/year.
- The water supply will be 95% reliable, with most variability in reliability occurring up to Year 4 of the 30-year mine period.

Table 8.2: Average annual water balance over life of mine

Water demand		Water supply	
Water use	**Median annual (ML)**	**Water source**	**Average annual (ML)**
Plant demands	80	Runoff	848
Dust suppression	126	Rainfall	36
		Groundwater	14
		Marulan Creek dam	98
		Bore/Tallong weir	7
		Evaporation	-64
		Sediment basin overflow	-9
		Diversion	-7
		Seepage	-714
		Adjustment for change in storage	-8
Total	**206**	**Total**	**201**

Table 8.3: 10th and 90th percentile water supply, use and loss predictions

Range	Water supply (ML/year)				Water use (ML/year)		Water losses (ML/year)		
			Supplementary supply						
	Runoff	Runoff used for supply	Marulan Creek dam	Tallong dam	Dust suppression	Plant	Evaporation	Seepage	Overflows
Low (10th percentile)	279	82	84	15	125	80	20	200	3
High (90th percentile)	1,685	109	109	85	127	80	95	1,575	19

Flooding in pit during operations

An average of 583 ML/year of runoff from the pit catchment and overflows from the water storage dams and sediment basins S1 and W2 will drain to a sump at the base of the pit, which will be 5 m deep and below the lowest level of mining. The average water level in the pit will be 0.5 m for most of the time. However, heavy rain will cause the sump to fill and extreme rain will cause flooding up to 7.9 m above the pit floor. This water will seep away quickly and there will be no long term accumulation of water in the pit.

Sensitivity analysis

The sensitivity of the model to climate change impacts on median annual rainfall was assessed by applying multipliers of 0.8 (for less rainfall) and 1.2 (for more rainfall) to the runoff calculations. The model demonstrated:

- A change in runoff of ±20% will lead to a range of changes in the average supply from the Marulan Creek dam of -6.5% to +9% for all climatic conditions.
- A change in runoff of ±20% will lead to an average increase in overflow from the sediment basins by about ±35% for median climate conditions. However, the number of days per year of overflow remains in the expected range in (Department of Environment and Climate Change, 2008a).

An increase in runoff by a factor of 1.2 will increase the maximum water level in the pit from between 12.9 m to 16 m, which will quickly seep into the base of the pit.

Post mine closure water management

The mine will be rehabilitated as described in **sections 4.5** and **4.9**. the post Mine closure water balance model was based on the assumptions in Section 7.12 of **Appendix G** and determined an average of 466 ML/year of runoff will flow into the void. This will result in minor quantities of water in the base and would occasionally hold water up to 13 m deep. All water in the base of the void will be lost to seepage and there is no risk of overflow from the void.

Main Gully will be restored to be similar to the pre-mining landscape, comprising a catchment of approximately 136 ha of rehabilitated land and an average annual surface water flow of 102 ML/year, which is similar to the pre-mining flow of approximately 122 ML/year.

The Tangarang Creek catchment will increase by 50 ha, which will drain to Tangarang dam (the Peppertree Quarry water supply). This will lead to a 9% increase of average annual inflow to the dam, however, there will be a negligible impact on the daily flow regime.

8.2.2 Surface water impacts

Catchment areas

Catchment areas and receiving waters that will be impacted by the Project are summarised in Table 8.4.

Table 8.4: Changes in catchment areas in Project area

Catchment	Receiving water	WSP management zone	Existing catchment area (ha)	Future catchment area (ha)	Overflow control
NOE (north-west corner)	Tangarang Creek (north-eastern tributary)	Barbers Creek	40	73 (26 ha overburden emplacement)	Sediment Basin N2 with controlled discharge
WOE (northern section)	Tangarang Creek (north-eastern tributary)	Barbers Creek	99	116 (49 ha overburden emplacement)	Sediment Basin W1 with controlled discharge
Tangarang Creek upstream of Tangarang Creek dam	Tangarang Creek dam	Barbers Creek	614	664 (75 ha overburden emplacement)	See above
WOE and adjoining areas	Main Gully	Bungonia Creek	38	186 (93 ha overburden emplacement)	Sediment Basin S2
Tributaries of Barber Creek	Barbers Creek	Barbers Creek	98	98 (65 ha overburden emplacement)	Revegetated Overburden Emplacement (Eastern Batters)
Tributaries of Bungonia Creek	Bungonia Creek	Bungonia Creek	45	45	Revegetated Overburden Emplacement (Eastern Batters)

Changes to catchments will result in minor impacts to flows, comprising the overflows of sediment dams described in the summary section of **Section 8.2.1**.

It is expected there will be a requirement in the water licence for the Marulan Creek dam to maintain a daily riparian release. The dam design will allow for release of water and this has been included in the water balance. This release will result in a flow of 0.3 ML/day and annual average flow downstream of the dam will reduce from 1,023 ML/year currently to 829 ML/year during operation of the Project.

The flow regime upstream of the dam full storage level will not change (above 597 m AHD), with no impact on stream geomorphology. Downstream of the dam embankment, riparian releases will maintain a similar flow regime when the dam water level is below the full storage level. When the dam is full, flow in the creek will pass through the dam spillway such that downstream flow is the same as that upstream. With the maintenance of a similar flow regime in Marulan Creek, creek geomorphology downstream of the dam is not expected to be impacted.

Water quality

Water will be released from the mine as the occasional overflows from the water management system described in **Section 8.2.1** and clean runoff from rehabilitated overburden emplacement areas following completion of mining. Seepage from the mine pit is not considered a release.

As described in **Section 8.2.1**, there will be an average 1.6 days of overflows at the sediment basins per year. This is in the range of one to two overflows per year as specified (Department of Environment and Climate Change, 2008a) for sediment basins designed to capture fine or dispersive sediments in runoff from a 95th percentile rainfall event before discharging to sensitive environments. This level of treatment is consistent with requirements of the NorBE checklist.

Dissolved metals and metalloids in initial runoff and seepage from most overburden emplacements are unlikely to mobilise and impact surface water quality as they are sparingly soluble in slightly alkaline contact water.

The proposed water management system will reduce sediment loads in the pit, which will result in less sediment discharge to groundwater and its receiving waters. Further, infilling of the south pit will increase the distance between the pit and discharge points along Bungonia Creek. Infilling will also slow the rate of seepage from the pit, which will act as a large sediment basin.

Water quality in the Marulan Creek dam will be similar to the baseline water quality in Marulan Creek. The dam riparian release arrangement will be determined during detailed design, detailing the dam offtake points and how releases are made at different dam levels. Riparian release water quality will be like the baseline conditions, with seasonal variation in water quality parameters depending on catchment conditions and rainfall. No impacts on downstream water quality are anticipated as a result of the operation of the dam.

Flooding

As described in **Section 8.2.1**, there could be minor flooding of the pit floor during operations and post-mining, however, this will not result in overflows from the pit during floods.

The Marulan Creek dam wall will be approximately 1 km downstream of a railway bridge. The potential for floods upstream of the dam to impact this bridge was assessed using the 1% annual exceedance probability (AEP) flood. The 1% AEP flood would currently pass below the bridge. Including the dam in the model resulted in a 0.5 m increase in water level upstream of the dam, which would not inundate the railway.

The extent of flooding in the Marulan Creek dam will be controlled by the spillway geometry. Detailed design will ensure that the extent of flooding remains within Boral owned land, through adjustments to the spillway design. The maximum extent of flooding in a 1% AEP flood is shown on **Figure 4.11**.

8.2.3 Cumulative impacts

As described in **Section 8.2.1**, the Project may slightly increase flows to Tangarang Creek and the Peppertree Quarry's water source. This will have a negligible impact on the daily flow regime.

The nearby Lynwood Quarry may contribute a 6 mm increase in the flood level of Marulan Creek immediately downstream of the quarry during the 20 year annual recurrence interval storm. This will not have any discernible impact on flow and water quality in Marulan Creek.

8.3 Management measures

8.3.1 Erosion and sediment control

The principal surface water management measure is design and implementation of the water management system, which is described in **sections 3.1**, **4.5** and **4.9**. The key feature of this system is to divert runoff from the overburden emplacements to sediment basins designed and operated in accordance with (Department of Environment and Climate Change, 2008a).

Construction of the Marulan Creek dam will be subject to a construction environmental management plan (CEMP), which will include an erosion and sediment control plan prepared in accordance with (Department of Environment and Climate Change, 2008a).

Construction of a new section of Marulan South Road will be subject to the standard erosion control measures in Appendix D of (Department of Environment and Climate Change, 2008b).

Operation of the Project will be subject to a MOP, which will include a water management plan (WMP) for the mine and Marulan Creek dam. The WMP will detail the final water management system design and will include provision for training, community consultation, complaint resolution protocols, strategies for performance improvement and responses to exceedances.

The WMP will include a trigger action response plan (TARP), which will identify triggers, actions and responses based on the guidelines listed in **Section 8.1.1**.

8.3.2 Water quality monitoring

Discharges

As described in **Section 8.2.1**, there will be occasional discharges from the sediment basins to the streams in **Table 8.5**. The following parameters will be monitored in accordance with (Deprtment of Environment and Conservation, Approved methods for the Sampling and Analysis of Water Pollutants in NSW):

- oil and grease;
- pH;
- total suspended solids; and
- turbidity.

Table 8.5: Discharge locations

Receiving water	Discharge structure	Type of discharge	Monitoring
Main Gully	Sediment Basin S2 and automatic water sampling facility	Discharge to water	Daily samples collected during any discharge offsite, except where rainfall exceeds the design criteria
North-eastern tributary of Tangarang Creek	Sediment Basin N2	Discharge to water	Daily samples collected during any discharge offsite, except where rainfall exceeds the design criteria
Eastern tributary of Tangarang Creek	Sediment Basin W1	Discharge to water	Daily samples collected during any discharge offsite, except where rainfall exceeds the design criteria

Quarterly monitoring

The quarterly ambient surface water quality monitoring described in **Section 2.2.1** will continue during the Project. However, monitoring may cease in Barbers Creek and the Shoalhaven River once the NOE and WOE and externally draining sections of the SOE are complete and rehabilitation is established. This will depend on results of initial monitoring after completion of these emplacements.

Trigger values

The TARP will incorporate the trigger values in **Table 8.6**, which modify the (Australian and New Zealand Environment and Conservation Council, 2000) guidelines for ecosystem protection to account for the 20^{th} and 80^{th} percentile values from historical monitoring in the Shoalhaven River.

Table 8.6: Trigger values for Bungonia Creek and Barbers Creek

Parameter	ANZECC default trigger for ecosystem protection	Trigger values
pH	6.5 – 8.0	6.5 – 8.5
EC (µS/cm)	350	1,600
Total nitrogen (mg/L)	0.25	4.0
Total phosphorus (mg/L)	0.02	0.03
Turbidity (NTU)	25	25
Total suspended solids (TSP) (mg/L)	N/A	50

The values will be triggered by results of monitoring upstream and downstream of the mine on Barbers and Bungonia creeks and used as follows:

- 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.

8.3.3 Water balance

Water levels in the mine water dams will be recorded monthly and flowmeters will be installed on transfer pipelines and water use points such as the lime plant and dust suppression outlets that will record flow rates and total flows. The data will be cross referenced with the water balance to confirm its accuracy and predict water supply shortfalls.

8.3.4 Licensing

Boral will seek to transfer its existing entitlement for water from Tallong Weir and/or acquire any additional water licences from the Barbers Creek management zone to cover the maximum supplementary 183 ML/year supply from Marulan Creek dam.

Under the 2011 Greater Metropolitan Region Groundwater Sources WSP, groundwater extraction requires an authorisation under a water access licence or some form of exemption. The mine currently has two bores with a total entitlement of 12 ML/year. These bores would most likely run dry early in Stage 1 of the Project, if not before, due to the north advancing mine pit.

There is no process in place to consider return flows/groundwater recharge. Therefore, all groundwater take (incidental or otherwise) needs to be accounted for by obtaining a groundwater entitlement sufficient to account for the peak take prior to that extraction occurring. In order to address this requirement Boral obtained additional groundwater entitlement (WAL41976) of 838ML in September 2017.

Dams on first or second order streams used solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source are ‘excluded works’ and do not need to be licensed under the WM Act. Therefore, it is expected that the sediment basins and mine water storage dams proposed for the Project would not require licensing.

Other dams totalling 29.2 ML could be constructed on first or second order streams without the requirement for a licence under harvestable rights.

A works approval to construct and operate the Marulan Creek dam would be obtained from DPI–Water. Works supply approvals and controlled activity approvals under the WM Act are not required for SSD.

8.4 Residual impacts

The primary residual impacts on surface water will be the overflows from the sediment basins, water accumulation in the void post-mining, and reduction in flows in Marulan Creek downstream of the Marulan Creek dam.

The overflows from the sediment basins will be within the range specified in (Department of Environment and Climate Change, 2008a) and will be consistent with NorBE. Therefore, the overflows will not have a significant impact on the receiving waters.

Water could accumulate up to 13 m above the base of the void after mining has ceased. This will not result in flooding in adjacent areas as the water will not accumulate above the top of the void walls.

Seepage will occur from the base of the Marulan Creek dam to maintain daily riparian flow along Marulan Creek downstream from the dam.

Chapter 9

Groundwater

VOLUME 1

Groundwater

Groundwater sources in the Project site are shallow unconsolidated aquifers and deep consolidated aquifers. The main groundwater system in the Project site is the limestone targeted for mining. The predominantly north-south jointing/fracture pattern in the limestone is the main flow pathway in the limestone.

Groundwater storage and flow in the limestone body is influenced by fractures, jointing and solution-enhanced fissures. This results in rapid flow through fissures and solution cavities, while the limestone matrix itself is relatively impermeable.

The water table elevation up gradient from the mine is between 550 m and 600 m with a relatively low gradient. The hydraulic gradient of the water table steepens considerably closer to Bungonia and Barber's creeks with groundwater discharging into the gorge and 'daylighting' at springs on the northern face of the gorge. The recharge zone is likely to be the exposed limestone in the mine and outcrop, where higher permeability and exposure allows direct rainfall recharge.

There are 22 bores registered on the NSW Government's Pinneena database around the Project site, which are for domestic water supply and a few for industrial use. There is Shoalhaven Gorge Forest in the southern (into Bungonia Gorge) and eastern (into Barbers Creek) slopes of the Project site, which has high potential for groundwater interaction. There is also spring dependent flora of high ecological value along Barbers Creek and Bungonia Gorge.

A numerical model was developed which demonstrated the Project will result in up to a 1 m drawdown of groundwater, which will not extend to bores held by other groundwater users. Therefore, 'make good' arrangements with surrounding land owners will not be necessary. Mining will result in a slight increase in groundwater inflows of 1 m^3/day over 30 years to the pits due to the increased groundwater gradient towards the pits. The increased pit inflows will result in a slight increase in spring flows down gradient.

The modelled level and extent of drawdown will be verified by groundwater monitoring, and changes will be investigated if drawdown is deeper or more extensive than predicted.

The Project will not change the current quality of groundwater as the current recharge pathways are not proposed to be altered. Changes to groundwater levels and quality will be investigated if monitoring results deviate from historical monitoring results.

9 GROUNDWATER

9.1 Introduction

This chapter summarises the groundwater technical study report, which is in **Appendix H**. It describes the hydraulic properties of the geology underlying the Project area; potential impacts on groundwater level and quality; and mitigation measures where impacts are unavoidable.

9.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on groundwater (**Table 9.1**).

Table 9.1: Groundwater related SEARs

Requirement	Section and appendix where addressed
an assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the EPA's, NSW Office of Water's and Water NSW's requirements and the NSW Aquifer Interference Policy	9.3.2, 9.3.5, Appendix H
an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users;	9.3.1, 9.3.2, Appendix H
a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant Water Sharing Plan or water source embargo;	6.3.10, Appendix H
a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts;	3.1.8, 4.4.2, 4.6, 9.4, Appendix H

The following guidelines were used during the assessment:

- NSW Aquifer Interference Policy (NSW Government, 2012b);
- Neutral or Beneficial Effect on Water Quality Assessment Guideline (Sydney Catchment Authroity, 2015);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000); and
- Australian Groundwater Modelling Guidelines (National Water Commission , 2012).

9.1.2 Overview of assessment methods

Summary

The following methods were used during the groundwater assessment:

- Review and collate existing geological and groundwater information and identify data gaps.
- Review of relevant statutory requirements and development of impact assessment criteria.
- Field work to gather additional data to support the assessment.
- Identify and describe the existing environment in the context of groundwater levels and quality (baseline conditions), relevant groundwater sources, GDEs and water users.
- Develop a conceptual model of the groundwater system and interconnected surface water systems.

- Develop a numerical model reflecting the conceptual model to assess the potential impacts including estimating:
  - groundwater take from alluvial and consolidated strata water sources;
  - potential changes to baseflow in connected streams;
  - potential influence on water users including groundwater dependent ecosystems (GDEs);
  - predictions of during and post mining groundwater conditions;
  - predictions for potential cumulative impacts; and
  - water licensing requirements, including consideration of proposed activities to operate within relevant water sharing plan (WSP) rules and available allocations.
- Identify and recommend avoidance, mitigation and adaptive management and monitoring strategies to minimise potential groundwater impacts.
- Document the outcomes of the study in a technical report addressing the SEARs and the (NSW Government, 2012b) as part of the EIS.

Isotope analysis

Four water samples were collected in February 2015 from MW1, MW2 and the ‘blowhole’ and ‘Main Gully’ sampling points for source analysis and dating using the deuterium, oxygen-18 tritium and carbon-14 isotopes.

Hydraulic properties, gradients and flows

In-situ permeability slug tests were conducted in the groundwater monitoring wells installed in 2014 to measure the hydraulic conductivity within the limestone and overburden.

Bulk hydraulic properties were tested in 2013 and 2015 by measuring the seepage of ponded stormwater in the north and south pit floors by placing a pressure transducer in the pit floor, which monitored the accumulated rate of seepage into the underlying limestone. The pressure transducer data from the pits were combined with water level and volume estimates from direct observations on-site and used to analyse the discharge rate through the pit floors.

Water levels in off-site groundwater bores collected during a bore census in 2015 and water levels of on-site groundwater monitoring wells, recorded since their installation in 2014, were interpolated to produce water level contours, which show the regional groundwater flow direction.

Figure 2.7 presents a simplified cross-section of the conceptual model showing the groundwater system and interconnected surface water systems including stratigraphy, groundwater flow, recharge and discharge zones.

Groundwater flow model

The impact of the future mining activities was assessed against the Aquifer Interference Policy ‘minimal impact considerations’ for less productive groundwater sources using a numerical groundwater flow model, with assessment focussed on the:

- volume and quality of groundwater flowing to the creeks and springs that occur between the mining area in the west and the Barbers and Bungonia gorge systems in the east and south-east; and
- water level at private water bores in the plateau to the west of the mine.

The following specific impacts were assessed:

- groundwater take from the alluvial and fractured/sedimentary rock water sources;
- baseflow reduction;
- influence on GDEs; and
- water licensing requirements.

While the numerical model does not simulate changes in groundwater quality, it was used as a tool to qualitatively assess the potential for significant changes in groundwater quality.

A Class 2 groundwater model (which is recommended for assessing impacts of major projects) was prepared using the MODFLOW-USG modelling code. The mining schedule in **Figure 4.7** was modelled.

The model covered 38.7 km^2 around the Project area with approximately 10 m by 10 m cells in the Project area (to represent structural features) and approximately 200 m by 200 m cells outside the Project area. Most of the model boundaries were located along watershed lines, assuming that the water table is a subdued reflection of the surface topography with topographical highs that translate into groundwater divides. Where groundwater divides were not thought to exist, a general head boundary condition was implemented along the edge of the model to allow for the model domain to interact with outside influences such as aquifer systems continuing beyond the boundary.

The model consisted of ten layers. The uppermost layer represents unconsolidated sediments and regolith as well as areas of alluvium adjacent to the significant streams within the model domain. Layer 2 to Layer 10 represent the bedrock, including structural (linear) features such as faults, weathering contact zones and volcanic intrusions (dykes). The bedrock was divided into layers with the intent to capture the major elevations of the pit floor during proposed mining expansion as well as other structural features such as the karst system behind the Main Gully Spring Cave ('Blowhole').

In terms of model limitations, the fractured nature of the limestone along with the karst properties means the model is not capable of representing the small scale geological detail in the limestone body. However, it is adequate to assess the impacts of the mine on the adjacent groundwater systems, groundwater users and GDEs.

Assumptions about the existence of the karst conduit system are based on the discharge points (springs) in Bungonia Gorge. Although not precisely defined in terms of spatial extent and interconnectedness, its function as drainage is understood enough to be modelled with sufficient level of precision, especially where the dewatering impacts on groundwater levels surrounding the mine are concerned.

9.2 Results

There were two outputs from the groundwater model:

- predicted groundwater levels (heads); and
- predicted groundwater budgets, which were used to estimate flows into the mine pit or other areas of interest.

The model was run with and without the mining scenarios to determine the influence of proposed mining activities on the groundwater system.

9.2.1 Groundwater levels

Predicted groundwater levels at the end of mining shows the same general trend observed at the start of the mining process, which is consistent with the conceptual model. Groundwater will move from higher terrain in the north-west and west to lower areas in the east and south-east, and water will continue to drain to the gorges of Barbers and Bungonia creeks as mining progresses.

The bedrock blocks intersected by fractures will continue to drain as per the conceptual model. The only major barrier to drainage of the granodiorite north of the pit is the dolerite dyke which runs across the north of the existing north pit.

The groundwater elevation below the active mining area will stabilise between 210 m and 250 m AHD as the active fractures connect the bedrock with the Bungonia Creek alluvium. Therefore, the groundwater in the limestone will discharge into the Bungonia Creek alluvium and contribute to the flow of Bungonia Creek.

There will be minimal change in groundwater levels in areas outside the limestone bodies during mining, which confirms the concept of a combined porous and fractured aquifer system with interconnected fractures that have pre-drained the limestone. Therefore, mining will only remove water from the porous space of the rock.

Looking out to 250 years after mining there will be continued drainage from the limestone, with the only change being a slight increase in recharge due to the larger overall pit size. This will result in an increased baseflow to Bungonia Creek.

9.2.2 Groundwater budgets

Water take from fractured bedrock aquifers

The water budget for inflows to the mine pit from the surrounding bedrock is small (average 9.1 m^3/day) compared to the main recharge source, which is rainfall (average 142.4 m^3/day). Most of the water flows out of the pit via bedrock seepage through the underlying limestone karst system (approximately 111 m^3/day).

Pit inflows

While the water table is below the pit floor as the limestone is mostly drained from the interconnected fracture systems, water can still flow into the pit from the pit walls. This water originates from water stored in the rock itself, and has the potential to increase as the pit wall dimensions increase with each stage of mining.

The take from the ore body (limestone) and overburden (sandstone and shale) aquifers is likely to be 19 m^3/day (7 ML/year) to 63 m^3/day (22 ML/year) with an average take of 39 m^3/day (14.2 ML/year).

Water take from alluvial aquifers

The model accounted for three alluvial zones associated with the Shoalhaven River, Bungonia Creek and Barbers Creek, which are not extensive but are key groundwater sinks. The alluvium receives water from the:

- associated river or creek, which recharges the aquifer through the stream bed;
- groundwater, which seeps across or upwards from the bedrock; and
- rainfall, which is minimal compared to the other sources given the small surface area of the alluvium.

Groundwater from the alluvium is also lost as base flow to the river and creeks, and seepage into the bedrock and downstream areas of alluvium. A minor quantity is lost through evapotranspiration.

The majority of water in the Shoalhaven River alluvium is from the river, with contributions from the alluvium along the Bungonia and Barbers creeks and the bedrock and weathered regolith. These sources can contribute as much as 151 m^3/day, with rainfall contributing only 6 m^3/day of this total.

Bungonia and Barbers creeks have intermittent flows, with their alluvial zones receiving on average 17 m^3 and 23 m^3, respectively, per day from the streams. The Bungonia Creek alluvium also receives approximately 601 m^3/day from the bedrock that is fed by a system of fractures in the limestone.

The Shoalhaven River and Bungonia Creek provide an outflow for the alluvial aquifer, with the river alluvium discharging an average of 391 m^3/day and the creek alluvium discharging 454 m^3/day. No water is discharged from the Barbers Creek alluvium to the creek as it loses water via down valley flow (approximately 81 m^3/day to the Shoalhaven River alluvium and 6 m^3/day via seepage).

Groundwater extraction for water supply

The water balance prepared during the surface water assessment (**Appendix G**) demonstrated that there would be a water deficiency for the mine should the Marulan Creek dam not be constructed. A contingency option is to source groundwater for mine use from approximately six wells between the mine and Peppertree Quarry. Extraction from these potential wells was modelled to determine the quantity of water available for extraction.

The wells would be drilled into the granodiorite between the mine and Peppertree Quarry, which has low horizontal hydraulic connectivity. The model predicted the pumping rate will vary from 80 ML/year in model year 2018 and will quickly reduce to 25 ML/year in 2019 followed by a slow decline to 18 ML/year in 2049.

The model had significant limitations based on data availability and uncertainty about the locations of fractures in the granodiorite. Notwithstanding, the predictions are valid given it has been previously established there is insufficient groundwater stored in the granodiorite for any meaningful extraction.

9.3 Impact assessment

Potential impacts on groundwater from the mine were determined from the difference between the modelled no-mining and mining scenarios in heads (groundwater drawdown) and flows (impact on bedrock and alluvial aquifers).

The no-mining scenario comprises the current state of the mine if it was only subject to rainfall recharge and evapotranspiration. The mining scenario will result in changes to the existing landform and introduces removal of groundwater by mining activities, in addition to the rainfall recharge and evapotranspiration.

9.3.1 Fractured rock aquifers around the mine

Proposed expansion of the mine to the west into the limestone-sedimentary-metamorphic blocks will have minimal impacts on groundwater as this area has already been drained by the naturally occurring interconnected structural features. The only groundwater that will be removed in this area will be that contained in the porous spaces of the limestone.

Mining will result in a slight increase in groundwater inflows to the pits due to the increased groundwater gradient towards the pits, which will increase to 1 m^3/day over the proposed 30-year mine life. As the water intercepted by model drains ceases to be available to discharge back to the fractured geological environment, the outflows will decrease by ~24 m^3/day (8.8 ML/year)

9.3.2 Groundwater users

Groundwater drawdown will be more extensive in the upper north pit and along the eastern edge of the pit between the current north and south pits by the end of mining. The 1 m drawdown contour encompasses the area from approximately 620 m northeast of the northern edge of the pit to approximately 290 m from the eastern edge of the current pit (**Figure 9.1**).

The 1 m drawdown contour will expand after mining to reach equilibrium approximately 1.2 km to the north-east of the void and approximately 600 m to the west and east of the void (**Figure 9.2**).

No groundwater users will be impacted by the Project, and Boral's current production wells WP16/WP17 and in-pit monitoring wells MW1 and MW2 will be consumed by the mine.

Figure 9.1
Predicted groundwater drawdown - End of mining (year 30)

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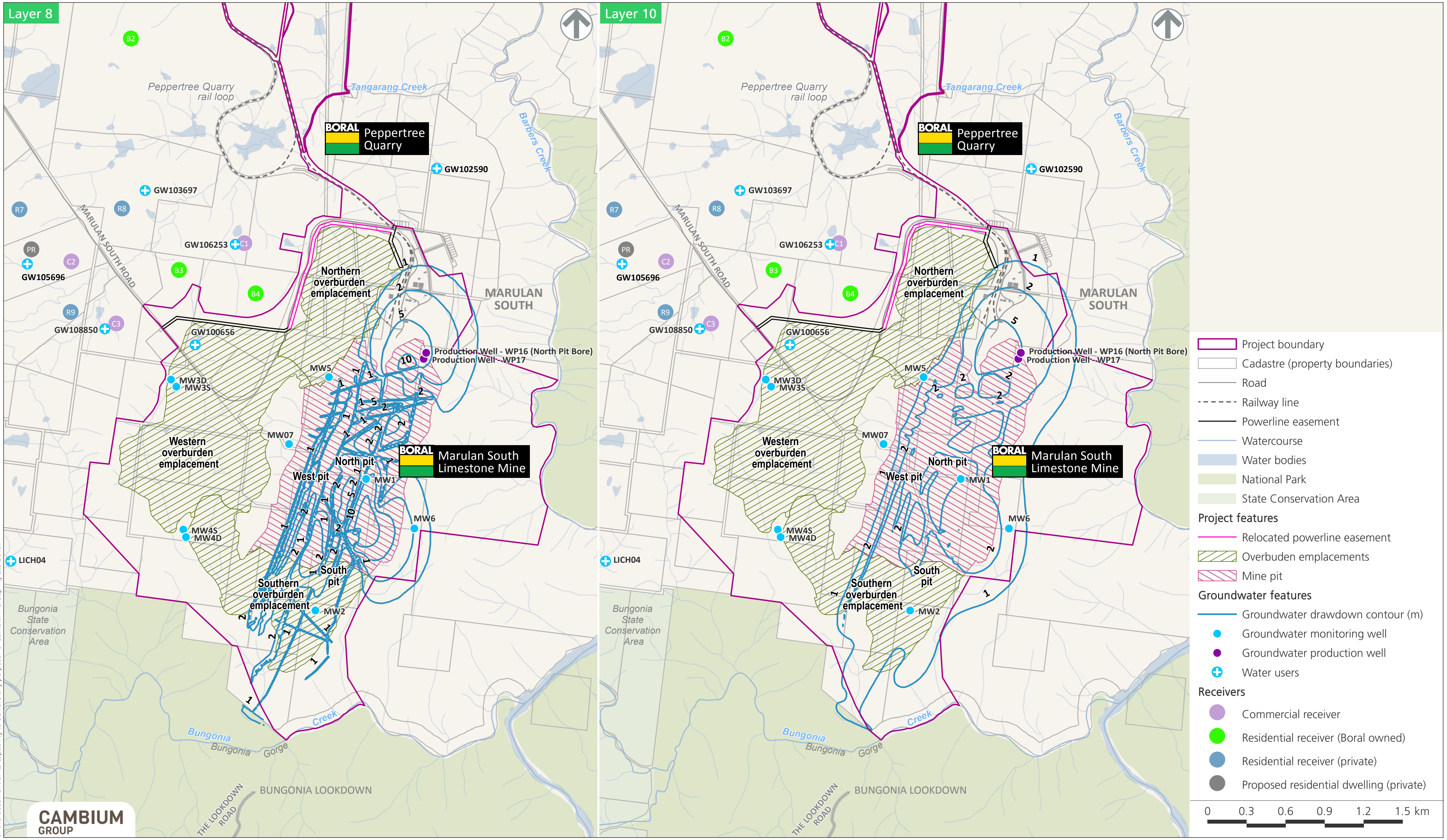
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Commonwealth of Australia (Geoscience Australia) (2011), Australasian Groundwater and Environmental Consultants Pty Ltd (2018), Cambium Group (2019).

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Figure 9.2
Predicted groundwater drawdown - Post mining equilibrium (Year 2300)

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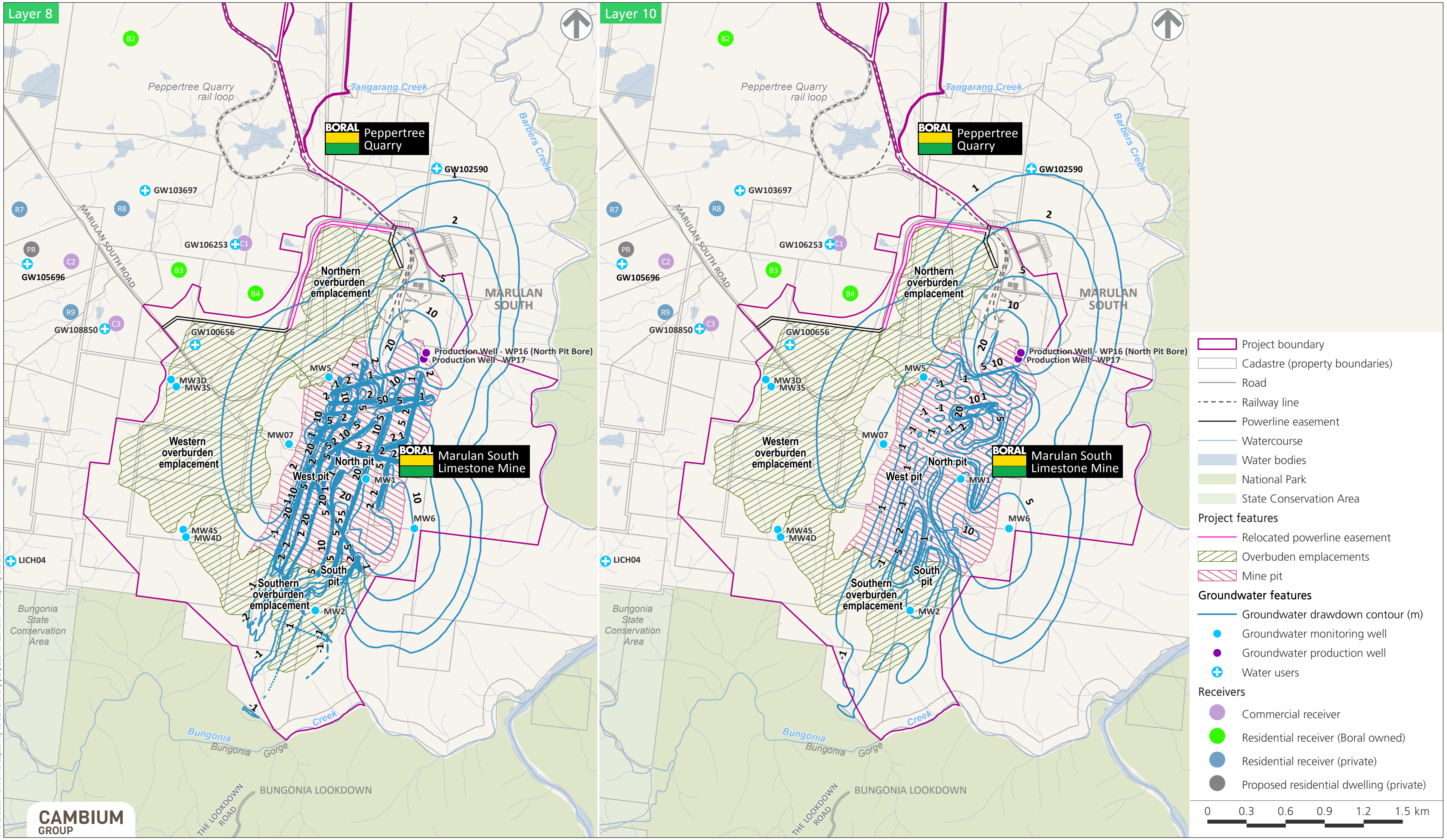
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Commonwealth of Australia (Geoscience Australia) (2011), Australasian Groundwater and Environmental Consultants Pty Ltd (2018), Cambium Group (2019).

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9.3.3 Groundwater dependent ecosystems

According to the BOM's Groundwater Dependent Ecosystem Atlas, the following areas have potential for groundwater interaction (**Figure 9.3**):

- There is high potential the eastern slopes down to Barbers Creek and the southern slopes of Bungonia Gorge rely on subsurface presence of groundwater.
- The area immediately west of the existing pit has a moderate to low potential for interaction with groundwater.
- There is high potential that Bungonia and Barbers creeks rely on surface expression of groundwater.
- The Main Gully drainage line has moderate potential for groundwater interaction.

The following GDE types were identified in the Project site during the stygofauna surveys (described in **Section 14.2**):

- subsurface phreatic (deep groundwater) aquifer ecosystems;
- baseflow stream (surface ecosystems);
- baseflow stream (hyporheic ecosystems); and
- phreatophytes - groundwater dependent terrestrial vegetation.

Flora and fauna surveys identified aquatic fauna and spring dependent flora of high ecological value along drainage lines, especially Barbers Creek and Bungonia Gorge. There is no apparent impact of current mining activities on the aquatic fauna and the potential groundwater drawdown associated with the Project is unlikely to impact GDEs as the drawdown zone only marginally overlaps with the zones with high potential for groundwater interaction.

9.3.4 Springs

Springs have been observed at the base of Bungonia Gorge and are assumed to occur elsewhere near the mine where the water table is intersected by the slopes of gorges. Springs are unlikely to be adversely impacted as mining is likely to result in an increase of 11 m^3/day of outflow from the pit to the underlying geology.

9.3.5 Groundwater quality

The limestone aquifer is currently recharged by rainfall, surface runoff and from adjacent geological units. The Project will not change these recharge pathways, provided the surface water management measures in **Section 8.3** are implemented, which will maintain surface water flow and quality in the pit. The geochemical investigation of the overburden and limestone ore (**Section 11.2.3**) demonstrated that overburden emplacement and ore stockpiling will have a minimal to negligible impact on groundwater quality.

Recharge from the bedrock into the Bungonia Creek alluvium is likely to only reduce by 1% as a result of the Project, and therefore there is unlikely to be any detrimental impact to the Barbers Creek alluvium. Therefore, impacts on the baseflow water quality of the creeks is likely to be minimal as changes to flows will be minimal and there will not be any additional contaminants in pit water.

9.3.6 Marulan Creek dam

The clayey weathered granodiorite profile below the proposed Marulan Creek dam could provide a hydraulic barrier between the body of water and the underlying groundwater system. Leakage of surface water from the dam into the groundwater will be limited and the dam is likely to have minimal impact on the groundwater regime.

9.3.7 Cumulative impacts

The mine is adjacent to the Peppertree Quarry, which was not included in the groundwater model as it is a shallow quarry with negligible groundwater impacts.

Groundwater impacts from the Project are likely to be confined to the mined limestone body and adjacent geological units. This is due to the geological constraints which limit flow in the east to west direction.

Figure 9.3
Impact of mining on groundwater dependent ecosystems

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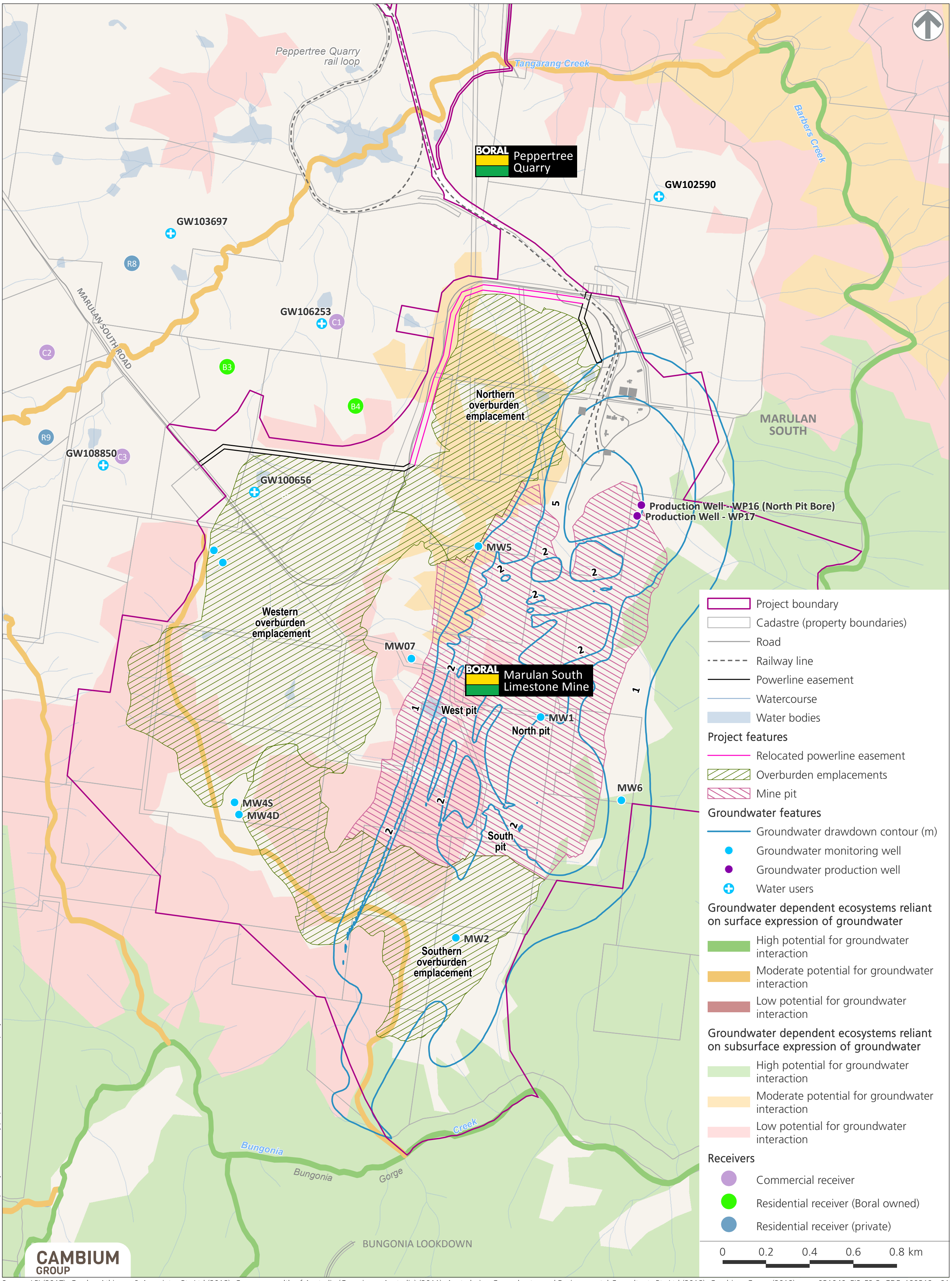

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Commonwealth of Australia (Geoscience Australia) (2011), Australasian Groundwater and Environmental Consultants Pty Ltd (2018), Cambium Group (2019).   031040_EIS_F9-3_GDE_190319_v01

9.4 Management measures

There is an established ground and surface water monitoring network around the mine, which will continue to be used and maintained during the life of the Project and includes sampling points at the drainage line below two springs south of the south pit in Bungonia Gorge. Monitoring will include:

- Water level monitoring – Boral will continue to download data from the pressure transducers in the groundwater monitoring wells, which electronically record water levels.
- Water quality monitoring – Boral will continue to sample from the monitoring wells for acidity, salinity, major cations, major anions, metals and fluoride.

The monitoring wells will continue to be monitored at quarterly intervals, with data used to compare the extent and rate of depressurisation against the model. The existing monitoring network will also be used to monitor seepage from the overburden storage areas. Monitoring results and analysis will continue to be reported in the annual environmental management report.

Changes to groundwater levels and quality will be investigated if monitoring results deviate from historical monitoring results.

Groundwater monitoring wells which are removed during mining will be replaced over the life of the Project if determined to be necessary by an appropriately qualified groundwater specialist.

9.5 Residual impacts

The primary residual impact on groundwater from the Project is likely to be an approximately 1 m drawdown of the water table at equilibrium (year 2300) to approximately 1.2 km north-east of the northern extent of the mine, and approximately 600 m east and west of the final void. This drawdown is not predicted to impact any private groundwater bores. Therefore, 'make good' arrangements with surrounding land owners will not be necessary. The modelled level and extent of drawdown will be verified by groundwater monitoring, and changes will be investigated if drawdown is deeper or more extensive than predicted.

Chapter 10

Soils and land capability

VOLUME 1

Soils and land capability

Soils in the Project site were surveyed and mapped using 63 samples and observations made over 13 test pits and six archaeological test pits to identify suitable soil for use during rehabilitation and to determine the Project site's land and soil capability.

There are a mix of texture contrast and shallow soils across the main Project site and Marulan Creek dam site. The duplex soils comprise Kurosols in lower sections and Sodosols on mid and upper sections. The shallow soils comprise Tenosols and Rudosols on steep slopes and ridges and there are narrow areas of Alluvial Rudosols along Barbers and Bungonia creeks.

There are land capability classes V to VIII in the Project site, which are moderate/low to extremely low capability land. Land uses in these land and soil capability classes are severely to extremely limited. There is no biophysical strategic agricultural land in the Project site.

Only the A1 horizon of the duplex soils is suitable for stripping, of which there will be 245,510 m3 available for rehabilitation. Given the low pre-disturbance land capability classes (V, VII and VIII) of the land proposed to be disturbed, the Project will have minimal negative impact on the overall land capability. Further, there is only infrequent and temporary agricultural activity in the Project site, comprising occasional grazing associated with a lease over a section of the Project site.

10 SOILS AND LAND CAPABILITY

10.1 Introduction

This chapter summarises the soils and land resources sections of **Appendix I**. It describes the soils and land capability of the Project site; outcomes of the site verification certificate process; potential impacts and mitigation measures where impacts are unavoidable.

10.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on soils, land capability, landforms and agriculture as well as the compatibility of the Project on other land uses in the vicinity (**Table 10.1**).

Table 10.1: Soils and land related SEARs

Requirement	Section and appendix where addressed
▪ an assessment of the likely impacts of the development on the soils, land capability, and landforms (topography) of the site;	10.3.1, 10.3.2, Appendix I
▪ an assessment of the likely agricultural impacts of the development; and	10.3.2, Appendix I
▪ an assessment of the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements in Clause 12 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.	6.4.1

The following guidelines were used during the assessment:

- Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (NSW Government, 2013);
- Guidelines for Surveying Soil and Land Resources (al, 2008);
- Australian Soil and Land Survey Handbook (National Committee on Soil and Terrain, 2009);
- *Australian Soil Classification* (Isbell, 2002); and
- The Land and Soil Capability Assessment Scheme: Second Approximation – A General Rural Land Evaluation System for New South Wales (Office of Environment and Heritage, 2012).

10.1.2 Overview of assessment methods

The following methods were used during the preparation of **Appendix I**.

Desktop study

A preliminary soil and landscape map was produced to guide selection of field investigation sites, referencing the following:

- surface geology mapping;
- regional biophysical strategic agricultural land (BSAL);
- land and soil capability mapping (there is no detailed soil mapping of the area, however, the *Soil Landscapes of the Goulburn 1:250,000 sheet* maps soil units to within 900 m of the Project site);
- soils and landscape information in Boral documents;
- aerial photography and LiDAR imagery; and

- soil profile and landscape information in OEH's Soil and Land Information System (SALIS).

Field survey

The Project site was inspected on 7 April 2015 to ground truth the preliminary soil and landscape map, make initial landscape observations and finalise the soil investigation locations.

Thirteen test pits were excavated up to 1.4 m deep in June and July 2015 for detailed soil profile description (sites 1 – 14, excluding 10 due to accessibility constraints). The sites provided even and representative coverage of the Project site, with emphasis on proposed disturbance areas.

The soil unit boundaries were also observed in six archaeological test pits.

The test pits and surrounding landscape were photographed and described, and the soil profiles were described in terms of boundary depths, colour, texture, structure, moisture, fragment size, presence of roots and field chemical parameters such as pH and carbonates.

Sixty three samples were sent to the NSW Soil Conservation Service Laboratory and analysed for pH, electrical conductivity, cation exchange capacity and exchangeable cations for calculation of exchangeable sodium percentage. Seven samples which indicated moderate to high dispersion in field testing also underwent an emersion aggregate test.

The preliminary soil and landscape map was revised with the soil test results and field observations to create a soil landscape unit map (**Figure 2.8**).

Topsoil resources

Soil proposed to be disturbed for the Project was analysed for its suitability for use as a post-mining vegetation growth medium. Analysis of the topsoil for use during rehabilitation comprised:

- identifying areas of soil that will be stripped in the Project site;
- identifying suitable topsoil in these areas based on structure, coherence, texture, pH, salinity, mottling, root presence and sand/gravel content;
- mapping the topsoil (**Figure 2.8**) accounting for suitable depth, no-stripping areas and identified hostile material; and
- estimating topsoil volumes based on soil unit areas and recommended stripping depths.

Land capability

The Project site was assessed for its land and soils capability in accordance with (Office of Environment and Heritage, 2012), which considers landform position, slope gradient, drainage, climate, soil type and characteristics to classify rural land in one of eight classes. The classes indicate the level of management required to sustain a land use without degrading the land and soil.

Biophysical strategic agricultural land

The presence of BSAL in the Project site (not including areas covered by CML 16, ML 1716 or historic mining activities) was determined by following the initial verification steps in (NSW Government, 2013) as follows:

- Identify the area that will be assessed for BSAL – the Project site was separated into the northern and southern assessment areas, which covered the likely maximum inundation level and surface disturbance area associated with the Marulan Creek dam; and the area subject to the continued open cut mine operations and associated overburden emplacement.
- Access to water – rainfall records from BOM's Marulan station were used (annual mean rainfall of 709 mm), which is above the BSAL criteria for reliable water supply (350 mm or more per annum).

- Assessment approach – on-site assessment was possible as the land was Boral owned and therefore accessible for soil surveys.
- Risk assessment – used to identify potential impact on agricultural land resources and determine the appropriate scale of investigation. Approximately 18 ha of the northern assessment area was predicted to be impacted by the Project, which had a moderate to high risk of impact to agricultural resources. A survey density of one detailed site per 30 ha was used in this area.
- Approximately 169 ha of the southern assessment area was predicted to be impacted by the Project, which had a high risk of impact to agricultural resources. A survey density of one detailed site per 20 ha was used in this area.
- Field observations and soil sample results were compared to the BSAL criteria in Figure 2 of the BSAL assessment (Appendix 2 of **Appendix I**) to determine if there was BSAL in the northern and southern assessment areas.

10.2 Results

10.2.1 Desktop study

The review of background soils information indicates the following major soil landscapes occur in areas of the Project site not currently impacted by mining. There are also anthroposols in the Project site, which are man-made soils as a result of mining activities.

Texture contrast soils

Also known as duplex soils, these occur as yellow duplex and red duplex soils in the southern assessment area.

The following duplex soils occur in the northern assessment area and lower gradients of the southern assessment area:

- Kurosols – low hills in the far west of the northern assessment area;
- Kurosols, natric – lower slopes, flats and drainage depressions in both assessment areas; and
- Sodosols – mid-slopes, upper-slopes and crests of undulating low rises across both assessment areas.

Shallow soils

Tenosols and Rudosols are mapped on the steep slopes and ridges in the east and south of the southern assessment area and far east of the northern assessment area. Narrow strips of Alluvial Rudosols are mapped along Barbers and Bungonia creeks along the eastern and southern Project boundaries.

Biophysical strategic agricultural land

The nearest mapped BSAL is approximately 7.5 km to the north-east of the Project site.

10.2.2 Field survey

The results of the field survey are summarised in **Section 2.2.7**.

10.2.3 Land capability

The regional land and soil capability map shows land capability 'Class V: severe limitations – land not capable of sustaining high impact land use without special management' on the flat to undulating land in most of the northern assessment area and the north-western part of the southern assessment area.

This land capability class coincided with the texture contrast soils observed during the field survey, and exhibited the following limiting factors:

- shallow soil depth;
- waterlogging potential; and
- acidic or sodic subsoils.

The moderate to steep slopes in the central southern parts of the southern assessment area are mapped as 'Class VII: extremely severe limitations – land incapable of sustaining most land uses'.

This land capability class coincided with the Tenosol (Bleached-Orthic/Brown-Orthic) soils, and exhibited the following limiting factors:

- shallow soil depth;
- acidic or sodic subsoils;
- slope gradient; and
- rock outcropping.

Areas of very steep slopes in the southern and eastern sections, and the far north-eastern corner, southern assessment area are mapped as 'Class VIII: extreme limitations – land incapable of sustaining any land uses'.

This land capability class coincided with the Tenosol/Rudusol (steep slopes) soils, and exhibited the following limiting factors:

- shallow soil depth;
- soil rockiness;
- steep slope gradient; and
- extensive rock outcropping.

The land capability of areas previously disturbed for mining were not assessed.

The areas of the different land capability classes in the Project site are summarised in Table 10.2 and on **Figure 10.1**.

Table 10.2: Area of land capability classes in Project site

Land capability class	Assessment area (ha)		Total (ha)
	Northern	Southern	
Class V: moderate to low capability land	27.5	127.2	155
Class VII: very low capability land	–	119.8	119.8
Class VIII: extremely low capability land	0.2	230.4	230.6
Not assessed: mining disturbed land	–	340.6	340.6
Total			**846**

Figure 10.1
Land capability

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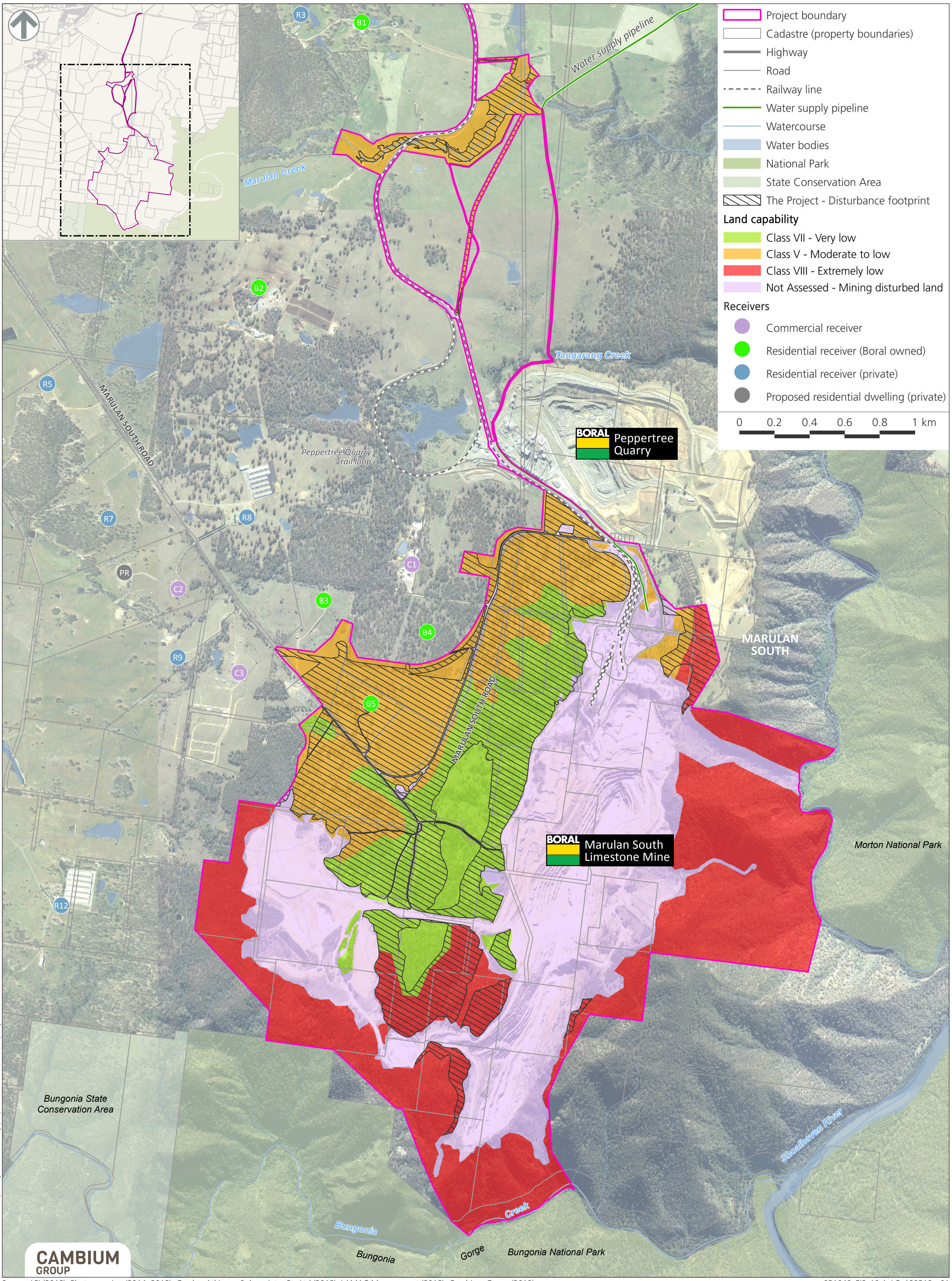

CAMBIUM GROUP

Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), LAMAC Management (2018), Cambium Group (2019).

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10.2.4 Biophysical strategic agricultural land

The BSAL assessment determined that the land and soils in the Project site area not BSAL. A BSAL site verification report was submitted to OEH in October 2015. OEH determined there was no BSAL in the Project site, and a site verification certificate was issued by DPE on 17 November 2015 (Appendix 2 of **Appendix I**).

10.3 Impact assessment

10.3.1 Topsoil resources

Only the A1 horizon of the duplex soils is suitable for topsoil stripping as the deeper soils are limited by chemical and physical properties, such as:

- increased sodicity in the A2 horizon (sites S02, S08, S09 and S14);
- moderate to strongly acidic B horizon (sites S04, S07, S09 and S14); and
- heavy clay B horizon (sites S01, S02, S04, S11 and S12).

Only the A1 horizon (10 cm) of the Tenosol soils is suitable for topsoil stripping due to:

- moderately acidic B horizon;
- heavy clay B horizon; and/or
- shallow weathered bedrock.

Tenosols and Rudosols on steep slopes; and areas of heavy outcropping, erosion, stony soils or very steep slopes are also not suitable for topsoil stripping.

Suitable topsoil stripping depths are summarised in **Section 10.4**.

10.3.2 Biophysical strategic agricultural land

Given the low pre-disturbance land capability classes (V, VII and VIII) of the land proposed to be disturbed, the Project will have minimal negative impact on the overall land capability.

Based on the BSAL risk assessment (Table 10.3), that is, the likelihood and consequence (permanence) of disturbance, there is a moderate to high risk of impact on agricultural land in the proposed mining disturbance footprint. However, given the relatively small area of proposed disturbance (256.5 ha) and low land capability in the assessment area, the overall risk of impact on agricultural resources is minimal.

The Project will have negligible impact on agricultural land outside the BSAL assessment area, with the majority of the remaining Project site comprising existing mining-disturbed land, or land capability Class VIII steep slopes and ridges.

Table 10.3: BSAL assessment

Site	Australian Soil Classification (to order) Suborder	Order	Is slope <10%?	Is there <30% rock outcrop?	<20% unattached rock fragments >60 mm?	Does <50% have gilgais >500 mm deep?	Is slope <5%?	Are there nil rock outcrops?	Does soil have moderate fertility?	Does soil have moderately high or high fertility?	Is effective rooting depth to a physical barrier >750 mm?	Is drainage better than poor?	Is pH between 4.5 and 8.1 in upper most 600 mm?	Is salinity <4 ds/m in upper most 600 mm?	Is effective rooting depth to a chemical barrier >450 mm?	Is the site BSAL?
1	Red	Sodosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
2	Brown	Sodosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
3	Bleached-orthic	Tenosols	Yes	Yes	Yes	Yes	Yes	Yes	No	No	50% Fe nodule layer @ 30-41 cm	Red mottle 30% & distinct	No	Yes	pH 4.3 @ 41-60 cm	No
4	Brown	Sodosol	Yes	Yes	Yes	Yes	No	N/A	N/A	No	Yes	Grey mottle 30% & distinct	No	Yes	pH 4.4 @ 30-48 cm	No
5	Brown-orthic	Tenosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	50% sandstone @ 60 cm	Yes	Yes	Yes	Yes	No
6	Bleached-orthic	Tenosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	60% granite 60 cm	Grey mottle 30% & distinct	Yes	Yes	Yes	No
7	Red	Sodosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yellow brown mottle 20% & distinct	Yes	Yes	Ca:Mg ratio <0.1 @ 60 cm	No
8	Brown	Sodosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Red brown mottle 20% & distinct	Yes	Yes	Yes	No
9	Brown	Chromosol	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Red mottle	Yes	Yes	Ca:Mg ratio	No

Site	Australian Soil Classification (to order) Suborder	Order	Is slope <10%?	Is there <30% rock outcrop?	<20% unattached rock fragments >60 mm?	Does <50% have gilgais >500 mm deep?	Is slope <5%?	Are there nil rock outcrops?	Does soil have moderate fertility?	Does soil have moderately high or high fertility?	Is effective rooting depth to a physical barrier >750 mm?	Is drainage better than poor?	Is pH between 4.5 and 8.1 in upper most 600 mm?	Is salinity <4 ds/m in upper most 600 mm?	Is effective rooting depth to a chemical barrier >450 mm?	Is the site BSAL?
												20% & distinct			<0.1 @ 60 cm; pH 4.3	
11	Brown	Chromosol	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grey mottle 50% & distinct	Yes	Yes	Yes	No
12	Brown	Sodosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Grey mottle 20% & distinct	Yes	Yes	Yes	No
13	Brown-orthic	Tenosol	Yes	Yes	Yes	Yes	Yes	Yes	No	No	70% granite 70 cm	Yes	Yes	Yes	Yes	No
14	Brown	Kurosol	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Ph 4.4 @ 45-60 cm	No

10.4 Management measures

Topsoil will be stripped from proposed disturbance areas and used for rehabilitation as described in **Chapter 26**.

The locations and volumes of topsoil to be stripped from proposed disturbance areas are summarised in **Table 10.4**. Actual stripped areas or depths may vary with local topography, specific conditions or constraints encountered during stripping. Field conditions which may prevent full topsoil recovery include:

- severe weed infestation;
- steep or broken terrain;
- outcropping or increased rock content;
- existing scalding or erosion;
- waterlogging; and
- soil contamination; or infrastructure (such as drains, dams and trails).

Table 10.4: Topsoil stripping information

Assessment area	Soil landscape unit	Stripping depth (cm)	Proposed disturbance area (m^2)	Volume (m^3)
Northern	Sodosol (creek and dam)	15	48,317	7,248
	Sodosol (access road)	10	23,480	2,348
Southern	Sodosol	10	1,018,764	101,876
	Kurosol, brown	15	104,069	15,610
	Tenosol	10	884,281	88,428
Total				**215,510**

The management measures in Appendix 5 of **Appendix I** for the following components of topsoil management will be implemented:

- topsoil stripping;
- location of topsoil stockpiles;
- stockpile construction and management; and
- stockpile maintenance.

10.5 Residual impacts

Management measures will not be required to maintain land capability in the Project site given the low pre-disturbance capability classes (V, VII and VIII) and the relatively small area of proposed disturbance (256.5 ha). Therefore, the Project will have minimal negative impact on the overall land capability.

Implementation of the topsoil management measures will ensure topsoil is only taken from proposed disturbance areas, and managed to maintain its suitability for use during rehabilitation. Therefore, there will be minimal residual impacts to the soil resources of the Project site.

Chapter 11

Contamination

VOLUME 1

Contamination

Existing and potential contamination from past and present land use was identified so that recommendations for future investigation, management and remediation to protect human health and the environment could be provided.

Eighteen potential sources of contamination were identified and three were assessed to have potential to impact human health and the environment, comprising petroleum hydrocarbons, asbestos and methylene blue active substances. It was determined the petroleum hydrocarbons and methylene blue active substances had negligible migration or human health risks.

There is a potential human health exposure pathway for asbestos at the former Marulan South township. One of the analysed fragments was friable and had potential to liberate asbestos fibres, which could occur during lawn mowing and landscaping. Implementation of management measures will prevent migration or human health risks from the asbestos.

11 CONTAMINATION

11.1 Introduction

This chapter summarises the phase 1 and 2 environmental assessment report, which is in **Appendix J**. It describes land condition of the Project site, contamination issues discovered during sampling, characterisation of the site, potential impacts and mitigation measures where impacts are unavoidable.

11.1.1 Assessment guidelines and requirements

There are no SEARs regarding contamination, however, the Technical and Policy Guidelines (Attachment 1) section of the SEARs recommend the use of the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (National Health and Medical Research Council, 1992).

DPE invited government agencies to recommend matters to be addressed in the EIS, matters relevant to contamination are outlined in **Appendix A**.

11.1.2 Overview of assessment methods

The purpose of the contamination assessment was to identify existing and potential contamination from past and present land use and provide recommendations for future investigation, management and remediation to protect human health and the environment. This comprised:

- a site walkover and desktop review of databases and previous reports to identify areas of potential environmental concern (AEC);
- preparation of a sampling, analysis and quality plan for investigative works;
- borehole drilling (BH1 to BH10) and soil sampling, comprising (**Figure 11.2**):
  - drilling 10 boreholes on 14 and 15 January 2015 through fill and overburden and into natural soil;
  - collection of nine shallow soil samples on 15 January 2015 for asbestos analysis;
  - screening of samples for volatile hydrocarbons using a photo ionisation detector;
  - analysis of 24 soil samples (including two duplicate and 2 triplicate samples) at a National Association of Testing Authorities (NATA) accredited laboratory for metals; benzene, toluene, ethylbenzene and xylene (BTEX); total recoverable hydrocarbons (TRH); monocyclic aromatic hydrocarbons; polycyclic aromatic hydrocarbons (PAH); phenolics; organophosphorous pesticides; organochlorine pesticides; pesticides; herbicide; surfactant; solvents; chlorinated hydrocarbons; halogenated hydrocarbons; halogenated benzenes; volatile organic compounds (VOC); semivolatile VOCs (SVOC); anilines; amino aliphatics; explosives; and nitroaromatics; and
  - collection of four fragments of suspected asbestos containing material and analysis at a NATA accredited laboratory.
- analysis of the monthly surface and ground water sampling;
- analysis of the surface and ground water sampling carried out specifically for the contamination assessment; and
- preparation of a phase 1 and phase report in accordance with:
  - Guidelines for Consultants Reporting on Contaminated Sites (Office of Environment and Heritage, 2011); and
  - Managing Land Contamination – Planning Guidelines – SEPP 55-Remediation of Land (Department of Urban Affairs and Planning, 1998).

11.2 Results

11.2.1 Desktop study

The following government databases were searched on 10 October 2014 to identify any contamination records in the area:

- Record of Notices in the EPA Contaminated Land Record database – the service stations on both sides of the Hume Highway were listed, which are over 4 km from the Project site.
- Notices under Section 60 of the CLM Act on the List of Contaminated Sites Notified to the EPA as of 18 September 2015 – a former gas works and service station in Goulburn, which are too distant from the Project site to pose a risk.

There have been many studies regarding land filling, asbestos and chemical management, at the Project site since 1995 which considered aspects of contamination. The AECs identified during the desktop study and the contaminants of potential concern (COPC) are summarised in **Table 11.1** and shown on **Figure 11.1**.

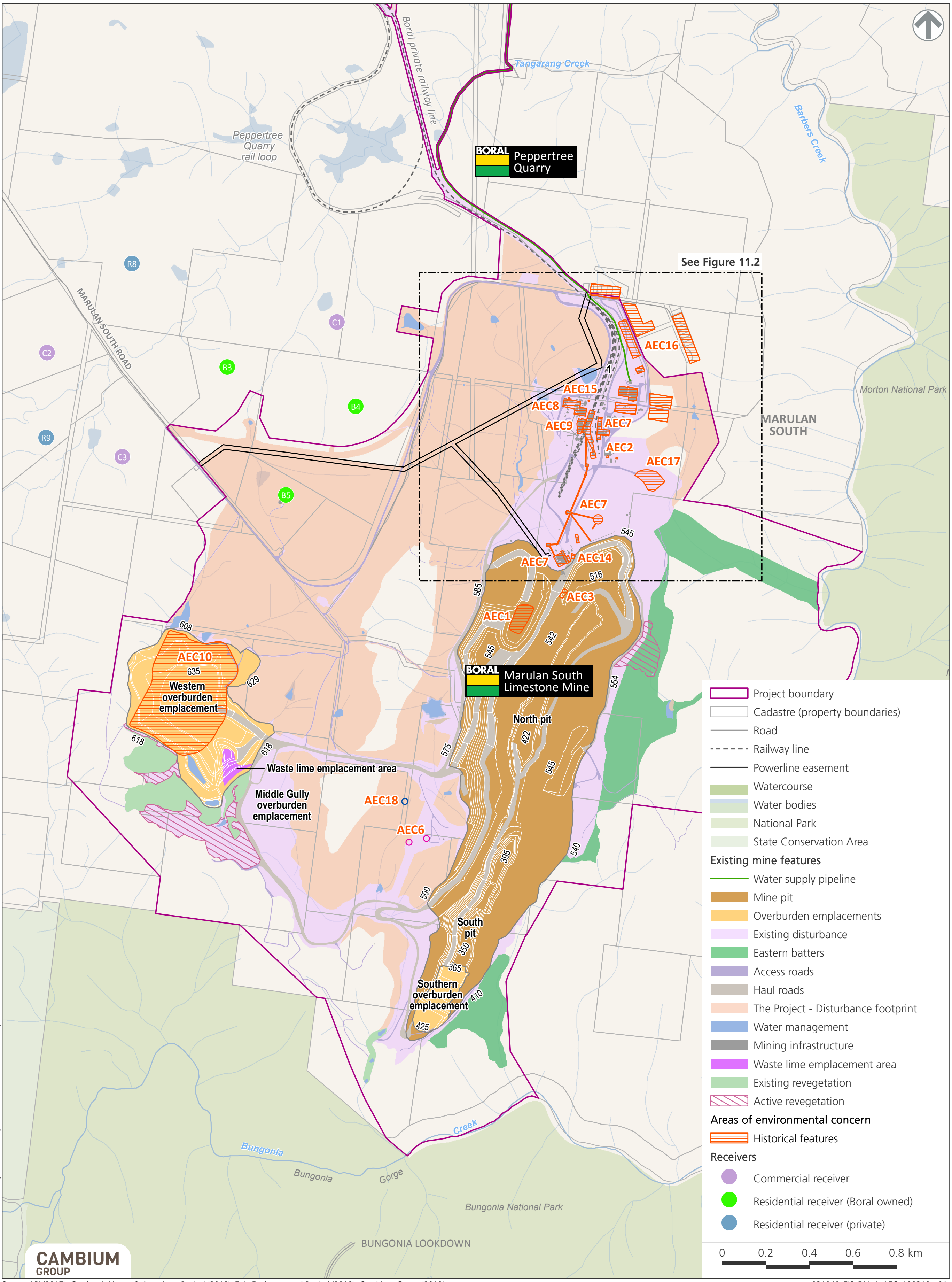
Table 11.1: Potential sources of contamination

No.	AEC	COCP	Review of AEC based on walkover and discussion with Boral
1	Refuse tip on eastern flank of 'Mount Fuji' (mixed waste)	M8, TPH, asbestos, SVOC, VOC	Boral advised that the tip had been excavated in its entirety and disposed off-site to appropriately licensed facilities, which was confirmed during the site visit.
2	Waste oil drum disposal area	M8, TPH, BTEX, PAH	Boral advised that the waste oil drum store had been upgraded to a roofed store built on stilts with associated bunding, which was confirmed during the site visit, with no visual evidence of contamination.
3	Former bulk fuel storage area in north pit (3 x AGST diesel: 140,000 L and 1 x AGST petrol: 10,000 L)	M8, TPH, BTEX, PAH	Boral advised that the above ground storage tanks (AGSTs) were removed from the pit and the area had since been excavated to remove limestone. This was confirmed by reviewing historic aerial photography and during the site visit.
4	Bulk fuel storage area (95,000 L AGST – diesel)	M8, TPH, BTEX, PAH	Boral advised that no knowledge of spillage had occurred from this AGST. It was noted during the site visit that the AGST is double skinned, present on concrete with drainage to a waste oil interceptor.
5	Bulk fuel storage area (12,000 L UST (underground storage tank) – petrol)	M8, TPH, BTEX, PAH	An aged bowser is present and is occasionally used for petrol powered equipment which could pose a potential risk should leaks or spills occur. No records of filling or use available. It was considered intrusive investigation was required.
6	Old workings/kiln/infilled gully to the south-west of south pit	Asbestos	Area comprised a collapsed kiln constructed from brick and metal. A second kiln feature was also noted with some heavily rusted drums and scrap metal. No visual evidence of filling or contamination was noted during the site visit.
7	Processing Plant (oil leaks)	TPH, PAH	Oil is only used locally for lubrication and no evidence of significant spillage was noted during the site inspection or fieldwork.
8	Lime Kiln (oil leaks)	TPH, PAH	Oil is only used locally for lubrication and no evidence of significant spillage was noted during the site inspection or fieldwork.
9	Hydrate Plant (oil leaks)	TPH, PAH	Oil is only used locally for lubrication and no evidence of significant spillage was noted during the site inspection or fieldwork.
10	Western Overburden Emplacement area (including oil stained soils)	TPH, PAH	A previous study had identified potentially oil stained soils. No visual evidence of contamination (eg staining) was noted during the site walkover. Boral representatives were unable to recall the presence of oil stained soils at this locality.
11	Undisturbed areas	None	Areas of previously undeveloped land that are proposed to be disturbed by the Project have been surveyed by specialists and site personnel during the technical investigations as part of the SSD assessment. Based on specialist surveys, a walkover of particular parts of the Project site by the contamination specialist, site personnel knowledge and review of available historical information it was concluded that these parts of the Project site are unlikely to be contaminated.
12	Proposed Marulan Creek dam	None	The proposed Marulan Creek dam site comprises previously undeveloped land along Marulan Creek with historical disturbances including the construction of Boral's private railway line in 1928, the Tallong Water Pipeline and minor unsealed access tracks. This part of the Project site is unlikely to have been impacted by contaminants.

No.	AEC	COCP	Review of AEC based on walkover and discussion with Boral
			Boral advised that the majority of the Tallong Water Pipeline is below ground, with the exception of the crossing of Marulan Creek, downstream of the proposed Marulan Creek dam Wall. Although the section of the pipeline in the vicinity of the Marulan Creek dam does contain asbestos, it will not be disturbed by the Project. One exception may be during the connection of the pumping line from the proposed Marulan Creek dam into the existing Tallong Water Pipeline when asbestos containing material (ACM) may be exposed.
13	Workshop/oil interceptor	M8, TPH, PAH, SVOC, VOC	Operational – potential for soil contamination from spills or leakage noting that drainage goes via the waste oil interceptor. It was considered intrusive investigation was required.
14	Wash down bays/waste oil tanks	M8, TPH, PAH, BTEX, surfactants	Operational – potential for soil contamination from run off or leakage noting that partial drainage goes via the waste oil interceptor. It was considered intrusive investigation was required.
15	Oil storage below retaining wall near Kiln Pre-heater	TPH, PAH	No visual evidence of contamination but the vicinity of disused, empty AGSTs needs to be investigated. It was considered intrusive investigation was required.
16	Surface asbestos debris near community hall, bowling greens and cottages	Asbestos	Potential for surface asbestos due to historical demolition of former Marulan South Township. Sampling to be targeted to surface identification of ACM fragment or to provide general coverage within footprints of former structures. No development/disturbance is proposed in the former Marulan South township where buildings once existed. Risk of exposure to ACM in this area is very low and would be limited to maintenance activities eg mowing. It was considered intrusive investigation was required.
17	Old Machinery/Scrap Yard	M8, TPH, BTEX, PAH	Area was well ordered with good housekeeping and no visual evidence of potential contamination.
18	Explosives store	Radiation	Comprises an isolated secure brick explosive store which also historically temporarily stored low level radioactive equipment in accordance with an appropriate license. Store to be retained. The only low level radioactive source present in the Project site relates to fixed gauges associated with Conveyor 2.

Figure 11.1
Areas of environmental concern

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Zoic Environmental Pty Ltd (2018), Cambium Group (2019).

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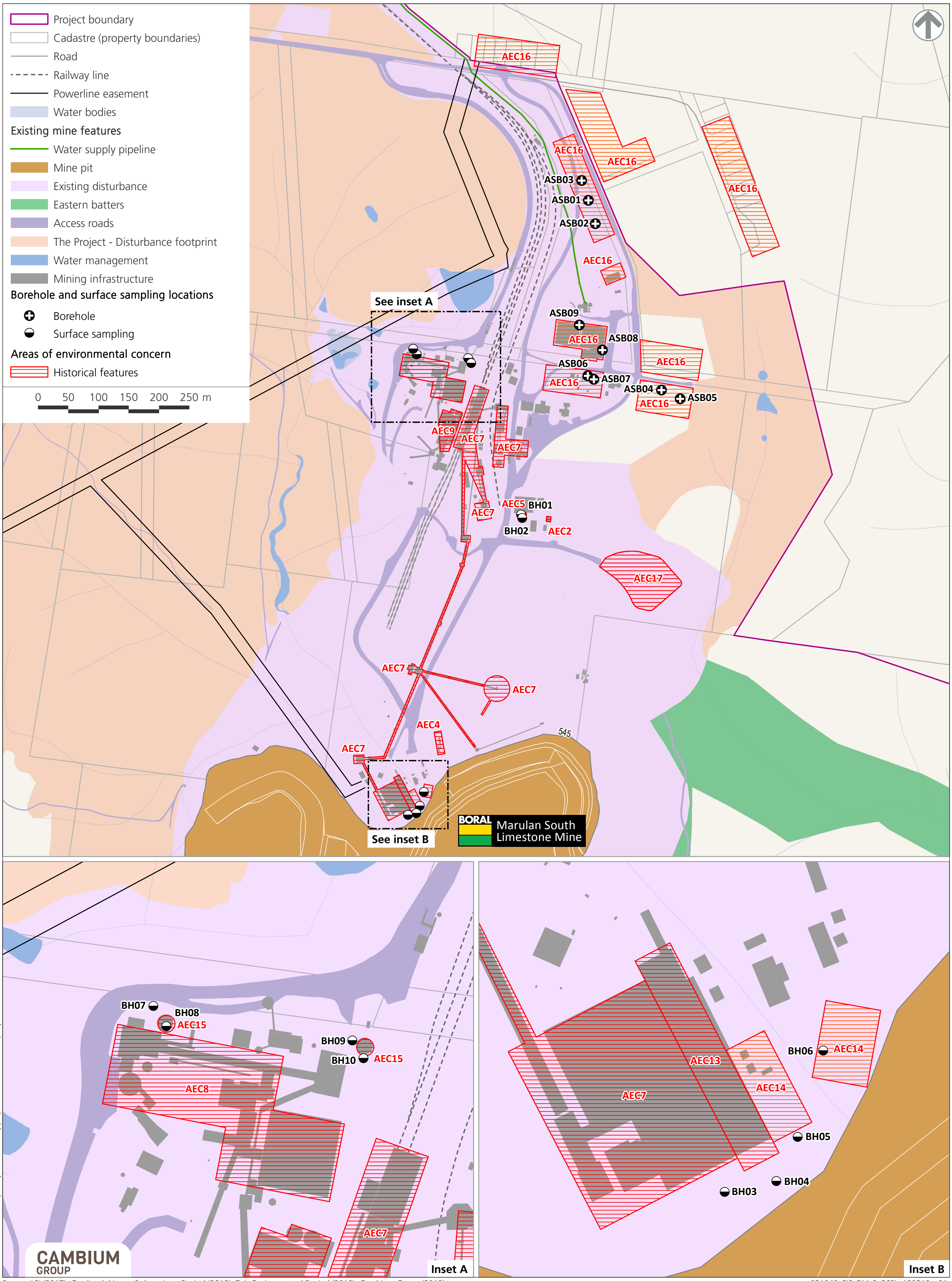
Figure 11.2
Borehole and surface sampling locations

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Zoic Environmental Pty Ltd (2018), Cambium Group (2019).

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11.2.2 Sampling results

Results from the sampling described in **Section 2.2.1** are summarised in Table 11.2.

Ongoing groundwater sampling

The following was noted during analysis of the ongoing groundwater monitoring results for the site:

- The metals in **Table 11.2** were recorded above the guidelines in (Australian and New Zealand Environment and Conservation Council, 2000).

Table 11.2: Results of metals in groundwater sampling

Metal	Guideline value (µg/L)	Maximum recorded value (µg/L)
Aluminium	55	600
Arsenic	24	149
Chromium	1	450
Copper	1.4	144
Lead	3.4	46
Nickel	11	47
Selenium	5	100
Zinc	8	2,450

- Oil and grease recorded on 26 March 2015, 19 May 2015 and 21 July 2016 in WP16 (6-9 mg/L) was above the 5 mg/L limit of reporting but had returned to <5 mg/L during the subsequent ten monitoring rounds. The readings are not considered indicative of significant environmental impacts as the most recent 12 months of readings were below the detection limit.
- Monitoring wells MW03 and MW05 are upgradient (i.e. north and west of operational areas) whereas MW01, MW02, 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.

Ongoing surface water sampling

The following was noted during analysis of the ongoing surface water monitoring results for the site:

- The metals in **Table 11.3** were recorded above the (Australian and New Zealand Environment and Conservation Council, 2000) guidelines.

Table 11.3: Results for metals in surface water sampling

Metal	Guideline value (µg/L)	Maximum recorded value (µg/L)
Aluminium	55	410
Chromium	1	7.6
Copper	1.4	14

Metal	Guideline value (µg/L)	Maximum recorded value (µg/L)
Selenium	5	10
Zinc	8	63

- Waste rock analysis identified aluminium and chromium at levels slightly above (Australian and New Zealand Environment and Conservation Council, 2000) guidelines. Notwithstanding, only aluminium was recorded above adopted criteria in the Shoalhaven River and Marulan Creek Upstream samples. Given that aluminium concentrations are not elevated in Bungonia and Barbers Creeks, it is unlikely that the mine is causing these elevated results.
- The difference between the observed upstream and downstream water quality for Barbers Creek and Bungonia Creek is not significant, indicating that under existing operational practices, the mine has no effect on the surface water quality of these waterways.
- Water quality improves as it moves downstream along Marulan Creek. Also, the water quality for both Marulan Creek and Tangarang Creek indicate that this water is diluted in Barbers Creek, as demonstrated by the comparably better water quality of Barbers Creek.
- Copper concentrations recorded in the Main Gully Auto Sampler show results above the guideline value of 1.4mg/L. However, the absence of elevated copper concentrations in any other surface water sampling point indicates these results are unlikely to be affecting surface water quality in downstream receiving waters.
- Results for oil and grease were below the detection limit of the test. The exception was the Main Gully Autosampler where oil and grease was recorded at 6 mg/L on one occasion in February 2010 above a detection limit of 2 mg/L. Given that this was an isolated incident, it is not considered as being indicative of significant environmental impacts.
- Where analysed, results for TPH fall below the detection limit of the test. The exception was the Main Gully Autosampler in March 2012. Although no Australian criteria are available for TPH, these concentrations are below the Dutch Intervention Value for Mineral Oil (600 mg/L). Given the environmental setting of the site, location of AEC and distance to the closest surface water receptor, these concentrations are not considered to be indicative of significant environmental impacts.

11.2.3 Contamination assessment field observations

The Project site was inspected as described in **Section 11.1.2**. No staining of the ground surface or sheens were observed, however, faint to strong hydrocarbon odours were detected in boreholes 1, 2, 3, 4, 8 and 9. No asbestos containing materials (ACM) were identified during borehole drilling, however, ACM was detected when samples were tested from three of the shallow soil samples (ASB01, ASB05 and ASB09 – refer to Figure 11.2).

Surface and ground water

Refer to **Section 2.2** for historical ongoing ground and surface water monitoring results. The surface and ground water sampling carried out specifically for the contamination assessment are presented in Table 9.5 and 9.6 of **Appendix J**.

Groundwater analytical results are similar to the ongoing groundwater monitoring and generally fall below the criteria, with the exception of aluminium, chromium, copper, nickel, zinc and mercury.

The geochemical testing of overburden on site (to determine the potential of the material to generate acidity, salts and soluble metals / metalloids) showed concentrations of aluminium and chromium to be representative of the natural overburden rock. Concentrations of copper, nickel, zinc and mercury are also representative of background conditions rather than indicators of potential contamination. Consequently, there is no requirement for management or remediation of groundwater to protect human health or the environment.

The surface water analytical results are similar to those from the ongoing surface water monitoring and generally fall below the criteria. Consequently, there is no requirement for management or remediation of surface water to protect human health or the environment.

Soil

The only exceedance of potential soil contamination criteria was in BH8, which exceeded the TRH criteria as shown in **Table 11.4**.

Table 11.4: Soil exceedance summary

<table>
<tr><th rowspan="3">Criteria (mg/kg)</th><th colspan="6">Hydrocarbon results and sample (mg/kg)</th></tr>
<tr><th colspan="3">Carbon atom range[1]: 10-16</th><th colspan="3">Carbon atom range[1]: 16-34</th></tr>
<tr><th>0.5-0.9 m</th><th>DUP1</th><th>TRIP1</th><th>0.5-0.9 m</th><th>DUP1</th><th>TRIP1</th></tr>
<tr><td>NEPM[2] – 170</td><td rowspan="2">1,090</td><td rowspan="2">1,170</td><td rowspan="2">1,100</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>NEPM[3] – 1,000</td></tr>
<tr><td>NEPM[2] – 1,700</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">7,300</td><td rowspan="2">8,500</td><td rowspan="2">8,200</td></tr>
<tr><td>NEPM[3] – 3,500</td></tr>
</table>

Notes:

1. The analytical technique and method used for petroleum hydrocarbon testing depends on the carbon atom range of the petroleum products of interest. The 10-16 range equates to most petroleum products except waxes, asphalt and pitch. The 16-34 range also encompasses most petroleum products except gasoline, JP-4, Stoddard solvent and fresh creosote.
2. (National Environment Protection Council, 2013) – Ecological screening limits for petroleum hydrocarbon compounds (Commercial/Industrial).
3. (National Environment Protection Council, 2013) – Physical and aesthetic management limits for petroleum hydrocarbon compounds (Commercial/Industrial).

There were elevated levels of anionic surfactants (methylene blue active substances – MBAS) at 1 m to 1.3 m in BH 5 (less than 100 mg/kg) and 1.5 m to 2 m BH 6 (less than 200 mg/kg) (AEC 14). There are no guideline values for MBAS. This was due to matrix interference by organic or inorganic chemicals, which could include elevated concentrations of MBAS.

11.3 Impact assessment

Potential impacts to human and ecological health from identified contaminants were considered in the context of the industrial nature of the Project site, that is, with the absence of sensitive receivers in the area of potential impact. Contaminants are described in terms of their potential to migrate and exposure to humans.

11.3.1 Borehole 8

The TPH at 0.5 m to 0.9 m depth in BH8 is likely due to spills at the oil storage tanks at AEC 15. There is negligible risk of health impacts as the:

- concentrations are below the human health criteria;
- area is covered;
- concentrations are below the (CRC for Contamination Assessment and Remediation of the Environment, 2011) criteria, indicating negligible risks associated with future excavation of the area;

- the absence of hydrocarbons in BH 7 indicates there has not been lateral migration of contaminants;
- the absence of hydrocarbons deeper than 1 m below ground level in BH 8 indicates there has not been vertical migration of contaminants; and
- if contaminants did migrate to groundwater (deeper than 20 m below ground level), they would need to migrate up to 2 km before reaching the nearest off-site receptor (Barbers or Bungonia creeks).

11.3.2 Asbestos

There is a potential human health exposure pathway for asbestos at the former Marulan South township (AEC 16) as the fragments in the upper 0.1 m of the soil exceeds the (National Environment Protection Council, 2013) guideline requirement for no visible asbestos for surface soil, and there are areas of bare ground in the area. One of the analysed fragments was friable and had potential to liberate asbestos fibres, which could occur during lawn mowing and landscaping.

Similarly, there is also an exposure pathway for the asbestos in the westernmost bowling green north of the current administration building.

11.3.3 MBAS

The elevated levels of MBAS at BH 5 and BH 6 have negligible migration or human health risks as the:

- concentrations were below the detection limits of the test (less than 1 mg/kg) in shallow samples (0 m to 0.5 m) taken at BH 5 and BH 6; and
- as the contamination source would have been at the surface, the shallow samples should have higher concentrations if contamination was present. However, the elevated concentrations were at depth, which suggests the interference was caused by something other than contamination in the soil matrix.

11.3.4 Duty to report

Based on the information available to date, it is considered there is no duty to report contamination to NSW EPA under the *CLM Act 1997*.

11.4 Management measures

The following management or remediation will be implemented:

- AEC 16 will be inspected by a qualified occupational hygienist who will identify and remove asbestos and issue a clearance certificate;
- Findings from the inspection of AE16 by the occupational hygienist will be added to the site’s asbestos register;
- Where there is an absence of grass or vegetation within AEC16, a layer of 10 cm of clean suitable material will be placed and vegetation encouraged to grow;
- Damage to the asbestos kerb of the bowling green will be repaired and the entire kerb painted to prevent further deterioration of the asbestos containing structure. A hand propelled mower will be used around the kerb to prevent further damage; and
- The UST at AEC 5 presents an ongoing risk of soil and groundwater contamination. If the UST is removed it must be remediated and validated in accordance with the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2014.

Further measures will be implemented to prevent future contamination and address unexpected contamination issues:

- The pumping line from the Marulan Creek dam to the Tallong Water Pipeline (AEC 17) must be connected by an appropriately qualified and experienced person to prevent exposure of ACM.
- All potential contaminants will be removed from equipment as part of the decommissioning of machinery and spare parts prior to being placed in the Old Machinery/Scrap Yard (AEC 17). Where this is not practical, appropriate containment, signage and management should be implemented. Recovered hydrocarbons and ACM must be handled, stored, transported and disposed of appropriately. Given the extensive history of the mine, the presence of isolated areas of contamination should not be discounted. Although these are unlikely to pose a significant risk to human health or the environment, it is recommended that an unexpected finds protocol be prepared in case below ground excavations identify potentially contaminated materials.

11.5 Residual impacts

There will not be any residual impacts from known contamination in the Project site provided it is managed and remediated as described above. Preparation and implementation of an unexpected finds protocol will prevent or reduce impacts associated with the discovery of presently unknown contaminants in the Project site during future operations.

Chapter 12

Terrestrial biodiversity

VOLUME 1

Terrestrial biodiversity

Biodiversity impacts were assessed in accordance with the NSW Office of Environment and Heritage's biodiversity assessment method (BAM) using the BAM Calculator. This comprised assessing the Project site's landscape features, native vegetation and threatened species and populations, followed by an impact assessment considering avoidance and minimisation of impacts, impact and offset thresholds and offset requirements.

There are five native and one non-native plant community types in the Project site, with one threatened ecological community; Yellow Box Blakey's Red Gum grassy woodland on the tablelands, South-eastern Highlands. This community is listed as an endangered ecological community (EEC) under the EPBC Act and a critically EEC under the EPBC Act.

The BAM Calculator predicted 31 threatened flora species could occur in the search radius, but it was determined only the *Solanum celatum* would occur, with one specimen recorded during the survey.

The BAM Calculator predicted 64 threatened fauna species could occur in the search radius, with 25 of these candidates for species credits (requiring offsetting if their habitat is present and/or habitat would be impacted). The list of candidate species was reduced to the Large-eared Pied Bat (*Chalinolobus dwyeri*) and Koala (*Phascolarctos cinereus*) after fieldwork. A further seven threatened species were recorded in or adjacent to the Project site.

The following direct impacts will result from the Project:

- clearing of native vegetation and associated habitat, conservatively estimated to be 182.4 ha, including 88.6 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC;
- clearing of associated species credit fauna habitat, comprising:
  - clearing of an estimated 132.4 ha of Koala habitat;
  - clearing of an estimated 140.3 ha of Large-eared Pied Bat habitat;
- removal of one individual Solanum celatum.

The assessments of significance had the following conclusions:

- the removal of TEC and impact to Koala habitat will have a significant impact and triggers the need to offset the impacts under the EPBC Act;
- offsets will not be required for the Large-eared Pied Bat under the EPBC Act, but offsets will be required under the BC Act; and
- impacts on the other threatened and migratory species listed under the EPBC Act will not be significant and will not require offsetting.

A biodiversity offset strategy has been prepared to offset the impacts of the Project on biodiversity. A total of 3,093 ecosystem credits and the following species credits will need to be retired:

- *Solanum celatum* – 2;
- Koala – 2,941; and
- Large-eared Pied Bat – 4,567.
-

Boral has investigated offsetting opportunities in the Bungonia subregion and adjacent subregions and has purchased a 1,000 ha property and a 360 ha property in the Bungonia subregion for this purpose. The properties would satisfy most of the BC Act offset liability and all of the EPBC Act liability.

The remaining credit liability will be paid into the BCT Fund.

12 TERRESTRIAL BIODIVERSITY

12.1 Introduction

This chapter summarises the biodiversity development assessment report (BDAR), which is in **Appendix K**. It describes the ecological context of the Project site, study methods, flora and fauna discovered during surveys, potential impacts and mitigation measures where impacts are unavoidable.

12.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on biodiversity (**Table 12.1**).

Table 12.1: Biodiversity SEARs

Requirement	Section and appendix where addressed
▪ An assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the NSW Biodiversity Offsets Policy for Major Projects and the requirements of OEH;	12.3, Appendix K
▪ Measures taken to avoid, reduce or mitigate impacts on biodiversity;	12.4, Appendix K
▪ Accurate estimates of proposed vegetation clearing; and	12.3, Appendix K
▪ A comprehensive offset strategy to ensure the development maintains or improves biodiversity values of the region in the medium to long term.	12.5.1, Appendix K

The SEARs recommend use of the following guidelines, which were used during the assessment:

- NSW Biodiversity Offset Policy for Major Projects (NSW Office of Environment and Heritage, 2014);
- Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (NSW Department of Environment, Climate Change and Water, 2009);
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (NSW Department of Environment and Climate Change, 2004);
- Threatened Species Assessment Guidelines: the Assessment of Significance (NSW Department of Environment and Climate Change, 2007);
- Biodiversity Assessment Method Operation Manual – Stage 1 (NSW Office of Environment and Heritage, 2018);
- *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (Department of Sustainability, Environment, Water, Population and Communites , 2012);
- NSW State Groundwater Dependent Ecosystems Policy (NSW Department of Land and Water Conservation, 2002); and
- Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NSW Office of Water, 2012).

12.1.2 Overview of assessment methods

Biodiversity impacts were assessed in accordance with OEH's biodiversity assessment method (BAM) using the BAM Calculator, which comprises two stages:

- Stage 1 – biodiversity assessment, involving assessment of:

- landscape features;
- native vegetation; and
- threatened species and populations.

- Stage 2 – impact assessment, involving consideration of:
  - how to avoid and minimise impacts on biodiversity values;
  - impact and offset thresholds; and
  - offset requirements.

Landscape assessment

The habitat value of the landscape is determined by comparing the current state of the landscape with the state of the landscape should the Project proceed, and considers:

- native vegetation cover;
- rivers, streams and estuaries;
- areas of geological significance; and
- habitat connectivity.

Note on fieldwork

The fieldwork targeted the areas described in **Section 4.1** which are proposed for disturbance and some areas in and adjacent to the Project site, but not proposed to be disturbed.

Native vegetation and flora

Previous records of threatened flora within a 10 km radius of the Project site were retrieved from the NSW Bionet Atlas and the EPBC Act Protected Matters Search Tool.

The plant community type (PCT) mapping in OEH's Vegetation Information System was used to determine potential biodiversity constraints on the Project. The PCTs were validated with fieldwork between 3-6 February 2015 and 12 February 2018 using OEH's Framework for Biodiversity Assessment, then 31 July to 1 August 2018 using the BAM. The assessment involved observing vegetation attributes in the Project site using transects and 'walking meanders' to identify flora species and confirm the PCTs and their condition. High threat and priority weeds were also recorded during the fieldwork.

The validated PCTs were mapped and it was determined if any threatened ecological communities (TEC) were present in the Project site.

The BAM Calculator was used to predict the presence of threatened flora in the Project site, which were targeted during the fieldwork. The list of potential threatened flora was refined after the fieldwork based on previous records within the search radius, observed PCTs, their condition and habitat features. Then a determination was made on the likelihood of threatened flora occurring in the Project site.

Native fauna and habitat

The NSW Bionet Atlas and EPBC Act Protected Matters Search Tool were also searched for records of threatened fauna within a 10 km radius of the Project site. The results were considered during fieldwork planning and the likelihood of occurrence analysis.

Fauna and habitat fieldwork focussed on threatened species (species credit fauna) and comprised:

- survey of the Project site between 26 November and 1 December 2014, comprising spotlighting, call playback, and habitat-based assessment;

- targeted fauna survey from 2-6 February 2014, comprising camera trapping, spotlighting, and habitat assessment;
- amphibian and habitat survey along Barbers Creek, Bungonia Creek and areas of Shoalhaven River between the confluences with the above creeks on 2-4 March 2015;
- flora and fauna survey on 19-21 May 2015, comprising Koala (spot assessment technique – SAT) surveys, spotlighting, call-play back, habitat assessment, bird surveys and Anabat analysis; and
- Koala SAT survey in the NOE on 5 February 2018.

The habitat assessment recorded:

- slope, aspect and landscape position;
- geology and soil type;
- dominant vegetation communities including their composition, structure and condition;
- form, quality and location of water sources;
- presence, size, number and condition of habitat features such as tree hollows; and
- level of disturbance.

Impacts

Direct, indirect and cumulative impacts to native vegetation and habitat were assessed. Serious and irreversible impacts were assessed in accordance with the BAM, which provides criteria to determine if a project will have serious and irreversible impacts on biodiversity. Biodiversity which will be seriously and irreversibly impacted by a project require offsetting, which is determined by using the Biodiversity Credit Calculator to calculate ecosystem and species offset credits. The credits are retired by establishing a biodiversity stewardship site or payment into the Biodiversity Conservation Trust Fund.

12.2 Results

12.2.1 Native vegetation and flora

Plant community types

The PCTs validated during fieldwork and their TEC status are summarised in **Table 12.2** and presented in **Figure 12.1**. Five native and one non-native vegetation types were described. The native vegetation had different condition classes as there were obvious differences in structure and quality within areas of the PCTs.

The Yellow Box – Blakey's Red Gum grassy woodland on the tablelands, South-eastern Highlands (PCT 1334) is listed as an EEC under the BC Act and an CEEC under the EPBC Act.

Table 12.2: Summary of PCTs in Project site

PCT	TEC	% cleared	Condition	Area (ha)
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	EEC under BC Act CEEC under EPBC Act	92	Medium	48.8
			Poor	31.9
			Acacia*	7.9
PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	Not listed	15	Medium	57.9
			Poor	7.5
PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges,	Not listed	40	Medium	13.7

PCT	TEC	% cleared	Condition	Area (ha)
north east South Eastern Highlands Bioregion (SR624)			Poor	2.6
731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524)	Not listed	80	Medium	12.0
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	Not listed	92	Non-EEC water dependent	0.1
Non-native vegetation	-		-	70.0
			Total	**252.4**
			Total native vegetation	**182.4**

*consisting of planted and regenerating Acacias and occasional Eucalypts; not a CEEC under the EPBC Act.

High threat and priority weeds

The following high threat weeds listed under the NSW *Biosecurity Act 2015* were recorded during the fieldwork:

- Serrated Tussock (*Nassella trichotoma*);
- African Box Thorn (*Lycium ferocissimum*);
- Rhodes Grass (*Chloris gayana*);
- St Johns Wort (*Hypericum perforatum*); and
- Dallas Grass (Paspalum dilactatum).

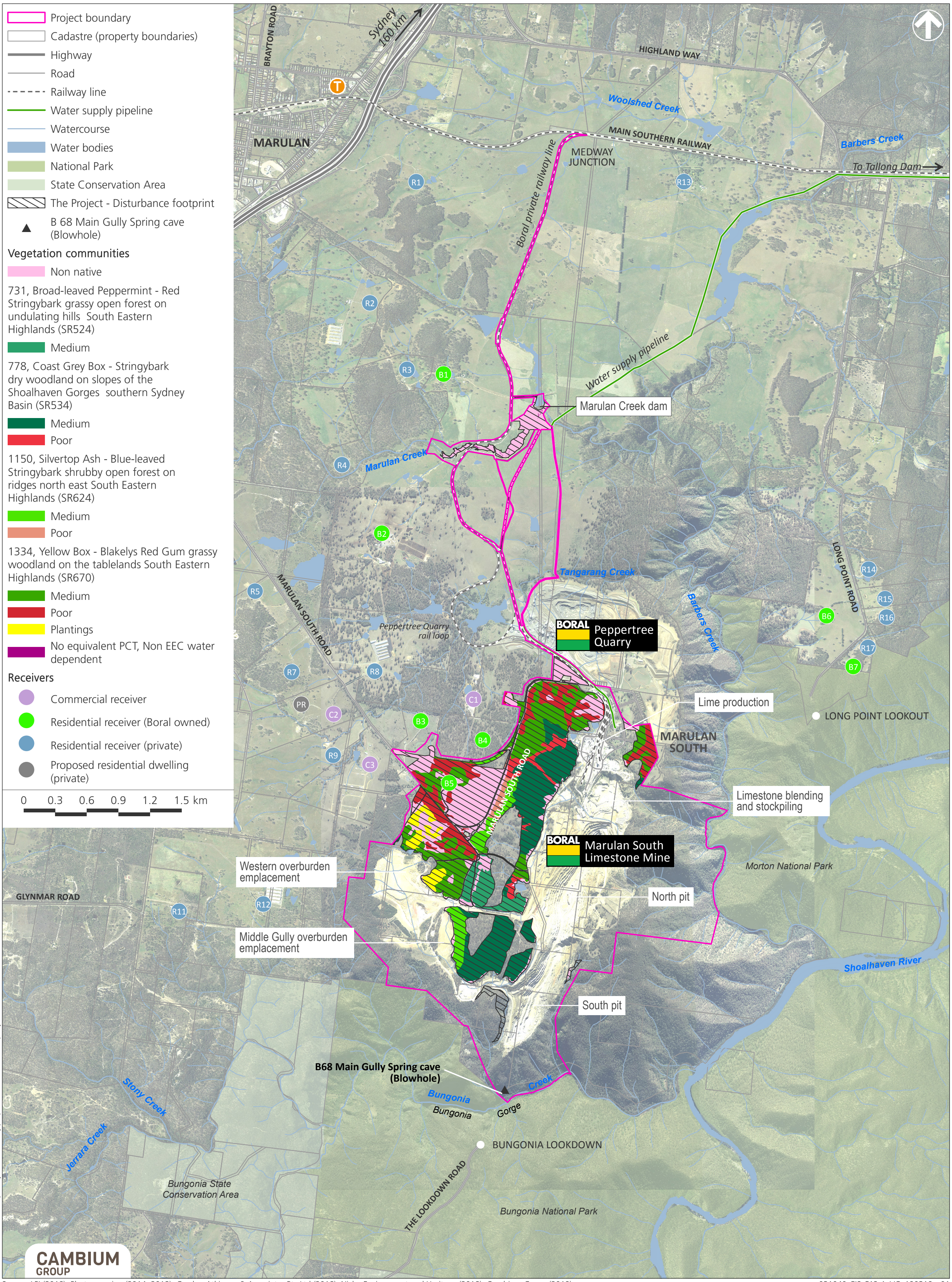
The abundance and cover of Serrated Tussock was high across most flora transects, particularly in PCT 1334.

Threatened flora

The BAM calculator predicted the 31 threatened flora species in Appendix 1 of **Appendix K** could occur in the Project site. This list was refined and only one species, *Solanum celatum*, was determined to occur in the Project site. One individual of this species was observed during fieldwork (**Figure 12.2**).

Figure 12.1
Vegetation communities

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



Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Niche Environment and Heritage (2018), Cambium Group (2019).

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12.2.2 Fauna and fauna habitat

Fauna habitat

The following general habitat types occur in the Project site:

- grassy woodlands;
- dry sclerophyll forests with a shrubby/grass understorey; and
- aquatic habitat (creeks, dams and wetlands).

There has been much habitat disturbance in the Project site, associated with:

- selective clearing – timber has historically been cleared in accessible areas resulting in trees of similar age, extensively cleared understorey and very few hollow bearing trees;
- weed invasion – weeds vary in density from moderately sparse in the dry sclerophyll vegetation to common in grasslands;
- livestock grazing – the site of the northern part of the WOE is infrequently grazed under a lease agreement, and the ground cover is a mix of native and introduced pasture species;
- macropod grazing – a high level of macropod grazing occurs in grasslands and much of the native ground cover in these areas is parse in composition and richness; and
- feral animals – Rabbits, Brown Hares, Foxes and Goats are common in the Project site.

Vegetation in the Project site is connected to large areas of native vegetation in the east and south and proposed clearing will result in fragmentation of some habitat, which will be progressively reinstated during rehabilitation.

Threatened fauna

The BAM Calculator predicted the 64 threatened fauna species in Table 8 of **Appendix K** could occur in the search radius, with 25 of these 'candidate' fauna species (i.e. species credit species). The list of candidate species was reduced to the Large-eared Pied Bat (*Chalinolobus dwyeri*) and Koala after the fieldwork.

The 132 species listed in Appendix 5 of **Appendix K** were recorded during surveys of the proposed disturbance areas and other areas in and adjacent to the Project site. Results comprised seven reptile, 34 mammal, two fish, 79 bird and 10 frog species.

Nineteen of these were threatened species and the following seven were in or adjacent to proposed disturbance areas:

- Large-eared Pied Bat (140 ha of habitat in the proposed disturbance areas – **Figure 12.4**);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (possible recording);
- Eastern Bent-wing Bat;
- Yellow-bellied Sheath tail Bat (*Saccolaimus flaviventris*);
- Eastern Free-tail Bat;
- Scarlet Robin (*Petroica boodang*); and
- Diamond Firetail (*Stagonopleura guttata*).

The following species were recorded in habitat along Bungonia Gorge and the Shoalhaven River:

- Glossy Black Cockatoo;
- Koala (however, there were feed trees in the proposed disturbance areas and there is approximately 132 ha of habitat in the proposed disturbance areas – **Figure 12.3**);
- Southern Myotis (*Myotis aelleni*);
- Eastern False Pipestrelle;
- Rufous Fantail (*Rhipidura rufifron*s);
- Grey-headed Flying Fox;

- Golden-tipped Bat (*Kerivoula papuensis*);
- Eastern Cave Bat (*Vespadelus troughtoni*);
- Powerful Owl (*Ninox strenua*);
- Sooty Owl (*Tyto tenebricosa*);
- Turquoise Parrot (*Neophema pulchella*);
- Yellow-bellied Glider (*Petaurus australis*); and
- Varied Sittella (*Daphoenositta chrysoptera*).

The Koala, Large-eared Pied Bat and Southern Myotis are 'species credit' fauna which require biodiversity offsetting if their habitat is present and/or habitat would be impacted by the Project. The Eastern Cave Bat, Glossy Black-cockatoo, Powerful Owl, Sooty Owl and Grey-headed Flying Fox are 'dual credit' species with the species credit component only triggered if breeding habitat is present. The remainder of the species are 'ecosystem credit' species, which are assumed to have habitat in the vegetation types of the Project site.

No Southern Myotis were detected in the Project site and there is no habitat for the species in the Project site (land within 200 m of pools greater than 3 m wide), except for the Marulan Creek dam site, where there is no suitable surrounding vegetation.

The Regent Honeyeater was also identified in correspondence by DoEE as likely to utilise the study area. However, it should be noted that the species was not detected during the field survey and there are no historic records within or immediately surrounding the study area.

12.3 Impact assessment

The Project will directly and indirectly impact biodiversity during construction and operation. Most impacts on biodiversity will occur during continued mining operations, associated with clearing of native vegetation and removal of habitat.

The following direct impacts will result from the Project:

- clearing of native vegetation and associated habitat, estimated to be 182.4 ha, including 88.6 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC;
- removal of one individual *Solanum celatum*; and
- clearing of associated species credit fauna habitat, comprising;
  - clearing of an estimated 132.4 ha of Koala habitat; and
  - clearing of an estimated 140.3 ha of Large-eared Pied Bat habitat.

Most of the vegetation likely to be affected by the Project has been subject to historic clearing, grazing and other agricultural activities and is therefore thinned, fragmented and contains the introduced Serrated Tussock.

Assessments of significance were undertaken for direct impacts on White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, and potential impacts to habitat associated with the Koala and Large-eared Pied Bat. An assessment of significance was also undertaken for Grey-headed Flying Fox habitat, and other EPBC listed migratory species (refer to Appendix 8 of **Appendix K**).

The assessments of significance had the following conclusions:

- the removal of TEC and impact to Koala habitat will have a significant impact and triggers the need to offset the impacts under the EPBC Act;
- offsets will not be required for the Large-eared Pied Bat under the EPBC Act, but offsets will be required under the BC Act; and
- impacts on the other threatened and migratory species listed under the EPBC Act will not be significant and will not require offsetting.

Indirect impacts will mostly occur during the construction phase of the Project and will be short term and largely confined to the Project site and immediate surrounds. The primary indirect impacts will be:

- increased noise, dust and light spill from the construction and operation of the Project;
- loss of connectivity and fragmentation of habitats at a regional scale through clearing of intact areas of native vegetation;
- increased edge-effects for surrounding vegetated areas;
- changes in vegetation composition and structure as well as available fauna habitats due to altered fire regimes (more or less frequent fire);
- erosion and sedimentation in areas adjoining construction and operational activities; and
- spread of weed propagules, which could lead to invasion of native vegetation by weeds.

The Project is unlikely to result in impacts to biodiversity in adjacent protected areas. At the closest point, vegetation clearing will be approximately 350 m from Bungonia NP, and over 750 m from Morton NP. The Project site is further separated from these conservation areas by gorges, Bungonia Creek, Barbers Creek and bushland. The Project does not propose any mining or overburden emplacement activities any closer to the adjacent conservation reserves than has occurred in the past.

It is unlikely that the existing indirect impacts (noise, dust) at the mine will increase as a result of the Project to such a level that would result in significant impacts to fauna or threatened biodiversity in the conservation areas.

12.3.1 Cumulative Impacts

Cumulative biodiversity impacts will be the total impact on the environment resulting from the Project plus other projects that are of a similar nature to the Project. The Holcim Lynwood Quarry, which is approximately 10 km north-west, and Gunlake Quarry, which is approximately 15 km north-east, are developments of similar scope to the Project.

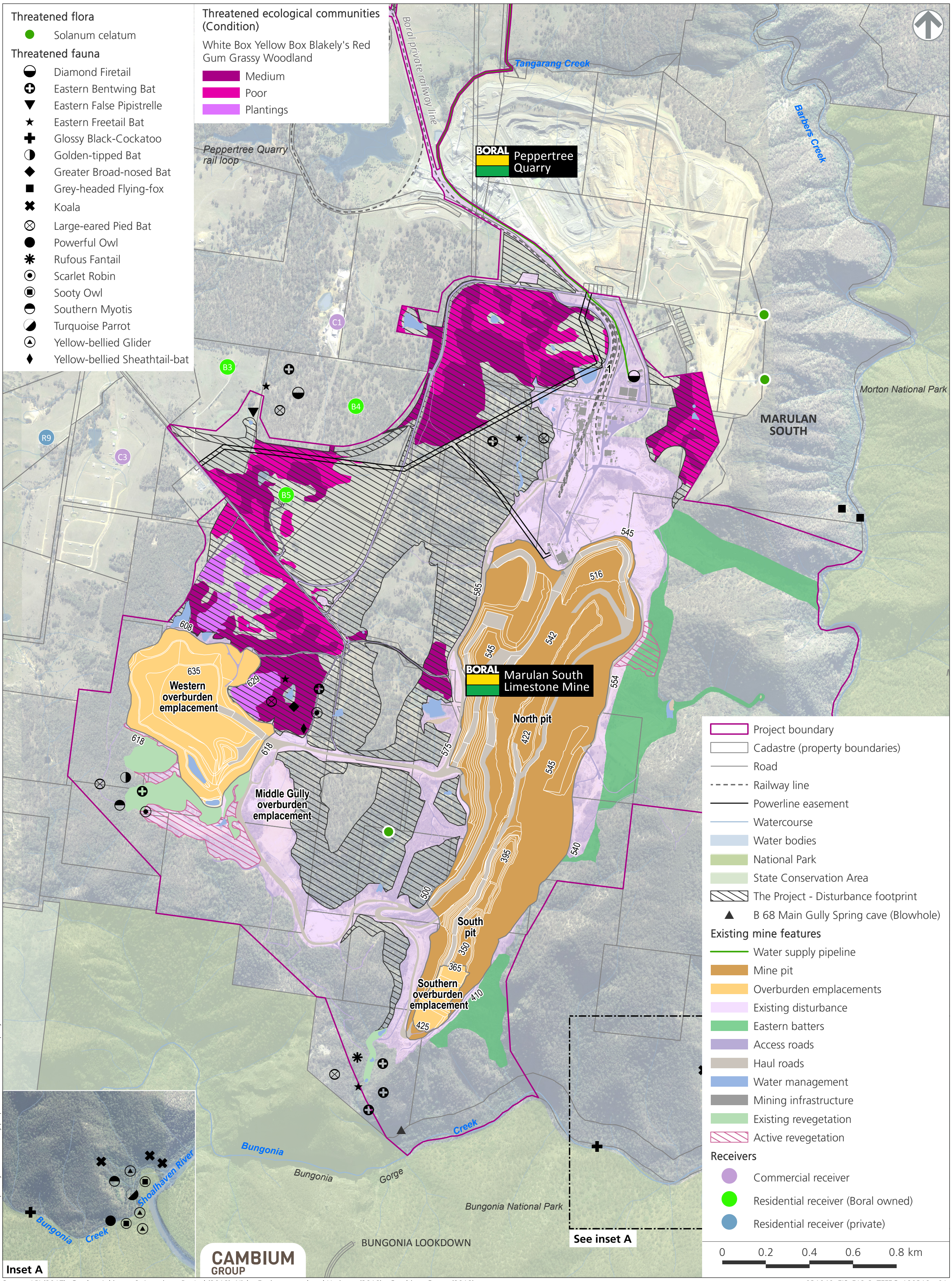
At a regional scale, the Project site is in the Tablelands landscape of the Southern Rivers Bioregion, of which approximately 44% is covered by the Goulburn Mulwaree LGA. Agriculture is the main land use in the LGA and comprises 56% of the area. Clearing has mostly occurred in the fertile lands and along riparian zones. This is consistent with the Project with grazing occurring in the Marulan Creek dam inundation area and WOE.

Only a small portion of the LGA (8%) comprises reserves and the remaining native vegetation represents only a small proportion of the pre-European vegetation. The main threat to remaining vegetation and to important ecosystem functions carried out by riparian zones and wetlands has been attributed to further clearing associated with agricultural practises and rural residential development in agricultural areas, rather than clearing or impacts associated with mining.

Even though the Project will result in degradation to native vegetation in the bioregion, the Project will involve an offset that will contribute to in-perpetuity managed conservation areas in the bioregion. This will contribute to objectives in the CMA's catchment action plan (NSW Southern Rivers Catchment Management Authority, 2013); in the Southern Rivers Bioregion it is proposed to increase the current 11,000 ha of conservation land to at least 41,000 ha.

Figure 12.2
Threatened flora, fauna and ecological communities

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

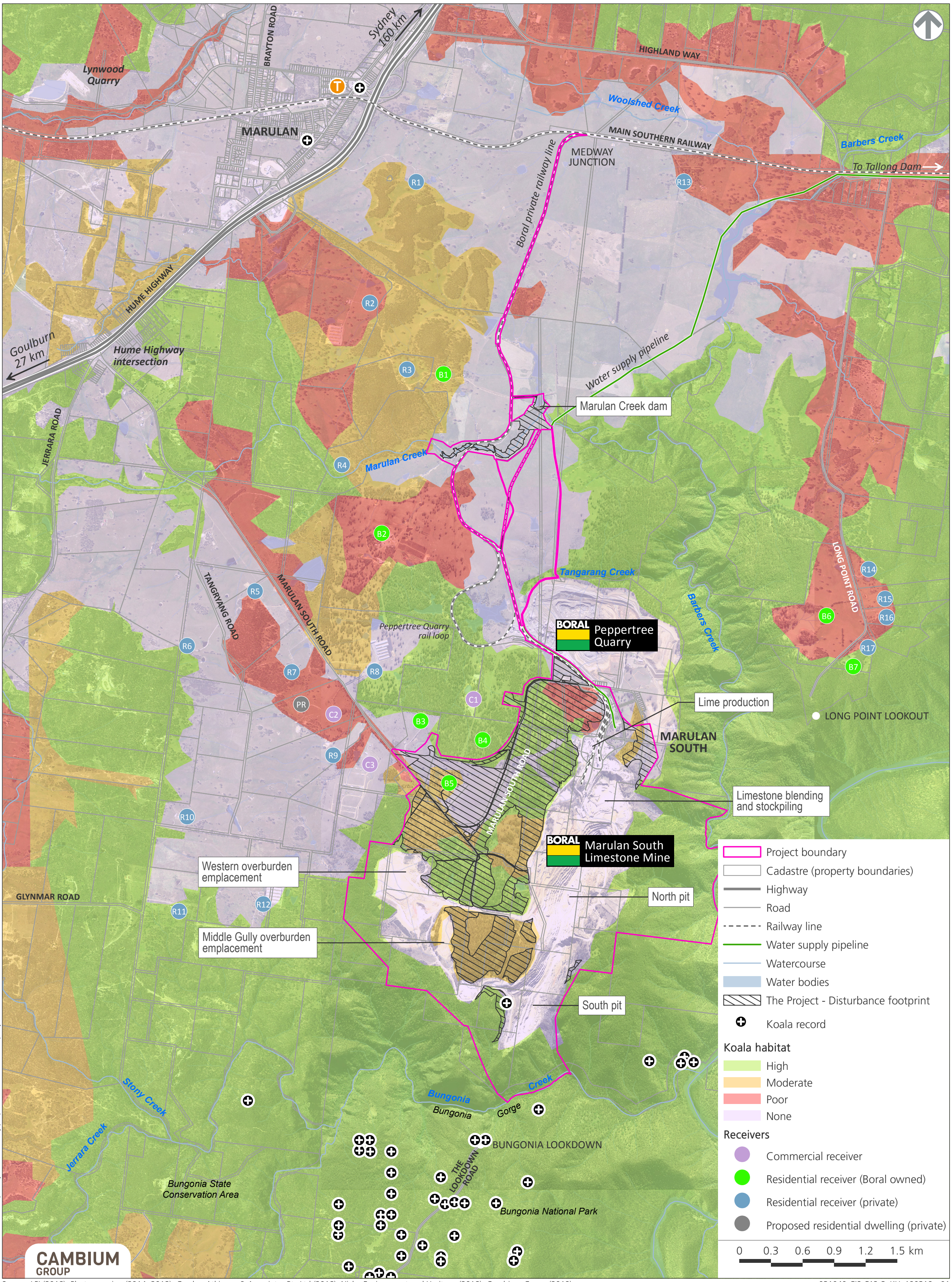


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Niche Environmental and Heritage (2018), Cambium Group (2019).

031040_EIS_F12-2_TFFEC_190319_v01

Figure 12.3
Koala habitat

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

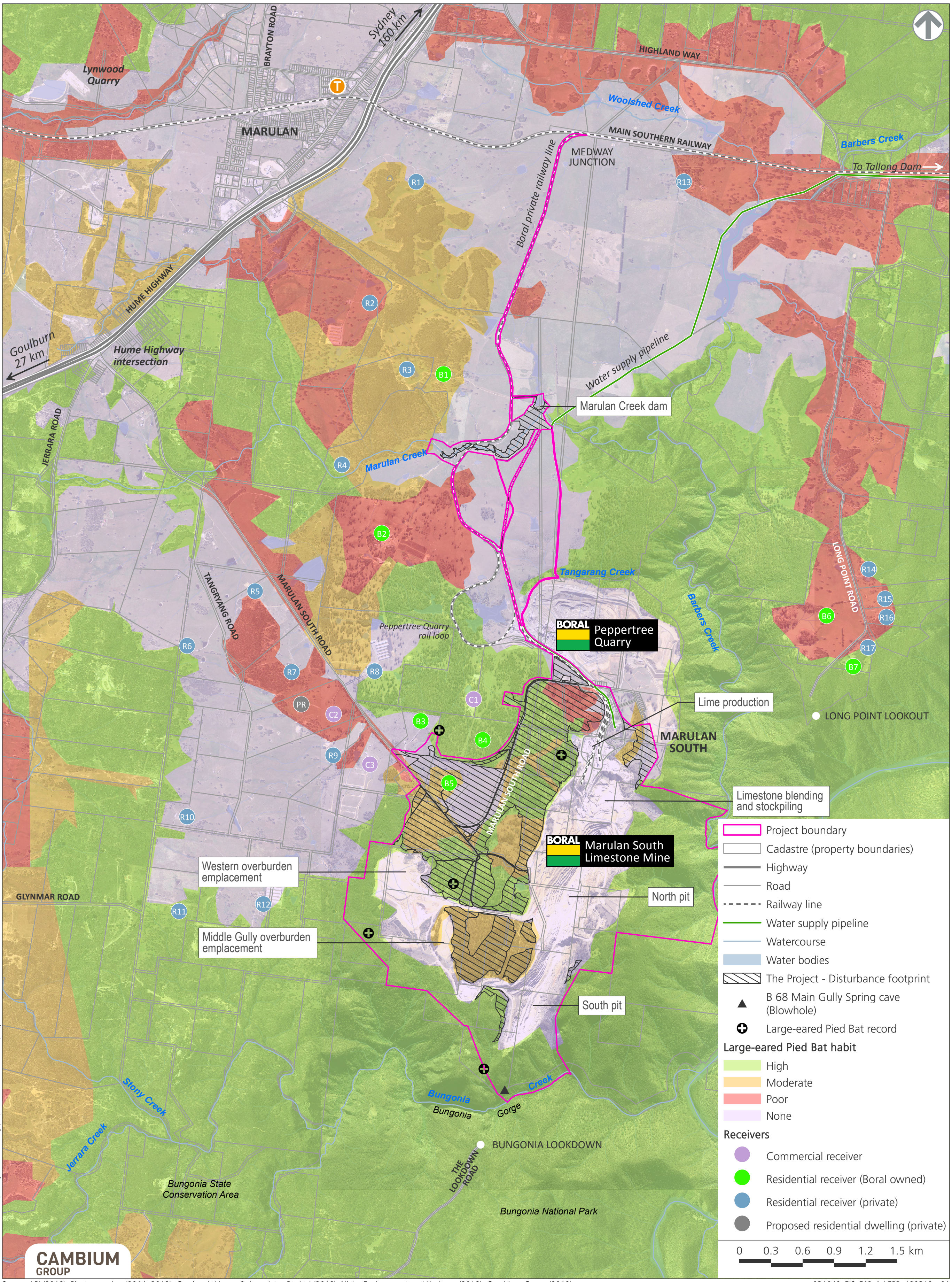


Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Niche Environment and Heritage (2018), Cambium Group (2019).

031040_EIS_F12-3_KH_190319_v01

Figure 12.4
Large-eared Pied Bat habitat

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



Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Niche Environment and Heritage (2018), Cambium Group (2019).

031040_EIS_F12-4_LEPB_190319_v01

12.4 Management measures

As outlined in **Section 7.1**, Boral applied a polycentric approach to considering all key issues and constraints during the planning phase of the Project including terrestrial biodiversity values. Where terrestrial biodiversity values could not be avoided, management and mitigation measures have been identified in the following sections (described in detail in Chapter 5 of **Appendix K**) to minimise impacts including offsetting where direct impacts are unavoidable.

12.4.1 Biodiversity management plan

A biodiversity management plan (BMP) will be prepared and implemented to reduce and mitigate biodiversity impacts and will contain:

- Demarcation and signposting – the boundary of vegetation clearing and no-go vegetation zones will be delineated with 2m high timber posts with brightly coloured tops, fences, marking tape and/or signs.
- Vegetation clearance protocol – a protocol will be implemented prior to and during vegetation clearing and will cover the following:
    - ground dwelling fauna will be searched and relocated prior to clearing of grasslands;
    - suitably qualified personnel will be engaged to supervise felling of hollow bearing trees;
    - displaced fauna will be caught and relocated to pre-designated areas by qualified wildlife handlers; and
    - the NSW Wildlife Information and Rescue Service will be requested to handle and care for wildlife encountered during operations.
- Pest and weed management – protocols will be implemented for:
    - management of feral animals such as foxes, goats, rabbits and cats within the Project site and particularly in rehabilitation areas; and
    - identification and management of noxious or important environmental weeds within the Project site and particularly in areas to be cleared, so that they are not transported to rehabilitation areas or other parts of the mine.

12.4.2 Rehabilitation

Disturbance areas will be progressively rehabilitated as described in **Chapter 26** to create a stable landform that does not result in sediment laden runoff or fugitive dust emissions, blends well with the adjacent natural landscapes of the Morton NP and Bungonia NP and re-establishes a native bushland dominated by White Box Yellow Box Blakely’s Red Gum Grassy Woodland species, which outcompetes invasive weed species.

A rehabilitation management plan (refer to **Chapter 26**) will be prepared, which will include biodiversity management measures to be implemented during the rehabilitation phases of the Project

12.4.3 Fire management

Boral implements a bushfire management plan (refer to **Chapter 23**) which contains fire prevention and suppression measures. The plan will be updated to reflect new Project elements and areas.

12.5 Residual impacts

The Project is likely to have ‘serious and irreversible impacts’ (as defined by the BAM) on the following threatened species and community:

- Koala habitat;
- Large-eared Pied Bat habitat; and
- White Box Yellow Box Blakely’s Red Gum Grassy Woodland TEC.

The Project will also impact the other PCTs in the Project site, with a total of 182.4 ha of native vegetation to be cleared as summarised in **Section 12.2**.

These impacts will require offsetting under the BC Act, with the proposed strategy summarised in the following pages.

12.5.1 Biodiversity offset strategy

The ecosystem credits required to offset vegetation and habitat impacts are summarised in **Table 12.3**.

Table 12.3: Ecosystem credit requirements

PCT	Required credits
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	1,466
PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	1,042
PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)	260
731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524)	325
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) - Non-EEC water dependent	0
Total	**3,093**

The species credits required to offset impacts on threatened fauna and flora are summarised in **Table 12.4**.

Table 12.4: Species credit requirements

Species credit species	Required credits
Solanum celatum	2
Koala	2,941
Large-eared Pied Bat	4,567

As required by the SEARs, a biodiversity offset strategy has been prepared for the Project. Boral has investigated offsetting opportunities in the Bungonia subregion and adjacent subregions and has purchased a 1,000 ha property and a 360 ha property in the Bungonia subregion for this purpose. The details of the properties have been withheld for confidentiality reasons.

The biodiversity values identified on the properties satisfy the following liabilities:

- PCT 778 Coast Grey Box stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin (SR534);

- PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) and subsequent EPBC listed White Box Yellow Box Blakely's Red Gum Grassy Woodland;
- the EPBC Act offset requirement for the Koala and Large-eared Pied Bat; and
- partially satisfy the Koala and Large-eared Pied Bat BC Act offset liability.

The properties have been surveyed by Niche Environment and Heritage Pty Ltd and biodiversity credits have been calculated. A stewardship application has not been submitted given the BCT has not provided a management action plan template at the time of the preparation of this EIS.

The remaining BC Act credit liability will either be paid into the BCT Fund.

Chapter 13

Aquatic biodiversity

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Aquatic biodiversity

Threatened species databases were searched and local streams were surveyed to assess the Project's potential impacts on aquatic biodiversity. Thirteen sites were surveyed upstream and downstream of the Project site along Barbers, Marulan and Bungonia creeks and the Shoalhaven River.

No threatened species were observed during the surveys. There were more macroinvertebrates at the downstream locations compared to the upstream locations in Bungonia Creek, which was likely due to the increased fine sediment and macrophytes in the downstream locations. There were no notable upstream/downstream differences in other waterways.

Barbers Creek had several pollution sensitive species present, indicating good stream health. Marulan Creek upstream of the Project site is in moderate health as there were several land use impacts on aquatic habitat, water quality and stream flow along the length of the waterway.

Fish communities differed between and within streams in the Project site. The introduced Mosquitofish (*Gambusia affinis*) was the only fish species observed in Marulan Creek. Barbers and Bungonia creeks showed longitudinal distribution of fish species, with Mountain Galaxias (*Galaxias olidus*) only observed upstream of the Project site in both systems.

Changes in flow regime will not adversely impact Tangarang Creek or Main Gully during or after mining and, therefore, there will be minimal impacts on aquatic habitat, flora, fauna or stream process.

The construction and operation of Marulan Creek dam is unlikely to have significant impacts as the system has already been altered by farm dams and water quality is relatively low from adjacent agricultural activities and low flows.

Except for the construction of Marulan Creek dam there is unlikely to be significant ecological impacts to these waterways resulting from the construction and operation of the Project. Impacts to Marulan Creek will not require offsetting as flows will be maintained after construction of Marulan Creek dam and the fish community in the creek mostly comprises introduced fish.

13 AQUATIC BIODIVERSITY

13.1 Introduction

This chapter summarises the aquatic ecology assessment report, which is in **Appendix L**. It describes the aquatic biodiversity of the Project area, potential impacts from the Project on aquatic biodiversity and mitigation measures where impacts are unavoidable.

13.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on biodiversity which includes aquatic biodiversity (**Table 13.1**).

Table 13.1: Biodiversity SEARs

Requirement	Section and appendix where addressed
An assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the NSW Biodiversity Offsets Policy for Major Projects and the requirements of OEH;	13.3, Appendix L
Measures taken to avoid, reduce or mitigate impacts on biodiversity;	13.4, Appendix L
Accurate estimates of proposed vegetation clearing; and	No aquatic vegetation proposed to be removed.
A comprehensive offset strategy to ensure the development maintains or improves biodiversity values of the region in the medium to long term.	No offsets required for impacts to aquatic biodiversity.

The SEARs recommend use of the following guidelines, which were used during the assessment:

- Policy and guidelines for fish habitat conservation and management (NSW Department of Primary Industries , 2013);
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (NSW Department of Environment and Conservation, 2004);
- Threatened Species Assessment Guidelines: the Assessment of Significance (NSW Department of Environment and Climate Change, 2007);
- New South Wales Australian River Assessment System (AUSRIVAS): Sampling and Processing Manual (NSW Department of Environment and Conservation, 2004);
- On Beyond BACI – sampling designs that might reliably detect environmental disturbances (Underwood, 1994); and
- Aquatic ecology in environmental impact assessment (NSW Department of Planning, 2003).

13.1.2 Overview of assessment methods

The following databases were searched in March 2018 for threatened species records in and around the Project site:

- NSW BioNet Atlas;
- Atlas of Living Australia Database;
- DPI–Fisheries Threatened Species Records Viewer and threatened species distribution maps;
- EPBC Act Protected Matters Search tool;
- AUSRIVAS data maintained by OEH; and

- Water NSW macroinvertebrate data.

The likelihood of occurrence of aquatic species in the Project site and appropriate survey locations were determined by analysing the results of database searches and review of previous literature on aquatic biodiversity in the region.

Streams were surveyed from 17-21 November 2014 and 2-5 March 2015.

Thirteen survey and sampling locations were selected upstream and downstream of the Project site along Barbers, Bungonia and Marulan creeks and the Shoalhaven River.

The surveys included a rapid visual assessment of the locations of the following parameters:

- geomorphology;
- channel diversity;
- bank stability;
- riparian vegetation and adjacent land use;
- water quality;
- macrophytes; and
- local impacts and land use practices.

Water quality and macroinvertebrates were surveyed at each location and fish were surveyed in Marulan, Bungonia and Barbers creeks and Shoalhaven River near the macroinvertebrate locations.

Fish were surveyed using visual, netting and trapping techniques including fyke netting, baited fish traps and seine nets. Nocturnal surveys targeted the threatened Macquarie Perch in Barbers and Bungonia creeks and Shoalhaven River.

13.2 Results

13.2.1 Threatened species

Database searches identified two threatened fish species in the Shoalhaven catchment; the Australian Grayling (*Prototroctes maraena*) and Macquarie Perch (*Macquaria australasica*). These threatened species were not observed during the survey.

13.2.2 Aquatic habitat

The waterways had distinct geomorphology and aquatic habitats. Marulan and Tangarang creeks were ephemeral with flows only during storms or after prolonged heavy rain. Tangarang Creek had a dam that supplied water to Peppertree Quarry and comprised a sequence of intermittent pools with little riffle habitat. The pool habitat was silts, sand, and cobble, with macrophytes common along the stream length. Downstream, the creeks discharged into Bungonia Gorge, where they merged with Barbers Creek.

Barbers and Bungonia creeks had similar geomorphology and aquatic habitat, comprising bedrock, large boulders, and pools with little macrophyte growth. These systems had a strong base flow component to the overall flow, and in lower flow periods often had no visible surface flow. They had strong subsurface connectivity, particularly in downstream sections.

Bungonia Creek had more water at the time of sampling compared to Barbers Creek, which ceased to flow more readily. Overall, the Bungonia Creek system downstream of the mine had a more diverse aquatic habitat than Barbers Creek, with large sandy pools and macrophytes near the confluence with Shoalhaven River.

The Shoalhaven River had large areas of pool and riffle habitat, a variety of substrata (cobbles, rocks, sand, silt), and macrophytes.

13.2.3 Macroinvertebrates

There were more macroinvertebrates at the downstream locations compared to the upstream locations in Bungonia Creek, which was likely due to the increased fine sediment and macrophytes in the downstream locations. There were no notable upstream/downstream differences in other waterways.

The results suggest that Barbers Creek and Bungonia Creek have good stream health, indicated by the presence of key sensitive fauna. Overall the stream health at the surveyed locations in the Shoalhaven River and Bungonia and Barbers creeks is moderate to good.

Barbers Creek had several pollution sensitive species present, indicating good stream health. Marulan Creek upstream of the Project site is in moderate health as there were several land use impacts on aquatic habitat, water quality and stream flow along the length of the waterway.

13.2.4 Fish

Fish communities differed between and within streams in the Project site. The introduced Mosquitofish (*Gambusia affinis*) was the only fish species observed in Marulan Creek.

Barbers and Bungonia creeks showed longitudinal distribution of fish species, with Mountain Galaxias (*Galaxias olidus*) only observed upstream of the Project in both systems. The habitat is typical for this species, which are known to occur in small streams above water falls/cascades that can act as a barrier to fish predators.

Flathead Gudgeon (*Philypnodon grandiceps*) and Australian Smelt (*Retropinna semoni*) occurred sporadically throughout the survey area, while Carp (*Cyprinus carpio*) and Eel-tailed Catfish (*Tandanus tandanus*) were recorded only downstream of the Project site.

Cox's Gudgeon (*Gobiomorphus coxii*) were commonly observed in Bungonia and Barbers creeks, while Australian Smelt dominated the observed fish community in the Shoalhaven River.

Previous ecological surveys further upstream in Shoalhaven River (upstream of Tallowa dam) discovered:

- Long-finned Eel (Anguilla reinhardtii);
- Short-finned Eel (*Anguilla australis*);
- Flathead Gudgeon;
- Cox's Gudgeon;
- Australian Bass (Percalates novemaculeata);
- Carp;
- Mosquito Fish; and
- Australian Smelt.

Most of these species were also identified during the surveys.

13.3 Impact assessment

13.3.1 Water flows

As described in **Section 8.2**, the flow regime of Tangarang Creek will be altered by an increase in total catchment area. However, the magnitude of change is unlikely to significantly impact aquatic ecology and may provide more habitat with the increased flow. There are unlikely to be significant changes to Main Gully during mining. However, flow will return to pre-mining rates after mine closure.

As described in **Section 8.2**, changes in flow regime will not adversely impact on Tangarang Creek or Main Gully during or after mining and, therefore, there will be minimal impacts on aquatic habitat, flora, fauna or stream process.

13.3.2 Water quality

It was concluded in **Appendix G** that no adverse water quality impacts are expected to Tangarang Creek, Main Gully or Bungonia Creek. Furthermore, groundwater quality is similarly unlikely to be impacted (**Appendix H**). Considering this, it is unlikely that there will be any impacts to aquatic ecology due to surface or groundwater quality in these systems.

13.3.3 Springs

As described in **Section 9.3.1**, water seeping into the pit floor will recharge the limestone and feed the springs. Springs are an important component of the river system and, given they will continue to be recharged, they will continue to add baseflow to streams with the associated positive impacts on aquatic habitat.

13.3.4 Marulan Creek dam

There were fewer macroinvertebrate families than expected in Marulan Creek, potentially due to poor stream health from adjacent agricultural activities and low flows.

Downstream sections of Marulan Creek could be impacted by the Marulan Creek dam. However, impacts are likely to be minimal as the system already has altered flows from farm dams, the Marulan Creek dam will be designed to contribute flow to the creek and the biodiversity is modified and adapted to ephemeral conditions. Impacts will diminish with distance from Marulan Creek dam as more water and aquatic habitat become available.

The construction of the Marulan Creek dam would also contribute temporary impacts such as sedimentation. Marulan Creek dam will pose a barrier to fish passage. However, only introduced fish species were observed in Marulan Creek indicating poor fish communities. Given the poor condition of the waterway and limited fish habitat, it is expected that the impact on fish passage/recruitment would be low.

The flooded area behind the Marulan Creek dam could provide aquatic habitat for lentic invertebrates, macrophytes, birds, amphibians and fish.

13.3.5 Likelihood of threatened species to occur

The Australian Grayling has not been observed in Shoalhaven River upstream of Tallowa dam, indicating the dam is an impediment to upstream migration. Habitat in the creeks in and adjacent to the Project sites do not have suitable habitat for the Macquarie Perch such as riffle substrate for breeding. There are also many barriers in the streams.

Given the above, it is unlikely the threatened species occur in the creeks in or adjacent to the Project site.

13.3.6 Key fish habitat

Marulan, Bungonia and Barbers creeks and Shoalhaven River are mapped as key fish habitat. Except for the construction of Marulan Creek dam there is unlikely to be significant ecological impacts to these waterways resulting from the construction and operation of the Project. With regards to Marulan Creek dam, offsetting for habitat loss is not required as:

- the degree of disturbance would be minimised as far as practical;
- flows will be maintained for downstream habitat post construction;
- the existing fish community in Marulan Creek consists primarily of introduced invasive fish; and
- there will be compensatory works to stabilise and rehabilitate areas affected by the construction of the Marulan Creek dam and areas immediately downstream and upstream as part of the maintenance and management of the waterway.

13.3.7 Key threatening processes

The Project will not generate the key aquatic biodiversity threatening processes listed under the BC Act, the FM Act and/or the EPBC Act or alter processes beyond existing conditions.

13.3.8 Cumulative impacts

The cumulative impacts will be the total impact on the environment that would result from incremental impacts (including both direct and indirect impacts) from the Project added to other existing impacts and proposed developments in the locality and region.

Other developments locally include Peppertree Quarry and Lynwood Quarry, which are in Barbers Creek Catchment. Both have been approved under recent major project planning processes and have strict water management requirements. These imposed conditions reduce the likelihood of cumulative impacts on water quality and flow regimes of receiving drainage systems.

As described in **Appendix L**, the above potential impacts from the Project will not have any cumulative adverse impacts on surface water resources and water quality in Barbers Creek, Bungonia Creek or the Shoalhaven River. Therefore, the Project would make a negligible contribution to any cumulative impacts associated with other projects in the local area, and as such is unlikely to measurably impact aquatic ecology.

13.4 Management measures

As described in **Section 8.3**, a water management system will be designed and implemented at the mine, which will result in a neutral or beneficial impact to receiving waters.

As described in **Section 8.3.1**, an erosion and sediment control plan will be prepared and implemented during construction of Marulan Creek dam, and seepage will occur from the dam during operations, to maintain daily riparian flow along Marulan Creek, downstream of the dam. Water quality monitoring will continue in Marulan Creek, which will be used to interpret changes in stream and aquatic biodiversity health after the dam is constructed.

13.4.1 Baseline monitoring

The aquatic biodiversity survey locations will be surveyed in autumn and spring for one year after the start of the 30-year mine plan to add to the baseline data and capture temporal variation in stream health.

13.4.2 Changes in water quality

If a water quality trigger threshold is exceeded in consecutive monitoring events (in accordance with the TARP) and if additional assessment finds that the change in water quality may be mining induced, then Boral will contact a suitable qualified aquatic ecologist to determine if the exceedance is likely to affect aquatic ecology and design/conduct an aquatic ecological monitoring program if required. Monitoring will:

- be conducted up and downstream of the site where the water quality threshold was triggered;
- be consistent with the biodiversity management plan and surface water management plan developed for the Project;
- use methods appropriate for the level of assessment; and
- be conducted at a frequency and over a timeframe appropriate for the level of assessment.

13.5 Residual impacts

As described in **sections 8.4** and **9.5**, the Project will not have significant residual impacts on groundwater or surface water in Bungonia and Barbers creeks and the Shoalhaven River. Therefore, the Project will not significantly impact aquatic biodiversity in these waterways.

Construction of the Marulan Creek dam will have the unavoidable impact of altering the morphology of Marulan Creek. However, Marulan Creek has existing poor aquatic biodiversity and the provision of new habitat behind the dam and base water flows downstream of the dam may have a slight beneficial impact.

Chapter 14

Stygofauna

VOLUME 1

Stygofauna

Groundwater can contain many highly sensitive, specialised and highly localised, endemic flora and fauna that cannot be found elsewhere and have little tolerance to change.

Impacts to stygofauna were assessed by using NSW Office of Water's aquifer risk assessment process. Eight groundwater monitoring wells in the Project site and several control bores outside the Project site were sampled for stygofauna. The hyporheic zones (the zone below and within the porous sand and gravel substrate of a riverbed) of streams and springs were sampled in 15 locations.

No stygofauna were found in any of the groundwater monitoring wells in the Project site. One species of stygofauna was found in a groundwater bore outside the Project site. Fifty species of macroinvertebrates were found in the spring and riverine habitats of Bungonia and Barbers creeks. The species are generally tolerant of moderate levels of disturbance.

Fauna were most abundant in the epigean zone (confined to surface water/creeks/rivers), especially at the springs. These species do not enter far into the deeper zones as they are poorly adapted to the low light/oxygen environment.

The largest zone in and around the Project site is the hypogean ecosystem (true groundwater) or aquifers but only one species of stygofauna was found in this ecosystem in a groundwater bore outside the Project site.

Four groundwater dependent ecosystem types were identified in and adjacent to the Project site.

The aquifer risk assessment process was applied to each of the stygofauna survey sites to determine the risk of stygofauna across the Project site being adversely impacted by the Project. All the groundwater monitoring wells/bores and the Bungonia Creek Upper site had low ecological value, while the remaining spring sites had high ecological value given the abundance and diversity of species and the ecosystem health.

The ecological risk was low at all sites as it is predicted that the groundwater table is likely to only reduce by up to 1 m within approximately 290 m of the eastern edge of the current mine pit as a result of mining during the 30-year mine life, and flows/water quality will be maintained at the springs. Additionally, none of the GDEs will be directly impacted by mining as they are outside the disturbance area.

Overall, the assessment determined the Project poses a low risk to stygofauna.

14 STYGOFAUNA

14.1 Introduction

This chapter summarises the stygofauna and groundwater dependent ecosystem assessment report, which is in **Appendix M**. It describes the stygofauna and groundwater dependent biodiversity of the Project site, potential impacts on this biodiversity from the Project and mitigation measures where impacts are unavoidable.

14.1.1 Assessment requirements

The SEARs require an assessment of the likely impacts of the Project on biodiversity which includes stygofauna and groundwater dependent biodiversity (**Table 14.1**).

Table 14.1: Biodiversity SEARs

Requirement	Section and appendix where addressed
▪ An assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the NSW Biodiversity Offsets Policy for Major Projects and the requirements of OEH;	14.3, Appendix M
▪ Measures taken to avoid, reduce or mitigate impacts on biodiversity;	14.4, Appendix M
▪ Accurate estimates of proposed vegetation clearing; and	No stygofauna habitat is proposed to be removed.
▪ A comprehensive offset strategy to ensure the development maintains or improves biodiversity values of the region in the medium to long term.	No offsets required for impacts to stygofauna.

OEH requested an assessment of the likely impacts of the Project on downstream water-dependent fauna and flora including groundwater dependent ecosystems and stygofauna (**Appendix M**).

14.1.2 Overview of assessment methods

Groundwater can contain many highly sensitive, specialised and highly localised, endemic flora and fauna that cannot be found elsewhere and have little tolerance to change. As there is no direct photosynthesis in aquifers, stygofauna rely on connections to the land surface to provide them with food. These connections may be hydrological, with infiltrating water bringing dissolved or particulate organic matter to form the basis of subterranean food webs, or it may be more direct, with tree roots that extend below the water table providing leachates or organic carbon or fine rootlets for food

Eight groundwater monitoring wells in the Project site were sampled for stygofauna. Several control bores outside the Project site were also sampled to determine any site-specific influences in the Project site and to compare results.

A combination of sampling techniques was used to collect all possible biota across the range of stygofaunal habitats. Submersible pumps, hand pumps, bailers and/or plankton nets were used to sample the groundwater wells/bores.

Hand pumps/syringe devices, hand nets and artificial substrates were used at the 15 survey sites in the hyporheic zones (the zone below and within the porous sand and gravel substrate of a riverbed) and spring sites.

All samples were preserved in the field with ethanol and returned to the laboratory where each sample was sorted under a stereomicroscope and stored in alcohol. All specimens were identified to the lowest possible taxonomic level, generally to genus, where possible. Specimens were identified under a compound microscope using a combination of current taxonomic works and keys.

Impacts to stygofauna were assessed by using NSW Office of Water's aquifer risk assessment process, where GDEs (in this instance aquifers) are identified and classified by their level of groundwater dependence, the GDE's ecological value ascertained, potential future impacts on the GDE predicted and the magnitude of risk from the impact to the ecological values determined.

14.2 Results

No stygofauna were found in any of the groundwater monitoring wells in the Project site. One species of stygofauna was found in a groundwater bore outside the Project site. Fifty species of macroinvertebrates were found in the spring and riverine habitats of Bungonia and Barbers creeks.

The species are generally tolerant of moderate levels of disturbance. The communities were dominated by predator feeding groups such as Coleoptera, Hemiptera and the detritivore feeding groups including an array of Chironomidae as well as large shredder/grazer guilds including the Ephemeroptera and seven species of Gastropoda. The high abundance of the Gastropoda on the hard substrates of the creeks and the springs were particularly notable as they indicated the abundance of habitat, good water quality and a lack of fine sediments.

Fauna were most abundant in the epigean zone (confined to surface water/creeks/rivers), especially at the springs. These species do not enter far into the deeper zones as they are poorly adapted to the low light/oxygen environment.

The next abundant fauna occurred in the hyporheic zone, which is the zone below and within the porous sand and gravel substrate of a riverbed. Only a small number of taxa and specimens were collected in this zone due to the fine grain nature of the substrate and occurrence of boulders and bedrock that made up the stream beds.

The largest zone in and around the Project site is the hypogean ecosystem (true groundwater) or aquifers. As outlined above, only one species of stygofauna was found in this ecosystem in a groundwater bore outside the Project site. The lack of stygofauna in this ecosystem within the Project site is likely due to the lack of horizontal connectivity in the limestone and inappropriate water chemistry.

The following GDE types were identified in the Project site:

- subsurface phreatic (deep groundwater) aquifer ecosystems;
- baseflow stream (surface ecosystems);
- baseflow stream (hyporheic ecosystems); and
- phreatophytes - groundwater dependent terrestrial vegetation.

The survey also demonstrated that:

- groundwater dependent spring and hyporheic communities are present downslope of the aquifers associated with the mining operations;
- the ecological value of the stygofauna community across the area is low with higher concentrations of biodiversity at springs with potentially a high degree of endemism;

- the ecological value of the springs downslope of the mining area is high; and
- there is connectivity between the alluvial aquifers and the shallow, fractured limestone aquifers.

14.3 Impact assessment

14.3.1 Stygofauna and groundwater dependent springs

The aquifer risk assessment process was applied to each of the stygofauna survey sites to determine the risk of stygofauna across the Project site being adversely impacted by the Project. This involved using the survey results to note presence of fauna at the sites, determining the ecological value of the site and determining the risk posed by Project impacts to determine the overall risk.

All of the groundwater monitoring wells/bores and the Bungonia Creek Upper site had low ecological value, while the remaining spring sites had high ecological value given the abundance and diversity of species and the ecosystem health.

The ecological risk was low at all sites as it is predicted that the groundwater table is likely to only reduce by 1 m within approximately 290 m of the eastern edge of the current mine pit as a result of mining, and flows/water quality will be maintained at the springs, as described in **Section 9.3.4**. Additionally, none of the GDEs will be directly impacted by mining as they are outside the disturbance area.

Overall, the assessment determined the Project poses a low risk to stygofauna.

14.3.2 Cumulative Impacts

Given the overall low abundance and diversity of stygofauna, except at the springs, and the limited impacts to ground and surface water from the Project, the Project will not add significantly to cumulative stygofauna impacts in the region.

14.4 Management measures

Since stygofauna were not observed in the Project site, no specific management measures or monitoring is proposed for stygofauna. However, management and mitigation measures to minimise potential groundwater and surface water impacts as outlined in **sections 8.3** and **9.4**, will also minimise impacts on any stygofauna that may exist within the Project site or in the local area.

As over fifty species of macroinvertebrates were found in the spring and riverine habitats of Bungonia and Barbers creeks, monitoring of macroinvertebrates in GDE's downstream of the mine (Bungonia Creek, Barbers Creek, Main Gully and springs), will help inform whether any impacts on water quality identified through the quarterly water quality monitoring program and attributed to the mine, are also impacting on the spring dependent macroinvertebrates. Monitoring of macroinvertebrates in GDE's downstream of the mine, triggered by repeated exceedances of the surface water trigger values (**Section 8.3.2**) will be undertaken in accordance with the aquatic ecology monitoring approach described in **Section 13.4** but using the GDE survey sites.

14.5 Residual impacts

As no stygofauna were found in the Project site and there is low likelihood of occurrence, it is unlikely the Project will directly impact stygofauna in the aquifers in and under the limestone. As described in **Section 9.3**, the Project will not have significant residual impacts on groundwater or springs. Therefore, the Project is unlikely to significantly impact stygofauna or groundwater dependent ecosystems in waterways downstream of the mine.

Chapter 15

Aboriginal heritage

VOLUME 1

Aboriginal heritage

Potential impacts of the Project on Aboriginal cultural heritage were assessed by searching OEH's Aboriginal Heritage Information Management System (AHIMS) for previous records of sites in and adjacent to the Project site, surveying the Project site for new sites and consulting Aboriginal parties. Some sites were also excavated to characterise sub-surface archaeological deposits.

According to AHIMS, there are 112 registered sites in a 10 by 10 km area around the Project site, 15 sites adjacent to the Project site and four items in the Project site.

The background environmental and cultural information was used to predict the following about the types of Aboriginal heritage items, and where they could occur, in the Project site:

- artefacts may be present as part of open camp sites or as isolated finds;
- rock shelters and art sites are not likely to be present due to the geology of the Project site;
- suitable landforms (eg elevated land, spurs and crests) next to reliable water will be of high archaeological potential; and
- culturally modified trees are rare but may be present where mature native trees remain.

The surveys targeted ground exposures on land near reliable watercourses; hill spurs and crests; and the relatively flat and undulating land near the proposed Marulan South Road realignment and the construction access road to the Marulan Creek dam. All mature trees and rock outcrops along the survey transects were inspected for evidence of scars on trees and grinding grooves, rock pools or engravings on rocks.

Forty one new sites were recorded during the survey comprising 28 artefact scatters, 12 isolated finds and one potential scar tree. The potential scar on the tree was later determined not to be of Aboriginal origin.

The survey team counted 236 artefacts, comprising 224 in scatters and 12 isolated finds. Effective survey coverage was not reliable due to the amount of surface cover and the incidence of artefact discoveries did not accurately reflect the potential for artefacts to exist in the Project site, given the amount of sensitive landscapes in the area.

Test pits were excavated as the survey was not sufficiently accurate to verify the predictive model. There were 539 artefacts in 17 of the 25 test pits, which represent 17 new sites. The pits with the highest amounts of artefacts were on broad spurs next to Marulan Creek (86% of all artefacts). The remaining 73 artefacts were recovered from 10 test pits in the main Project site, with over half of these from one location.

The test excavations demonstrated that the most extensive assemblages exist along reliable watercourses and that some artefact materials, including grey silcrete, were brought in through trade or importation. Marulan Creek appears to have been a focus of long term, sustained habitation, with frequent visitations to create a rich and varied artefact assemblage.

Forty nine sites will be impacted by the Project, comprising 39 which will be totally lost and 10 that will be totally disturbed. One site which will be totally lost has high archaeological significance and 11 of the sites to be totally disturbed/lost have moderate significance.

Thirty two sites comprising surface artefact scatters and isolated finds in the disturbance footprint will be collected by an archaeologist and RAPs, prior to disturbance by the Project.

An area of high archaeological sensitivity in the Marulan Creek dam disturbance footprint and an area of moderate archaeological sensitivity in the main Project site will be salvaged as they are likely to contain relatively intact subsurface deposits which will assist in understanding the Aboriginal past in the Project site and will be totally lost during the Project. Sites close to the proposed Project disturbance footprint that will be avoided, will be protected by demarcation and signage.

15 ABORIGINAL HERITAGE

15.1 Introduction

This chapter summarises the Aboriginal cultural heritage assessment (ACHA) report, which is in **Appendix N**. It describes the cultural context of the Project site, consultation with the Aboriginal community study methods, items discovered during surveys, the significance of the items, potential impacts and mitigation measures where impacts are unavoidable.

15.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on Aboriginal cultural heritage (**Table 15.1**).

Table 15.1: Aboriginal heritage SEARs

Requirement	Section and appendix where addressed
▪ an Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must: - demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; and	5.3, Appendix N
- outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures), having regard to OEH's requirements.	15.5, Appendix N

The SEARs recommend use of the following guidelines, which were used during the assessment:

- Draft guidelines for Aboriginal cultural heritage assessment and community consultation (Department of Environment and Conservation, 2005); and
- Aboriginal cultural heritage consultation requirements for proponents (Office of Environment and Heritage, 2010).

15.1.2 Overview of assessment methods

The following assessment methods were used during the ACHA.

Desktop study

Environmental features which could influence historic Aboriginal use of the area were characterised, for example landscape, drainage, geology, soils, vegetation, fauna and climate.

Literature such as previous heritage assessments of the region and local area were reviewed to understand historical Aboriginal use of the area and customs.

The AHIMS database was also searched as described in **Section 2.4.1**.

Information gathered from the desktop study is used to develop a predictive model of what types of Aboriginal sites are likely to occur within the Project site and where.

Aboriginal consultation

Thorough consultation was undertaken with Aboriginal parties in accordance with (Department of Environment and Conservation, 2005) and (Office of Environment and Heritage, 2010) as detailed in **Section 5.4**. Nineteen Aboriginal groups registered their interest in the Project and contributed cultural knowledge and archaeological expertise to the Aboriginal heritage assessment process.

Archaeological survey

The Project site was surveyed between 13 to 17 April 2015 by archaeologists and representatives of the registered Aboriginal parties (RAPs). The surveys targeted ground exposures on land near reliable watercourses; hill spurs and crests; and the relatively flat and undulating land near the proposed Marulan South Road realignment and the construction access road to the Marulan Creek dam. All mature trees and rock outcrops along the survey transects were inspected for evidence of scars on trees and grinding grooves, rock pools or engravings on rocks.

Potential Aboriginal sites were photographed and their locations recorded using GPS units.

Test excavation

Areas that were identified by the desktop study and survey as potentially containing Aboriginal items were excavated between 15 June to 1 July 2015 by archaeologists and representatives of the RAPs. The excavation program aimed to characterise the subsurface archaeological deposit and test the predictive model and survey results.

Test pits were 3 m by 1 m and were excavated by hand and machine. Excavated material was sieved and artefacts were washed and bagged for future recording.

15.2 Results

15.2.1 Desktop study

Results of the AHIMS database search are summarised in **Section 2.4.1**.

Early accounts from European settlers suggest Aboriginal people moved on small family groups belonging to clans of 30 to 50 people with ties to specific territories. There was evidence of covered sleeping areas (gunyahs) and tools and weapons made of timber and bark adhered with plant resins. Local and imported stones including quartz and silcrete were used to make a variety of tools. Aboriginal people ate plants, aquatic life, marsupials and reptiles. People were buried in a number of ways. Individuals could be interred in a shallow grave covered by stone, rocks or cobbles. Positioning of the burial may have been associated with ownership of areas. Burial could also have included placing the corpse in a hollow tree or in a sitting position in the ground.

The Marulan and Marulan South area may have been suitable for large or regular ceremonial and tribal meetings given the area is in the centre of a number of different geographical areas.

The background environmental and cultural information was used to predict the following about the types of Aboriginal heritage items, and where they could occur, in the Project site:

- artefacts may be present as part of open camp sites or as isolated finds;
- rock shelters and art sites are not likely to be present due to the geology of the Project site;
- suitable landforms (eg elevated land, spurs and crests) next to reliable water will be of high archaeological potential; and
- culturally modified trees are rare but may be present where mature native trees remain.

15.2.2 Survey

Survey coverage

Survey coverage, that is; the percentage of the ground surface exposed in each landform and the visible ground surface within exposures, is analysed to determine the effectiveness of the survey. For example, an archaeologically sensitive landform surface that is highly exposed by erosion is likely to reveal Aboriginal artefacts, whereas a similar landform that is thickly grassed will obscure surface artefacts if they are present.

Seventy one transects were walked covering 51 km (refer to Figure 6.1 and 6.2 in **Appendix N**), with effective coverage summarised in **Table 15.2**.

Table 15.2: Effective survey coverage

Landform	Length (m)	Area (m^2)	Area available for detection (m^2)	Effective coverage (%)
Hillslope	2,541	128,328	11,880	9.2
Undulating plain	6,217	310,850	51,221	16.5
Ridgeline	9,262	426,220	43,397	10.2
Watercourse	24,398	1,203,482	244,042	20.2
Spur	8,076	395,380	36,753	9.3
Total	50,494	2,461,260	387,292	15.7

Surface disturbance was variable with active mine areas having high levels of disturbance. Much of the Project site comprised cleared paddocks, which may have Aboriginal items mixed into the soil without fully diminishing their archaeological/cultural value. Visibility was restricted by grass in paddocks, with transects in these areas targeted at exposures.

The proposed Marulan Creek dam site comprised pasture and visibility was low. Notwithstanding, Marulan Creek was considered highly likely to contain evidence of past Aboriginal activity.

In contrast; the hill slopes, spurs and ridgelines in the proposed WOE, SOE and NOE areas had higher levels of exposure and visibility, suggesting surveys in these areas were more reliable.

Survey site results

Archaeological sites

Forty one new sites were recorded during the survey with the site types and their frequencies summarised in **Table 15.3**. One of the sites was a possible scar tree. However, closer inspection of the scar strongly suggests that it was caused naturally either by a lightning strike or generalised trauma damage, consistent with the characteristics described in (NSW Department of Environment and Conservation, 2005). The tree has a series of elongated and irregularly shaped scars curving around the trunk. There is no evidence of axe marks, appropriate margin shape (eg no rounded or square margins) or appropriate scar shape that would suggest the scar is of Aboriginal origin. Accordingly, site MSL 037 has not been discussed further.

Over half the sites were on watercourse landform types, with two thirds on the eroded stream banks of Marulan Creek. The other watercourse sites were on minor ephemeral streams in the proposed overburden emplacement areas.

Over one quarter of the sites were on spurs in the main Project site, which was likely due to high ground disturbance. This contrasts with the spur near Marulan Creek where there were almost no exposures and no artefacts were discovered. Three sites were on ridgelines representing the highest points of the proposed overburden emplacements and three sites were on the hillslopes north of the existing WOE.

Table 15.3: Site frequencies and landform associations

Site type	Hill slope	Ridgeline	Spur	Undulating plain	Watercourse	Total
Artefact scatter	2	1	11		14	28
Isolated find	1	2		1	8	12
Not a scar tree			1			1
Total	**3**	**3**	**12**	**1**	**22**	**41**
Artefact counts	**16**	**4**	**72**	**1**	**143**	

Two hundred and thirty six artefacts were counted during the survey with 224 in scatters and 12 as isolated finds. The scatters ranged from two to 30 artefacts, with most of the scatters comprising more than 10 artefacts discovered along watercourses.

Overall it was determined that effective survey coverage was not reliable due to the amount of surface cover and the incidence of artefact discoveries did not accurately reflect the potential for artefacts to exist in the Project site, given the amount of sensitive landscapes in the area.

Cultural site

During the survey a possible women's site was identified by an Aboriginal member of the survey team along Marulan Creek, in the vicinity of the proposed Marulan Creek dam. This site is not shown on figures in this report for confidentiality reasons.

15.2.3 Test excavation results

One of the most suitable ways to further investigate the predictive model and the results of the survey is through test excavation which provides valuable data on the subsurface archaeological character of the Project site.

Five hundred and thirty nine artefacts were discovered across 17 of the 25 test pits, which represented 17 new Aboriginal sites. The test pits, number of artefacts and landforms are summarised in **Table 15.4**.

Table 15.4: Test pits and artefact frequency

Test pit	Landform	No. artefacts
1	Undulating plain	34
2	Ridge	0
4	Ridge	0
5	Ridge	0
6	Spur	8
7	Spur	1
9	Hill slope	0
10	Drainage depression	0
11	Undulating plain	0
14	Spur	32
15	Spur	174
16	Spur	71
17	Spur	84

Test pit	Landform	No. artefacts
18	Undulating plain	1
19	Spur	2
30	Spur	2
31	Spur	2
32	Spur	4
33	Spur	5
34	Spur	0
35	Spur	40
36	Spur	8
37	Spur	68
38	Undulating plain	3
39	Hill slope	0
Total		**539**

The pits with the highest amounts of artefacts were on broad spurs next to Marulan Creek, with 86% of artefacts found in these pits despite them representing less than half of the overall excavation effort. The remaining 73 artefacts were recovered from 10 test pits in the main Project site, with over half of these from one location (TP35).

The resulting frequency of 22 artefacts per square metre near Marulan Creek is likely a medium frequency value for the region, while the average of four per square metre in the area of the proposed overburden emplacements is likely low. Marulan Creek appears to have been a focus of long term, sustained habitation, with frequent visitations to create a rich and varied artefact assemblage.

There were localised differences in artefact frequencies at Marulan Creek. The largest concentrations of artefacts (TP15, TP16 and TP17) were on broad spurs near bends, overlooking the creek. In contrast, TP10 and TP11 did not contain artefacts despite their proximity to the creek, which may be due to its potential to flood.

The largest group of artefacts in the main Project site were at TP35 which contained 40 artefacts. This test pit was on a large flat spur overlooking two drainage lines. Further south the landscape increases in gradient dramatically and the conditions for camping decrease in quality. Fewer or no artefacts were found in areas away from reliable water, plain landscapes or in areas where drainage was poor and flooding was common.

The artefact types and their amounts are shown on Figure 7.5 of the ACHA (**Appendix N**). The most common artefact type was complete flakes (60%), but only 5% of the complete flakes demonstrated evidence of being retouched, putting them in the category of 'tool'. Broken flakes were generally distal flakes (19%). Medial, proximal, longitudinally split and flaked pieces together made up 16% of the assemblage, while the remaining 5 % were cores. Overall, the assemblage appears to be primarily by-product of stone tool manufacture.

It is not unusual to have small numbers of tools in an assemblage as they were frequently reused and as such may be subject to different use and discard patterns when compared to stone shaping or other discard patterns.

The test excavations demonstrated that the most extensive assemblages exist along reliable watercourses and that some artefact materials, including grey silcrete, were brought in through trade or importation, as these materials do not naturally occur in the area. The majority of the artefacts were discarded from stone tool manufacture and were consistent with a landscape that was used for open camp sites.

The surveys and test excavations showed that the surface survey was most effective for the main Project site and test excavation was most effective for the Marulan Creek dam area. The results demonstrated that Aboriginals occupied the entire Project site, however, there was likely less intensive camping in the main Project site due to the steeper terrain and unreliable ephemeral streams. Slope was a key factor in the distribution of and intensity of occupation across the Project site, with camping mostly only occurring on slopes of 10 degrees or less and distant enough from watercourses to avoid flooding but close enough for easy access, with these requirements available near Marulan Creek.

15.2.4 Archaeological sensitivity model

An archaeological sensitivity model was developed based on the results of the ACHA and recent Aboriginal heritage assessments for the adjacent Peppertree Quarry. The purpose of the model was to indicate subsurface archaeological potential that could be impacted by the Project and to guide management and mitigation measures. Three levels of sensitivity were developed:

- Low – areas where the occurrence of subsurface artefacts is predicted to be less than two per square metre.
- Moderate – flat or undulating land within 200 m of Marulan Creek and the spur crest surrounding site MSL 055.
- High – the broad prominent crests surrounding Marulan Creek near the location of the proposed Marulan Creek dam.

15.3 Significance assessment

15.3.1 Overview

The values held by communities for heritage is an important management consideration, with the values collectively called cultural significance. The ACHA assessed potential impacts of the Project on the following aspects of cultural significance:

- Socio-cultural value – places which have meaning in accordance with memory or tradition but not associated with cultural items. Even though the broader landscape is significant to Aboriginal people, the ACHA sought to identify if the Project site had specific values in itself or as part of a specific local area of particular significance,
- Scientific value – where sites are assessed as having low, moderate or high ratings of the following:

Research potential – the contribution that a heritage site can make to present understanding of human society and the human past.

Rarity – the commonness of items, both in a regional context and reduced frequency over time due to development and change.

Integrity – how intact a site is and its ability to inform the history of the area and contribute to the cumulative knowledge of the site/item type.

Research themes – the ability of a site to address the key research issues for a region, which in a local context is associated with chronology of occupation and variability in artefact manufacturing technology.

Educational value – the capacity of a site to portray more easily recognisable archaeological features

15.3.2 Significance for the Aboriginal community

The Aboriginal community was consulted and the area researched to determine whether any socio-cultural heritage value relates specifically to the Project site regardless of archaeological evidence. Aboriginal heritage sites with archaeological evidence are all of value to the Aboriginal community through the tangible connection that they represent with pre-European Aboriginal land use.

During the survey a possible cultural site was identified by an Aboriginal member of the survey team along Marulan Creek, in the vicinity of the proposed Marulan Creek dam. A cultural heritage specialist was engaged to complete an investigation into the significance and values associated with the cultural site including an impact assessment. The socio-cultural values related to the site are considered in the ACHA (**Appendix N**). Discussion of the cultural site is limited in the main body of the ACHA and the EIS due to the culturally sensitive nature of the information. The cultural heritage specialist concluded that it is a cultural site and that it should be avoided.

15.3.3 Scientific values

The assessment of scientific significance determined that:

- One site has high significance (MSL 046) as it was likely a focus for Aboriginal activity in the area. It had rare elements; high research potential as it had tools and was potentially a constructed platform; and high educational value with a large range of distinctive implements and evidence of all parts of the tool preparation process.
- 11 sites have moderate significance (MSL 006, MSL 016, MSL 022, MSL 028, MSL 030, MSL 042, MSL 045, MSL 047, MSL 048, MSL 055, MSL 057). These featured large surface scatters with a diverse range of artefacts or contained a subsurface artefact density that could warrant further excavation.
- 45 sites have low significance. These had low artefact densities or were significantly disturbed.

The scientific significance of the 18 previously recorded sites within approximately 100 m of the proposed disturbance footprint were also assessed to have low scientific significance.

15.4 Impact assessment

15.4.1 Sources of impact

The expansion of the pit; construction of infrastructure, haul and access roads and Marulan Creek dam; inundation from damming Marulan Creek; relocation of Marulan South Road; and overburden emplacement, will impact known and unknown Aboriginal sites and items.

Aboriginal sites and items will be impact to the following degrees:

- Partial disturbance, for example minor displacement of an object as ground is inundated behind Marulan Creek dam.
- Total disturbance, for example an object may be permanently covered in silt under the water behind Marulan Creek dam.
- Partial loss, for example the loss of part of a site through excavation.
- Total loss, for example the total loss of a site through excavation.

Loss entails the loss of a site's elements, and includes salvage, where items are collected and stored or later returned to the site, as the context is irretrievably lost.

15.4.2 Measures to minimise harm and alternatives

The Project location is limited by the location of the limestone resource and the angle of the resource in the ground. This requires the removal of large amounts of overburden and does not allow much lateral movement of the mine pit. The mine has also had to find a balance between in-pit and out-of-pit emplacement of overburden as the former sterilises limestone resource, while the latter results in additional ground disturbance. The impacts are therefore necessary for the continued operation of the mine.

The construction of Marulan Creek dam has undergone a number of design iterations, some of which are directly based on a culturally sensitive area identified during field survey. As such, the proposed dam wall location and associated disturbance footprint has already been moved to protect intangible Aboriginal cultural heritage values; however, in doing so it will unavoidably impact parts of an area with high archaeological sensitivity. This area of high archaeological sensitivity is unavoidable as it extends some distance along the banks of Marulan Creek, and the dam wall can't be moved upstream of the area of high archaeological sensitivity as the volume of the dam would be significantly compromised to the extent that it would not meet the water demands of the mine and it would inundate private properties upstream.

15.4.3 Impacts on sites and areas of archaeological sensitivity

Seventy five sites were considered, comprising the 57 sites (MSL1 to MSL 57) and the 18 previously recorded sites within 100 m of the Project site (Table 15.5, **Figure 15.1** and **Figure 15.2**). Forty nine sites will be impacted by the Project, 25 sites will not be impacted and one site will be removed as part of approved mining (M1 – BCSC1). Of the impacted sites, 39 will be totally lost and 10 will be totally disturbed.

Table 15.5: Impact summary

Impact level	Significance			Total
	Low	Moderate	High	
No impact				
Mining (previously mined)	1			1
None	20	5*		25
Total disturbance				
Marulan Creek dam flood area	9	1		10
Total loss				
Emplacement	27	3		30
Haul road	3			3
Marulan Creek dam disturbance footprint	1	2	1	4
Marulan Creek dam haul road	2			2
Total	63	11	1	75

* Includes test pits MSL 045 and MSL 048 which will have areas of nearby sensitivity that will be impacted.

The highly significant site (MSL 046) will be totally lost during construction of the Marulan Creek dam. This is a subsurface deposit and is likely to continue along the spur crest beyond the test pit in which it was discovered. Part of the area of high archaeological sensitivity associated with this item will be impacted.

Four artefact scatters (MSL 016, MSL 018, MSL 022, MSL 028) and three subsurface deposits (MSL 047, MSL 055, MSL 057) of moderate significance will be impacted, with five totally lost and one total disturbed under the Marulan Creek dam inundation area.

Most of the maximum inundation level along Marulan Creek behind the dam will intersect with areas of moderate archaeological sensitivity. Subsurface artefacts are likely to be submerged but left *in situ* with the potential for sediment to accumulate over the current ground surface. The inundation of these areas will result in less concentrated stream flow and creek bank erosion compared to the existing situation.

The proposed overburden emplacements will impact the most sites (30), which are of varying significance, and an area of moderate archaeological sensitivity. The Project will have a low impact on subsurface archaeology as most sites comprise surface artefacts. The area of high archaeological sensitivity at the proposed Marulan Creek dam only represents a small proportion of land with high archaeological sensitivity along Marulan Creek.

15.4.4 Impacts on sites of cultural sensitivity

Although the cultural site in Marulan Creek has been avoided by redesigning the dam, concern was raised by Aboriginal cultural knowledge holders that the Marulan Creek dam would change the flow regime in Marulan Creek downstream of the dam, thereby impacting on the cultural site. Advisian (2018) have assessed the change in flow in Marulan Creek downstream of the dam and have recommended that the dam wall is designed to allow seepage of water from the dam. Further consultation with relevant Aboriginal cultural knowledge holders will be undertaken by an intangible cultural heritage specialist to determine whether they are satisfied that the proposed approach to maintaining environmental flows in Marulan Creek down stream of the dam will mitigate any previously perceived impacts on the cultural site.

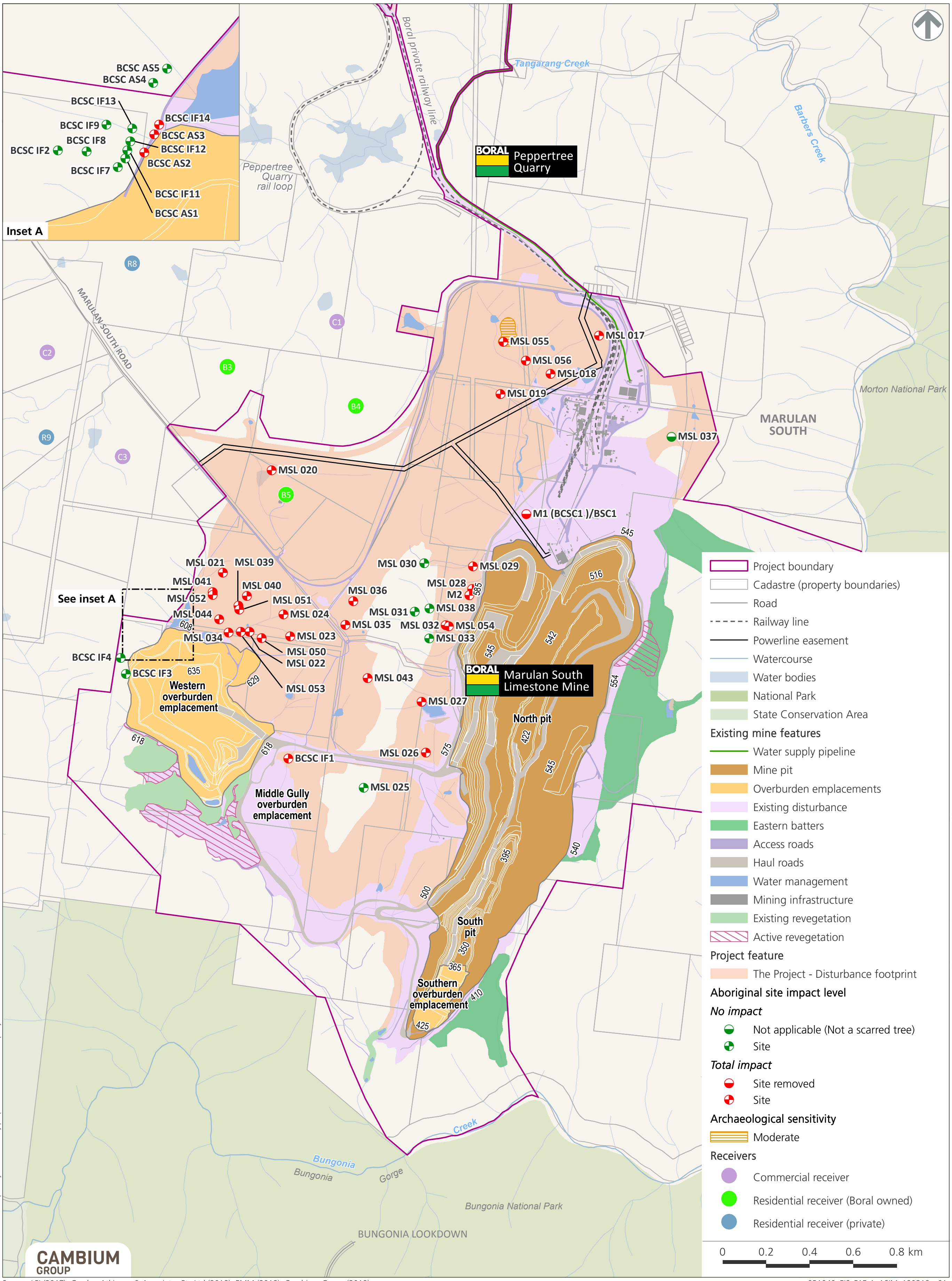
15.4.5 Cumulative impacts

Impacts to Aboriginal items in the main Project site will not significantly add to the cumulative impact on sites due to their low scientific value. Apart from providing evidence Aboriginal people occupied the area, they provide little extra information and sites to the west of the Project site will be avoided and will provide a comparable archaeological resource.

Impacts to the sites and archaeologically sensitive areas near the Marulan Creek dam will contribute to cumulative impacts in the area from impacts along Tangarang Creek associated with the adjacent Peppertree Quarry. However, impacts along Marulan Creek will be localised and large tracts of archaeologically sensitive land along Tangarang Creek have been conserved as part of Peppertree Quarry's habitat management area/Tangarang Creek area.

Figure 15.1
Aboriginal site impacts - Mine

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

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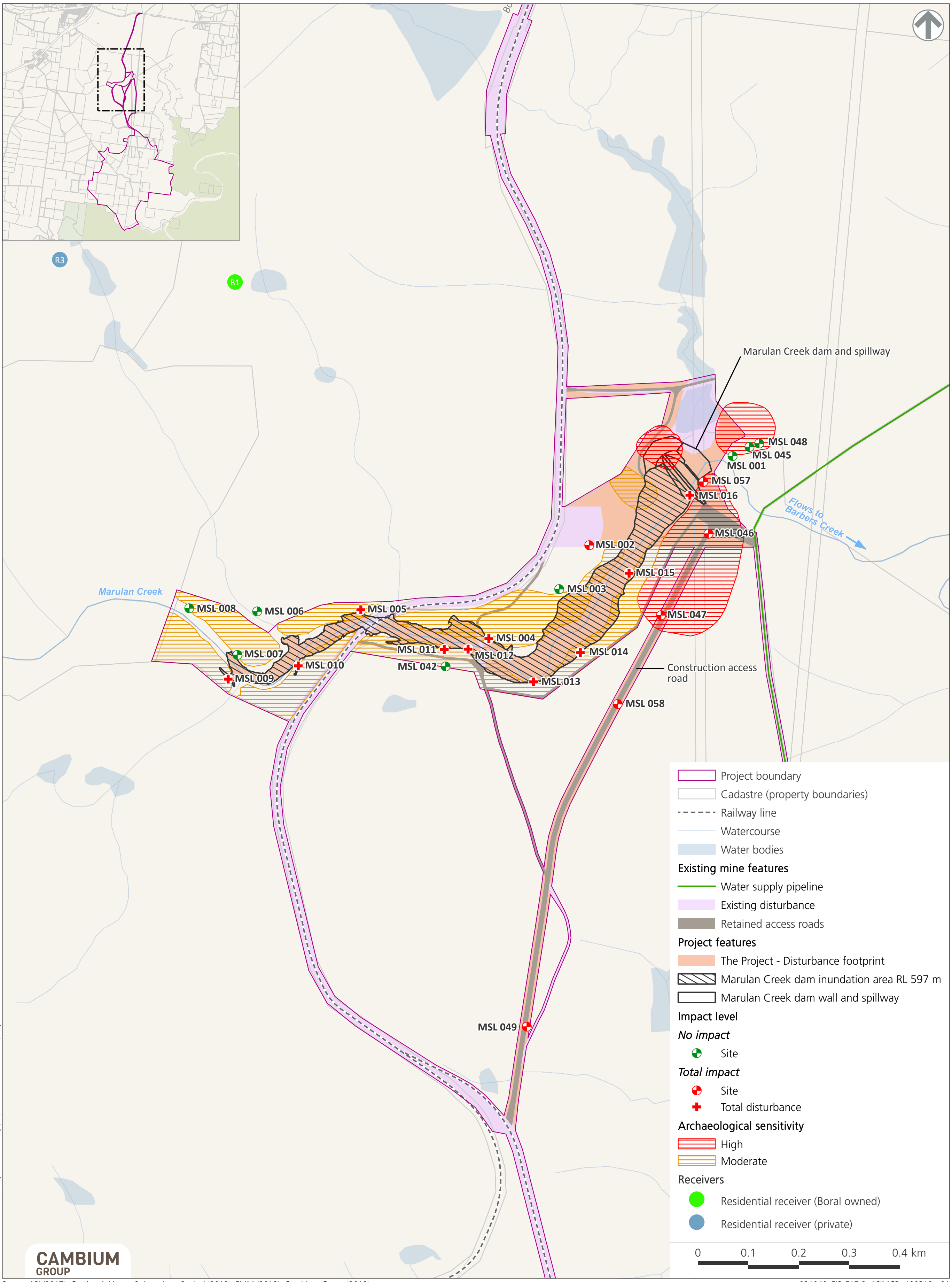
Figure 15.2
Aboriginal site impacts - Marulan Creek dam

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

031040_EIS_F15-2_ASIMCD_190319_v01

15.5 Management measures

15.5.1 Overview

The following mix of management measures will be implemented at the Project to avoid or reduce impacts to Aboriginal cultural heritage. The measures and sites they apply to are shown on Figure 15.3 and **Figure 15.4.**

15.5.2 Aboriginal heritage management plan

An Aboriginal heritage management plan (AHMP) will be prepared which will describe all Aboriginal sites in the Project site and measures for the management of these sites including protection, collection and salvage; induction of all personnel working on site; continued consultation with RAPs ; protocols for the discovery of new Aboriginal sites and suspected human skeletal remains; and artefact management.

15.5.3 Avoidance and protection

Archaeological sites

Twenty four sites will be avoided by the Project, of which 14 are within 20 m of the Project disturbance footprint and will be protected by high visibility poles. Poles would be erected around the visible extent of these sites with an approximate 5 m buffer from any surface material. A suitably qualified archaeologist will demarcate site locations and where the poles should be erected.

A suitably durable sign will be attached to the posts including words to the effect of:

> "Environmentally sensitive area; do not disturb; contact the Mine Manager for more information".

The location of Aboriginal heritage items that are not to be impacted by the Project will be identified in the Aboriginal heritage management plan (discussed below) and will be included in induction and training procedures.

Ten avoided sites will not require protection as they will be a sufficient distance from the Project disturbance footprint.

Cultural site

Although the Marulan Creek dam has been redesigned to avoid the cultural site, potential construction phase impacts will be mitigated through:

- erection of permanent[2] fencing 20 m from the outer edge of the cultural site prior to the commencement of construction in the vicinity of the site; and
- attaching signage to the exclusion fencing that states 'Significant environmental area – no unauthorised entry permitted'.

The fencing type and location is to be outlined in the AHMP. Other management measures that will be included in the AHMP, that have the potential to reveal culturally sensitive information, have been excluded from the EIS.

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[2] Permanent fencing to be erected unless otherwise agreed with Aboriginal cultural knowledge holders.

Further consultation with relevant Aboriginal cultural knowledge holders will be undertaken by an intangible cultural heritage specialist to determine whether they are satisfied that the proposed approach to maintaining environmental flows in Marulan Creek down stream of the dam will mitigate any previously perceived impacts on the cultural site.

15.5.4 Collection

Thirty two sites comprising surface artefact scatters and isolated finds in the disturbance footprint will be collected by an archaeologist and RAPs, prior to disturbance by the Project.

15.5.5 Salvage excavation

Two archaeological salvage excavations are proposed with the aim of providing information that may have otherwise been lost and has not been obtained by previous investigations:

- the area of high archaeological sensitivity within the Marulan Creek dam disturbance footprint including sites MSL 046, MSL 047; MSL 057 and MSL 045 and MSL 048; and
- the mapped area of moderate archaeological sensitivity on the flat spur overlooking ephemeral watercourses in the main Project site, including site MSL 055.

These sites have been chosen because they are likely to contain relatively intact subsurface deposits which will assist in understanding the Aboriginal past in the Project site and will be totally lost during the Project.

The excavations will comprise two phases, where regularly spaced 1 m^2 pits will be dug, then expanded if there is evidence of hearths or other features, or if 50 or more artefacts are discovered in pits. Excavation will cease if artefact densities decline across the expanded pits or if an area of 10 m^2 is reached.

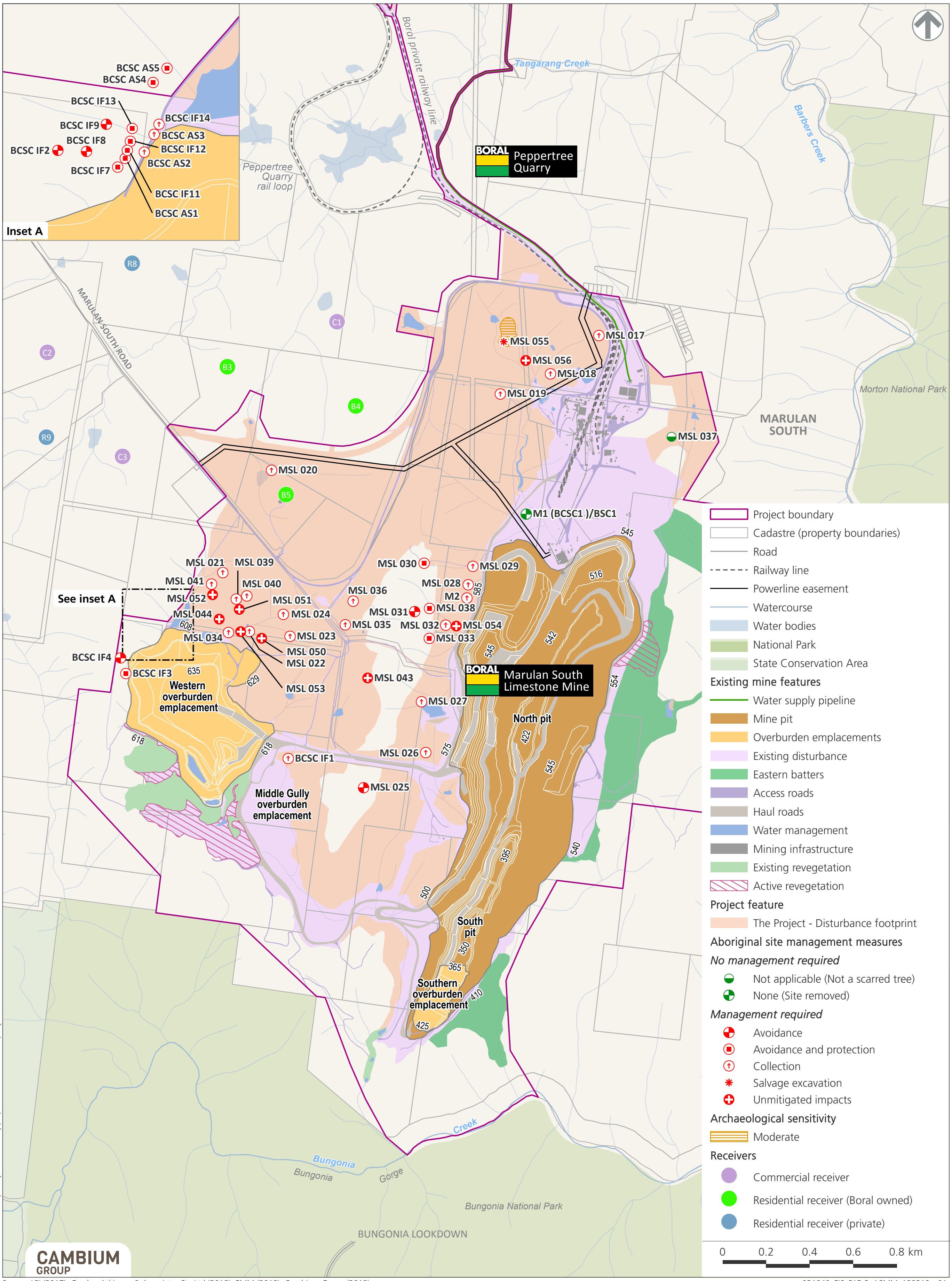
The salvaged and collected artefacts will be subject to attribute analysis to understand manufacturing technology, site function and to compare the assemblage to studies completed in the wider region. Collected and salvaged artefacts will either be kept in a keeping place or reburied after analysis.

15.6 Residual impacts

Eight Aboriginal sites in the main Project site and two sites along the Marulan Creek dam construction access road will have unmitigated impacts. These are subsurface sites of low scientific value which do not warrant further investigation or collection.

Figure 15.3
Aboriginal site management - Mine

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

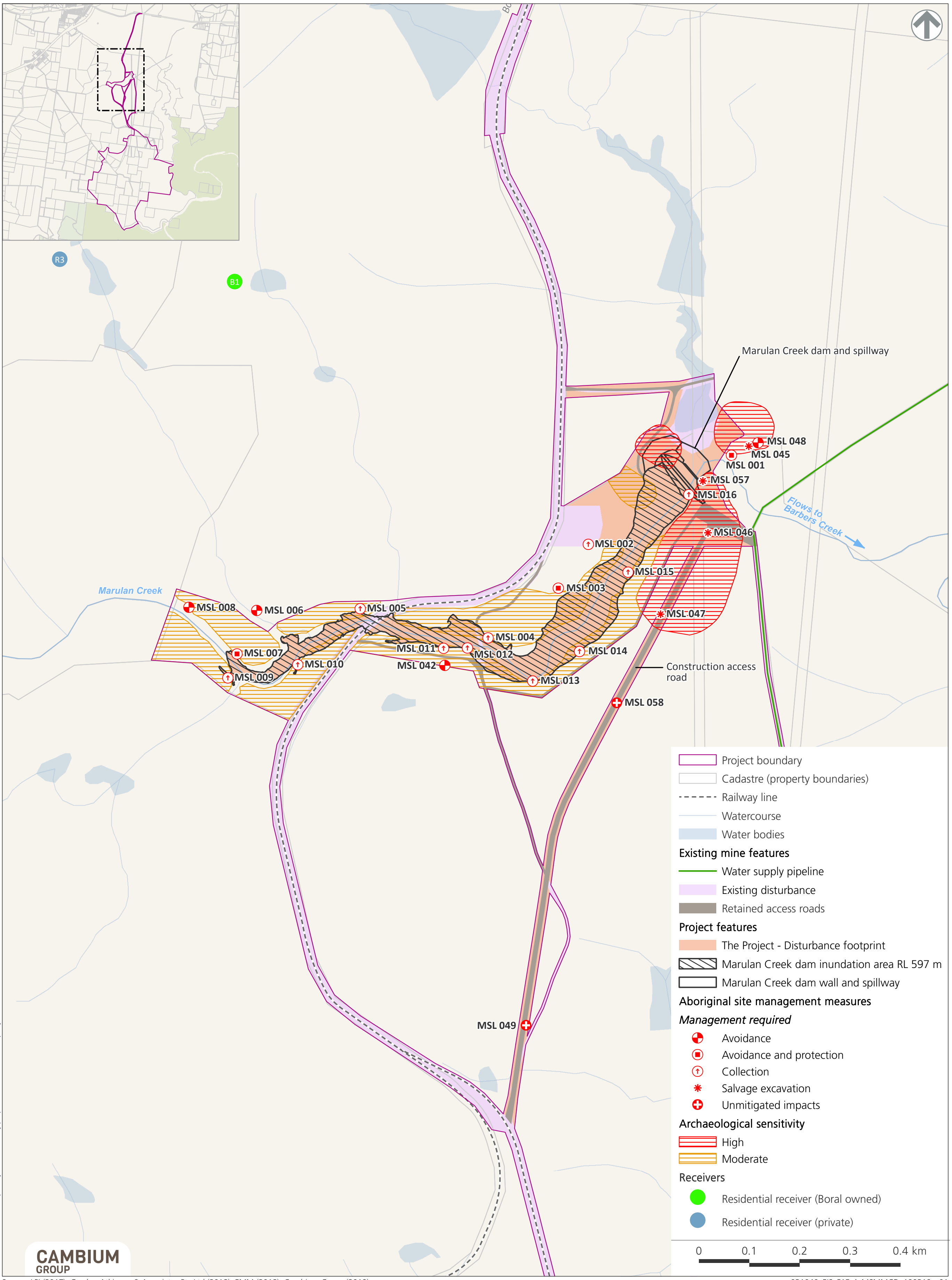


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

031040_EIS_F15-3_ASMM_190319_v01

Figure 15.4
Aboriginal site management - Marulan Creek dam

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

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Chapter 16

Historic heritage

VOLUME 1

Historic heritage

Potential impacts on items of historic heritage significance were assessed by searching State and Commonwealth heritage databases and surveying the Project site.

There are no registered heritage items in the Project site and the adjacent Bungonia State Recreation (Conservation) Area and nearby Glenrock Homestead and Outbuildings are listed under the LEP. Twelve items of local industrial, residential and road transport heritage significance were discovered in the Project site, all associated with historic mining. The Project will avoid five of the items and seven will be removed.

There is little opportunity to revise the proposed disturbance footprint to avoid impacts to heritage items due to the shape and orientation of the limestone resource. Therefore, it will not be possible to avoid impacts to items in the proposed disturbance footprint and alternative management measures will be required.

All items apart from one will be photographically archived and other measures such as archival recording, demarcation and signage will be applied to the other sites.

16 HISTORIC HERITAGE

16.1 Introduction

This chapter summarises the historic heritage assessment and statement of heritage impact report, which is in **Appendix O**. It describes the non-Aboriginal cultural context of the Project site, items discovered during surveys, the significance of the items, potential impacts and mitigation measures where impacts are unavoidable. The historic heritage assessment and statement of heritage impact report was prepared by qualified heritage consultants from EMM Consulting.

16.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on State or locally significant heritage items (**Table 16.1**).

Table 16.1: Heritage SEARs

Requirement	Section and appendix where addressed
▪ A historic heritage assessment (including archaeology) which must: - Include a statement of heritage impact (including significance assessment) for State significant or locally significant historic heritage items; and	16.3, Appendix O
- outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures), having regard to the Heritage Branch of NSW's requirements.	16.4, Appendix O

The SEARs recommend use of the following guidelines, which were used during the assessment:

- The Burra Charter (Australia ICOMOS, 2013);
- *NSW Heritage Manual* (Heritage Office, 1996);
- Statements of Heritage Impact Guidelines (Heritage Office, 2004);
- Investigating Heritage Significance (Heritage Office, 2004);
- Assessing Significance for Historical Archaeological Sites and 'Relics' (Heritage Branch, 2009).

16.1.2 Overview of assessment methods

The following assessment methods were used during the assessment.

Desktop study

Previous assessments of the Project site and surrounds for development applications and mining operations plans were reviewed to determine previously identified heritage items in the area. Additionally, publications regarding the history of the area and mining and domestic life in the Southern Highlands were referenced to understand mining and settlement patterns in the area.

Public registers were searched for previously recorded heritage items in the Project site and surrounds, with these registers and results summarised in **Section 2.4.2**.

Field survey

Results of the desktop study were used to plan the field survey by identifying areas of historical potential. The Project site was surveyed on 1 April 2015 and 26 June 2015, and targeted areas predicted to have evidence of historical development. The survey team was escorted by long term employees of the mine that have identified 'ruins' and 'rubbish dumps'.

The purpose of the field survey was to identify the following in the Project site:

- potential relics or known relics;
- structures; and
- significant cultural landscapes.

The survey results were described in the following terms:

- village – the former site of Marulan South comprising buildings, roads and street plantings;
- house – former dwellings with evidence of stone walls, mortar, chimney bases, landscape modification;
- camps – areas with evidence of habitation;
- industrial areas – remnants, for example, of kilns and aerial ropeway; and
- roads – identified on current or historical maps, aerial photography and the field survey.

16.2 Results

16.2.1 Desktop study

According to previous studies and historical accounts, the non-Aboriginal heritage of the area generally developed in the following way:

- Exploration – the first European explorers were sent to the area by Governor Hunter in 1798, who described the area as containing "fine open forest". The County of Argyle was first surveyed in 1824, which was bound by Lake George, the Shoalhaven River and the Wollondilly River.
- Pastoralism and agriculture – pastoralists started to settle in the area prior to 1820 even though the area was not available for settlement. Permits to cross the Cowpastures (Camden) were granted in 1820 and land grants were issued, however, Crown Land was still illegally used for grazing. Glenrock Estate, granted 1826, was one of the largest pastoral holdings in the Marulan district, which was adjacent to the Peppertree Quarry boundary, north of the mine. It was generally regarded land in the district was poor for cultivation but good for grazing.
- Towns (Marulan South) – the most recent phase of activities at the mine led to the rise of the village, even though the earliest reference to Marulan South was in the 1860s. Prior to this, families that moved to the area for work lived in camps and rudimentary houses. The earliest permanent resident arrived in 1929 and obtained an existing railway service store to operate as a post office and local store for mine workers. Approximately 30 houses, a school and recreational facilities were constructed over proceeding years. The village was closed in 1998 and the houses were transported to nearby Marulan.
- Transport and communications – main roads in the area were the Great South Road (constructed from 1820-1843), Argyle Road (constructed from 1818-1833) and Government Road (constructed from 1822-1839). Road construction was led by surveyors and most of work was carried out by convicts who travelled from their stockades (Towrang and Wingello) to site and back each day or slept in mobile huts. Marulan South Road was initially Lime Kiln Road, which fell into disrepair in the 1950s. A tramway was constructed around 1888 along most of the current alignment of the railway, with the railway becoming operational in 1926.

- Education – there were many schools in the Southern Highlands, possibly due to the lack of reliable transport and the long travel distances. There were two schools in Marulan (1860 and 1871), with the 1860 school still open today. The schools moved to follow the town, which was relocated twice, and struggled with inadequate facilities. A school was constructed in 1884 (Argyle (Lime-kilns) Public School), which was destroyed in a bush fire and its location is not known. A school was built in Marulan South in 1934, which remained open to 1995.
- Mining – there is a long history of limestone, marble, slate and quartz extraction, and gold to a lesser extent, in the Southern Highlands, with exploration and quarrying commencing around 1833. The limestone deposits in Marulan South started being recognised around 1826 and the area was not included in settler's grants. Land was bought by Mr Fuljames in the early 1800s and James Hogg bought some lots in the 1860s, both for the limestone deposits. Prior to 1928, the area was held under adjoining leases by Weenga Lime Limited, Hoskins Iron and Steel Limited and Southern Portland Cement. After 1928 the area was consolidated by Southern Portland Cement. The mine was fully amalgamated by Blue Circle Southern Cement, which was bought by Boral in 1987. The leases were consolidated under CML 16 in 2004.
- Mining method – The mining method at the mine has changed markedly over the years, with mining by hand with picks and shovels and carting via horse drawn wagons in the 1860s. in the early 1900s, the rock was excavated by steam shovel and carted from the pits by 25 horses. Construction of the aerial ropeway started in 1936, which regularly broke during operation.

16.2.2 Survey

Local items

Items of local heritage significance identified during the survey are summarised in **Table 16.2** and shown on Figure 2.10. All of these were recorded in the main Project site; no items of historic heritage significance were discovered in the area of the proposed Marulan Creek dam.

Historic views and vistas

Impacts associated with the Project are unlikely to be visible from land not owned by Boral. The most relevant and significant landscapes are present on a small scale in the Project site and impacts to these will be recorded before they are removed.

The Bungonia Lookdown to the south of the Project site overlooks a landscape representing a historic vista with natural values. The mine is already visible from the Lookdown, which will be rehabilitated with mass tree planting after mining operations have ceased.

Historic mining landscapes

Very few elements of the early mine landscape remain as they have been removed by continual mining. Intact areas of the early mine landscape are in the south of the Project site and comprise the lime kilns and aerial ropeway. These items are important as they are examples of changing mining technology and represent earlier incarnations of the mine.

Table 16.2: Items of local heritage significance

Item	Name	Location	Description
Industrial			
MS05	Lime kiln group	Immediately west of the south pit	Five D-type lime kilns in two areas (A and B) approximately 100 m apart on a hill slope. The kilns in Area A are in poor condition but the ramps to the road remain.
MS04	Aerial ropeway	Starting south-west of the lime kilns and extending in a north-west direction terminating north of Marulan South Road	Used to transport limestone from the pit to the processing areas and includes the control room (MS04_11), concrete plinths (MS04_1/3/5/6/7/8/9/10), two pulley towers (MS04_2/4), metal carriers and steel rope.
MS10	Mt Frome mining area	South of the Project boundary, south-west of the southern tip of the south pit	An early mining area including tracks from a short rail line.
Residential			
MS01	Marulan South	Former village of Marulan South in the north-east part of the Project site	A village established due to mining but moved to enable expansion of mining, with most buildings moved to Marulan. The community hall, bowling club, bowling green, streets and street plantings remain. A building of wattle and daub construction was discovered at the southern extent of the village.
MS03	Camp/hut site	West of the north pit	Evidence of land modification and possibly containing a hut and road.
MS08	House site	West of the existing Western Overburden emplacement	The remains of a house that have archaeological and research potential as they may provide insight into a prominent historical local family.
MS14	House	Approximately 200 m south-west of MS03, west of the north pit	Substantial evidence of a likely house including artefacts such as glass, ceramics and metal. Has archaeological and research potential as may provide information on the Marulan district.
MS09	Camp site	West of the north pit, north of the lime kiln group	Possibly the site of a hut lived in by a mine employee. Has research value related to the information it could provide about previous mine employee living arrangements.
MS11	Camp site	Half way between the north pit and Marulan South Road	Area contains remnants indicating its use as a camp which also held stock animals.
Roads			
MS07	Old Marulan South Road	Stretch of road from near Marulan South Road in the north to the main Western Overburden Emplacement haul road in the south	An unsurveyed road originally known as Lime Kiln Road, which is blocked to traffic at both ends and comprises a sealed section in bushland.
MS12	Lime Kiln Road	Stretch of road from main Western Overburden	A short stretch of road from giving access to the lime kilns, likely dating from the 1870s.

Item	Name	Location	Description
		Emplacement haul road to the lime kilns	
MS13	Frome Hill Road	From Marulan South Road to Mt Frome	A potential early road that was one of likely many tracks providing access to individual mines and passes in front of MS08.

16.3 Impact assessment

The significance of a heritage item must be determined before potential impacts on that item's significance can be assessed. In NSW, an item's heritage significance is assessed based on the Burra Charter and consider a combination of its:

- importance to State or local cultural or natural history (historical significance);
- association with the life works of a person or group of importance to State or local cultural or natural history (associative significance);
- demonstrates aesthetic characteristics and/or a high degree of creative or technical achievement (aesthetic significance);
- association with a cultural or community group for social, spiritual or cultural reasons (social significance);
- potential to contribute information about State or local cultural or natural history (research significance);
- possesses uncommon, rare or endangered (rarity);
- demonstrates the principle characteristics of a class of cultural or natural place or environment (representativeness).

16.3.1 Significance assessment

The assessment of the heritage items against the above categories is summarised in **Table 16.3**. The assessment of significance considered heritage values from an archaeological perspective as it is in the archaeological information that most of the research values lie. The issues of acquiring information from archaeological excavation have been considered in the assessment of significance.

The statements of significance for each item identified during the research and survey phases are summarised in **Table 16.4**. There was no evidence of any items of state significance. However, the level of local significance must be considered in view of the entire landscape and the cumulative significance of the component parts.

The archaeological resource is significant as it has the potential to demonstrate changes and adaptations of the pre-colonial ground to a landscape that was industrial and residential in nature. The spatial relationships of the sites, industrial and residential, to each other and the internal arrangements of each has the potential to shed light on the phasing and use of the landscape by the people that worked and lived there. As a result, the level of local significance of each item should be viewed as a cumulative high level of significance for the local area.

Table 16.3: Summary of assessment of significance

Item	Significance
Historical significance	
MS01/ MS02	The village was an important aspect of the mine's growth and its logical extension. It demonstrates the success of the limestone mine and the company's care towards its employees. The village demonstrates an early 20th century village in Southern tablelands of NSW which has come about due to a primary economical industry in the area. Its visual setting and contents demonstrate the necessity of nearby facilities at the time of its establishment and the subsequent lack of need due to changing times. It has local historical significance.
MS03	This site demonstrates the settlement pattern associated with working at the limestone mines and is of local historical significance.
MS04	The aerial ropeway is of historical significance as it provides information on the development of mining at Marulan South. It demonstrates the way in which product was transported around the steep mining area using a common system. It has a connection to the remaining concrete pillars that together reveal the route of the ropeway and its important role in connecting the mine to the railway. MS04 is of local historical significance.
MS05	The lime kilns signal the importance of the mine as they enabled processing on site when weather prevented the transport of material to the kilns at Old Marulan. The group is also significant as it may have been the earliest in the area. They demonstrate the development of lime quarrying from small-scale operations to larger enterprises when James Hogg established his business. They are of local historical significance.
MS06	While the explosives hut was part of the historical development of the limestone mine, it does not have a level of significance that meets the threshold.
MS07	This road is significant for the information it provides on the development of the limestone quarries and is a remnant of the historic landscape amongst large-scale change. It is of local historical significance.
MS08	These ruins are the most intact of all the occupation/domestic sites in the Project site and provide insight into the accommodation arrangements for workers at the mine(s). The ruins are of local historical significance.
MS09	The camp demonstrates the ingenuity and tenacity that people displayed during hard economic times and is of local historical significance.
MS10	This was one of the many limestone mines operating in the area in the early to mid-twentieth century and retains scars that can attest to its history. As a component of the history of limestone mining in the region, this item has historical value. It is however, outside the Project site but adjacent to the boundary and is of local historical significance.
MS11	This camp is an example of working life at the mine at the turn of the century. It may demonstrate ingenuity and resilience in difficult economic situations and forms a part of the larger industrial landscape. The existence of the makeshift ramp adds another layer to the story that is embedded in this place. It is of local historical significance.
MS12	Lime Kiln Road is the earlier former alignment of Marulan South Road that provided access to James Hogg's kilns and was a vital component of resource transportation. It is now a dirt track with lime kiln by-product on the slopes into the gully and is generally in poor condition and is of local historical significance.

Item	Significance
MS13	An alignment of the road from South Marulan Road to the quarry at Mt Frome. The general alignment of the road has significance as the access road to the Mt Frome workings. It demonstrates the development of the area for its industrial purposes and is of local historical significance.
Associative significance	
MS01/ MS02	The village is associated with the employees of the limestone mine since the 1920s but it is not associated with any individual or group of persons that would reach the threshold for associative significance.
MS03	The residents of this site are not known and are likely to have been mine workers. The item does not fulfil the criterion for associative significance.
MS04	The aerial ropeway was an important but short-lived technological solution, and is associated with the Hogg bros., who were the descendants of James Hogg and who continued the business he started. The item is of local associative significance.
MS05	The group of lime kilns in the south-west of the Project site were established by James Hogg, one of the earliest limestone operators in the area and they are of local associative significance.
MS06	This item does not fulfil the criterion for associative significance.
MS07	The Old Marulan South Road serviced Hogg's lime kilns at Marulan South and appears to be the southern terminus of the road from Marulan and is of local associative significance.
MS08	Local knowledge has identified this site as the home of local limestone miners and the site of the Argyle school, although there is no evidence to back up this second assertion. The site is of local associative significance.
MS09	The camp was the former residence of a family that worked in the mine but was short-lived and does not fulfil the criterion for associative significance.
MS10	This site does not fulfil the criterion for associative significance.
MS11	This site does not fulfil the criterion for associative significance.
MS12	This site does not fulfil the criterion for associative significance.
MS13	This site does not fulfil the criterion for associative significance.
Aesthetic significance	
MS01/ MS02	What survives of Marulan South Village is standard urban design from the 1920s to the 1990s. Elements of aesthetic characteristics and creative achievement are not demonstrated here. This site does not fulfil the criterion for aesthetic significance.
MS03	It has the appearance of being a residential site with landscape modifications but nothing was noted that would indicate it has evidence of creative or technical achievement embodied in the site and does not fulfil the criterion.
MS04	The aerial ropeway was a creative use of technology for the local area and was a major achievement for the industry at Marulan South and is of local aesthetic significance.
MS05	This group of items shows evidence of two types of kiln but are in a poor state of repair. The lime kiln group may have the ability to demonstrate technical achievement in the local area. MS05 is of local aesthetic significance.
MS06	This site does not fulfil the criterion for aesthetic significance.

Item	Significance
MS07	Old Marulan South Road is of standard road construction and a continuation, albeit a now-defunct alignment of the road from Marulan to the mines and does not fulfil the criterion for aesthetic significance.
MS08	The house does not appear to demonstrate technological innovation, but it is a visual (aesthetic) indication of settlement pattern around the mines and does not fulfil the criterion for aesthetic significance.
MS09	This site does not fulfil the criterion for aesthetic significance.
MS10	The remnants of tracks for early trams to be pulled plus the quarry scars demonstrates an early industrial landscape. The Mt Frome quarry is outside the Project site but directly adjacent to the boundary and is of local aesthetic significance.
MS11	This site does not fulfil the criterion for aesthetic significance.
MS12	The road does not demonstrate technological achievement on its own, rather it is representative of the larger limestone mining activities in the local area and does not fulfil the criterion for aesthetic significance.
MS13	This site does not fulfil the criterion for aesthetic significance.
MS14	The site of a former dwelling or camp that is identifiable by two exotic trees and surface modification using locally sourced stone. The modifications are horizontally substantial but further research (archaeological) is required to gain a clearer understanding of what the elements at MS14 represent. This site does not fulfil the criterion for aesthetic significance.
Social significance	
MS01/ MS02	Interviews with local residents indicate strongly that the village was an important place to the people that lived there as it was a small and close-knit community and it is of local social significance to the former residents of the village.
MS03	This site is not associated with a particular group of people or community and does not fulfil the criterion for social significance.
MS04	While not associated with a specific group or community today, the installation of the aerial ropeway would have made life easier and safer for the workers at the mine and thus has a low level of social significance but does not meet the threshold for social significance.
MS05	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS06	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS07	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS08	While the item housed a well-known family in the area, the house and property were/are not of any community importance and therefore this site item is not of social significance.
MS09	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS10	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS11	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS12	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
MS13	The item is not associated with a particular group or community and does not fulfil the criterion for social significance.
Research significance	
MS01/ MS02	Field research on Marulan South village has the ability to yield information about the place as a residential space prior to the village being built and it is of local research significance.

Item	Significance
MS03	The information that may be inherent in the archaeological resources may shed light on a certain group of the working class including itinerant workers and entrepreneurs trying to build a business in the growing colony. The site is of local research significance.
MS04	The Aerial ropeway system has the potential to yield information about the transportation of material from the limestone mine to its nearest destination, particularly on methods used to overcome the steep and difficult landscape. Closer inspection of the bins and other components that are scattered across the alignment will contribute to knowledge about the origins and operations of the aerial ropeway. The item is of local research significance.
MS05	The Lime Kiln group has the potential to answer a number of questions related to their purpose, ownership, construction and relationship of the kilns to the surrounding landscape. The lime kiln group is of local research significance.
MS06	The Explosives hut is of interest as part of the industrial landscape in the vicinity of the kilns and the aerial ropeway but it does not meet the threshold for local research significance.
MS07	The abandoned road alignment is of interest as it could provide information about the destination prior to its re-direction. As an item in isolation it does not meet the threshold for local research significance but as part of a group, the abandoned road alignment provides insight into access to the historic mine area and its phases. Old Marulan South Road is of local research significance when considered as a group with the surrounding historical industrial landscape.
MS08	Archaeological research into this house and its curtilage has the potential to shed light on the family that lived there, landscape modifications that were made to accommodate their lives, how they lived and information about the construction of the house. Additional questions exist about the place possibly being a school house that have not been answered by documents or oral history and answers related to this will also contribute to the understanding of what life was like when closely connected to the mine. The site is of local research significance for its ability to yield information about life in an industrial landscape.
MS09	This site has potential to yield information about how a family would treat the semi-wild landscape so that life was possible there and is of local research significance for its ability to yield information about life on the fringes of town.
MS10	This item retains elements that could yield information about early limestone mining that has since been lost with the expansion of the current mine and it provides an insight into what the historical landscape could have looked like prior to the amalgamation of the earlier mines into the larger Marulan South Boral operation. It retains the potential for interpretation as it is a rare and representative example of attempts at blasting and the use of horse drawn rails to transport product down the mountain and is of local research significance.
MS11	As a camp site that appears to be related to the limestone mine, it has the potential to provide information about working life at the mine in the early twentieth century and may date to an earlier period of prospecting and is of local research significance for its ability to yield information about working life and life on the fringes of town.
MS12	As with the Old Marulan South Road, this item is of significance for its ability to provide information about the destination prior to its re-direction. This abandoned road alignment is also a vestige of an earlier version of the current industry and has the ability to demonstrate the evolution of the place. This item is of local research significance when considered as a group with the surrounding historical industrial landscape.
MS13	Research on the Mt Frome Road could yield information about the importance of this road through its construction techniques, where other residences may have been placed and landscape modifications to accommodate larger, industrial vehicles. This item is of local research significance for its ability to yield information about the development of the area as a mining interest.
Rarity	

Item	Significance
MS01/ MS02	The village does not meet the criterion for rarity but if earlier buildings such as huts existed on the site prior to the village, these items may be considered rare at a local level.
MS03	Considering that little is known about MS03 or other similar sites, rarity is not a value that can be definitively established but knowledge about fringe camps, itinerant workers and individual mine owners living on the edge of mine pits is rare. This site is of local significance for its rarity value.
MS04	Aerial ropeways were a common method for transporting material from mining quarries across undulating landscapes in the nineteenth century but there are few remaining examples in NSW. The Bleichert Ropeway at Katoomba is the most notable example but its wooden construction is different to the concrete and iron towers at Marulan South. This item is of local significance for its rarity value.
MS05	The lime kiln group is a vestige of the historical period of limestone mining in the region. It is likely that there were more kilns associated with the mine in the immediate area but only those reported in this document were found during field survey. If there were more kilns closer to the earlier mines, they will have been removed, thus making Hogg's kilns rare in the local area. This item is of local significance for its rarity value.
MS06	This site does not fulfil the criterion for rarity.
MS07	As a former road, this alignment is not rare and the item does not fulfil the criterion for rarity.
MS08	Considering that little is known about MS08 or other similar sites, rarity is not a value that can be definitively established but knowledge about fringe camps, itinerant workers and individual mine owners living on the edge of a mine pit is rare and the site is of local significance for its rarity value.
MS09	Considering that little is known about MS09 or other similar sites, rarity is not a value that can be definitively established but knowledge about fringe camps, itinerant workers and individual mine owners living on the edge of their lease is rare and the site is of local significance for its rarity value.
MS10	The Mt Frome Mine group is rare at the local level for its ability to demonstrate small-scale historical mining enterprises as these physical marks have been left in the rock face. Little to no impacts have occurred on this site, except for the removal of some of the infrastructure. Areas with evidence of mining, particularly early blasting and horse drawn rails are rare in the local area. This item is of local significance for its rarity value.
MS11	Considering that little is known about MS11 or other similar sites, rarity is not a value that can be definitively established but knowledge about fringe camps, itinerant workers and individual mine owners living on the edge of their lease is rare. This site is of local significance for its rarity value.
MS12	As a former road, this alignment is not rare but it is a part of a larger industrial landscape that is disappearing through the continuation of the operations that created it. Lime Kiln Road is a rare vestige of the historic lime extraction industry in the local area and is rare at a local level.
MS13	This item is not rare in that its type is represented by other unsealed country roads.
Representativeness	
MS01/ MS02	This site does not fulfil the criterion for representativeness.
MS03	Information to support significance under this criterion would be gathered through archaeological excavation.
MS04	This item is representative of a concrete and iron aerial ropeway. It has examples of all the relevant components including the pulley tower, buckets, plinths and cables and is of local representative significance.

Item	Significance
MS05	As individual items, the lime kilns do not meet the threshold for demonstrating a principal characteristic of lime kilns but as a group, set into the edge of a drop, the lime kiln group represent a historic lime processing area, specifically from an archaeological perspective and they are of local representative significance.
MS06	This site is a modern example of a concrete-block (Bessa) storage hut and does not fulfil the criterion for representativeness.
MS07	This item represents many such roads and is an improvement of the earlier road to the lime kilns and it does not fulfil the criterion for representativeness.
MS08	The house, constructed of local stone and mortar is a vernacular structure; the surrounding landscape modifications represent attempts to create a home environment in the remote Australian landscape and is of local representative significance.
MS09	This item may have representative value as an archaeological resource and as a site used to house a family and the modifications made to create a home environment in the remote Australian landscape and may be of local representative significance.
MS10	Mt Frome is representative of the ways in which mining was conducted in the Marulan area during the nineteenth century and is of local representative significance.
MS11	The surface evidence that survives at this site does not provide a clear indication of its origins. It may have representative value as an archaeological resource and may be of local representative significance.
MS12	Lime Kiln Road has representative significance as an early industrial road. It may have elements in its construction, identifiable through archaeological excavation, that identify it clearly as an industrial road and it is of local representative significance.
MS13	Frome Hill Road has minor representative value as an early industrial road but does not meet the threshold for significance.

Table 16.4: Statements of significance

Item	Significance
MS01 / MS02	The former village of Marulan South is of local significance for the esteem in which it is held by the former residents. The former village also possesses research potential as it may retain evidence of earlier occupation there that is not visible in the ground or through documentary sources.
MS03	This house site is of local significance for its historical significance that also embodies rare surviving elements of domestic structures in close proximity to an industrial area. This site also possesses research value for its potential to answer questions that no other source can about life on the fringes of an industrial site and its relationship to the surrounding cultural landscape.
MS04	The aerial ropeway is of local heritage significance for its ability to contribute to the historical understanding of mining processes at Marulan South in the nineteenth and twentieth centuries. It provides insight into the workings of the mine as a whole, and how the elements of the mine, lime kiln group, ropeway, roads and railway fitted together. There is research potential in locating the techniques and infrastructure within a global context, specifically the technologies that were adopted from Europe such as the pulley system. It is of social significance as a landmark in the local area, particularly for the employees of the mine. Aerial ropeways were a common method for transporting material from mining operations across undulating landscapes in the nineteenth century but there are few remaining examples in NSW, as such the Marulan South aerial ropeway is a rare, representative example of this type of mining technique.
MS05	The Lime Kiln group is of local historical and research significance for its ability to contribute information about the development of a local industry and the mine. Despite its poor condition the lime kiln group is rare in the local area and has the potential to provide information on the construction and operation of lime kilns in the Southern Tablelands.

Item	Significance
MS06	This item does not possess heritage significance.
MS07	The blocked-off alignment of Old Marulan South Road is of local historical significance as a surviving element of the access network into the earlier mines. It has landscape value for its ability to allow interpretation of the earlier road networks associated with the local industry.
MS08	This house site if of local significance for its historical, representative and rarity values. It also has research potential as an archaeological site and as a modified landscape that is a residential component of a larger industrial landscape that surrounds it. Built using vernacular construction techniques and local materials, the site is of local historical significance for its ability to contribute to our understanding of the building techniques and materials used to construct houses in the local area. It is rare in the local area and is a representative example of vernacular buildings with the potential to provide research opportunities on construction methods.
MS09	This camp site is of local significance for its historical values and research potential. It could provide insights into the arrangement of structures in the immediate area and on a broader scale when compared to other such sites. It also has the potential to reveal aspects of life in a semi-permanent camp. It is also of significance to the Armitt family, who lived at the camp as children, with their parents.
MS10	The Mt Frome mine group is of local heritage significance for its ability to provide information on the early mining operations in the Marulan area. It provides a rare and representative example of attempts at blasting and the use of horse-drawn rails to transport product down the mountain.
MS11	The ephemeral camps are of local historical significance for their ability to contribute to our understanding of the relationship between workers and the mine and changes made to the natural landscape to make life a possibility in a remote location and at the edge of a mine pit. Their locations may provide information on the ways the landscape was used by workers.
MS12	Lime Kiln Road is of local significance for its historical values and rarity in the local area. Part of the original Lime Kiln Road (now Marulan South Road), it gave access to the lime kilns and an early section of the mine. It is a surviving remnant of one of the earliest roads into Marulan South.
MS13	Frome Hill Road is of local historical significance for its ability to contribute to knowledge about the development of the area and associated mining operations. This road provides access from Marulan South Road and is where one of the camps, MS08, was located and is therefore an early road to the mines. It is rare in the local context and also representative of early attempts to access the limestone resource.
MS14	This house site is a built and archaeological site with local historical significance and research potential as an example of the landscape modifications and building techniques used to create a home environment in the Australian landscape. It is a rare and representative example of vernacular buildings in the area and has the potential to provide research information on construction methods.
Bungonia National Park	
The Bungonia NP is adjacent to the Project site. The Bungonia NP is an item of local heritage significance for its ability to represent the geology of the local area and as a large natural landscape. The Lookdown within the park highlights these qualities. As a recreational area it also has social significance to the local and wider community.	
Glenrock homestead and outbuildings	
George Barber began purchasing land in the Marulan district from around 1835 including an allotment of 800 acres that he named “Glenrock”. While the size of the original property has shrunk, today the listed component of the property includes the homestead and surrounding outbuildings. Glenrock Homestead and Outbuildings is a good example of a Georgian style country home, particularly the facade which is of aesthetic significance as a good example of Georgian stonework. Glenrock Estate and its early owners are of historical and associative significance for their contribution to the understanding of the history of the area and the connection to George Barber and Isabella Hume. The item is listed on the Goulburn Mulwaree LEP.	

16.3.2 Impacts

The following ground disturbance activities have the potential to impact known and unknown historic heritage items in the Project site (**Figure 16.1**):

- construction of project infrastructure including haul roads, expansion of the pit, and realignment of Marulan South Road; and
- covering of areas by overburden emplacements.

No historical heritage items or potential heritage items were identified at the proposed Marulan Creek dam site or in the area between the mine and the dam.

Impacts have been assessed with reference to (Heritage Office, 2004) (**Table 16.5**), which provides questions relevant to different types of impacts eg demolition, partial demolition and change of use; and the types of items present. The type of impact is summarised in the 'impact type' rows in **Table 16.5**, with items that will be avoided by the Project not described further in the table.

The Old Marulan South Road (MS07), the Lime-Kiln Road (MS12) and the Frome Hill Road (MS13) are all remnants of the historic mining activities that developed into the enterprise it is today and were considered together. While as a group, with each other as well as with the other historic elements in the landscape, the roads have the ability to demonstrate transport processes and different phases of the mining activities, their research potential and historical significance can be captured through archival recording in photographic format and by mapping their locations.

Items which did not receive a unique heritage identifier in the technical report are summarised below.

The Bungonia NP is adjacent to the Project site and is an item of local heritage significance as it represents the geology of the local area and is a large natural landscape.

The mine is currently, and will remain, visible from the Bungonia Lookdown. Physical impacts to the recreation area and the national park are not anticipated. The mine, including the southern extent of the Project site (the south pit) has been part of the landscape for over a century. The Project will, therefore, not result in any new or more significant impacts, closer to this heritage item, than have already occurred during historic mining operations.

Glenrock Homestead and outbuildings are approximately 2 km from the proposed disturbance footprint and will not be impacted by the Project.

Table 16.5: Summary of impacts

Item	Discussion
Impact type	
MS01/ MS02	Avoided
MS03	Removal
MS04	Majority will be removed, items not removed are not significant without the other elements.
MS05	Removal
MS07	Removal
MS08	Avoided
MS09	Removal
MS10	Avoided
MS11	Avoided
MS12	Removal

Item	Discussion
MS13	Removal
MS14	Avoided
Have all options for retention and adaptive re-use been explored?	
MS01/ MS02	The area of the former village will remain as the administrative centre of the mine operations.
MS03	Not applicable.
MS04	Portions of the aerial ropeway will be retained, including the modern engine room, and a complete concrete plinth. Buckets located outside the mine disturbance area will also be avoided. These elements will remain *in situ* as a reminder of this historical technology in its original setting. The aerial ropeway cannot be adaptively reused as it is outdated technology and is in poor condition.
MS05	The group has had many of its component parts destroyed or removed with the passing of time and not enough remains for reuse. Location of the group in relation to the limestone resource does not allow for retention.
MS09	Not applicable.
How is the impact of the new development on the heritage significance of the item or area to be minimised?	
MS01/ MS02	Not applicable.
MS03	Impacts to the former house and camp sites will be reduced by recording the elements of each site and their position in the landscape.
MS04	Not applicable.
MS05	Not applicable.
MS09	Impacts to the former house and camp sites will be reduced by recording the elements of each site and their position in the landscape.
How does the new development affect views to, and from, the heritage item? What has been done to minimise negative effects?	
MS01/ MS02	Not applicable.
MS03	The sites will be removed and will not be subject to views of the Project.
MS04	Not applicable.
MS05	Not applicable.
MS09	The sites will be removed and will not be subject to views of the Project.
Will the additions visually dominate the heritage item? How has this been minimised?	
MS01/ MS02	Not applicable.
MS03	The sites will be removed and will not be subject to views of the Project.
MS04	Not applicable.
MS05	Not applicable.
MS09	The sites will be removed and will not be subject to views of the Project.
Will the public and users of the item still be able to view and appreciated its significance?	
MS01/ MS02	Not applicable.
MS03	The public is currently unable to view any of these sites as they are on Boral land and close to the active mining operations.
MS04	Not applicable.
MS05	Not applicable.
MS09	The public is currently unable to view any of these sites as they are on Boral land and close to the active mining operations.
Can all of the significant elements of the heritage item be kept and any new development be located elsewhere on site?	

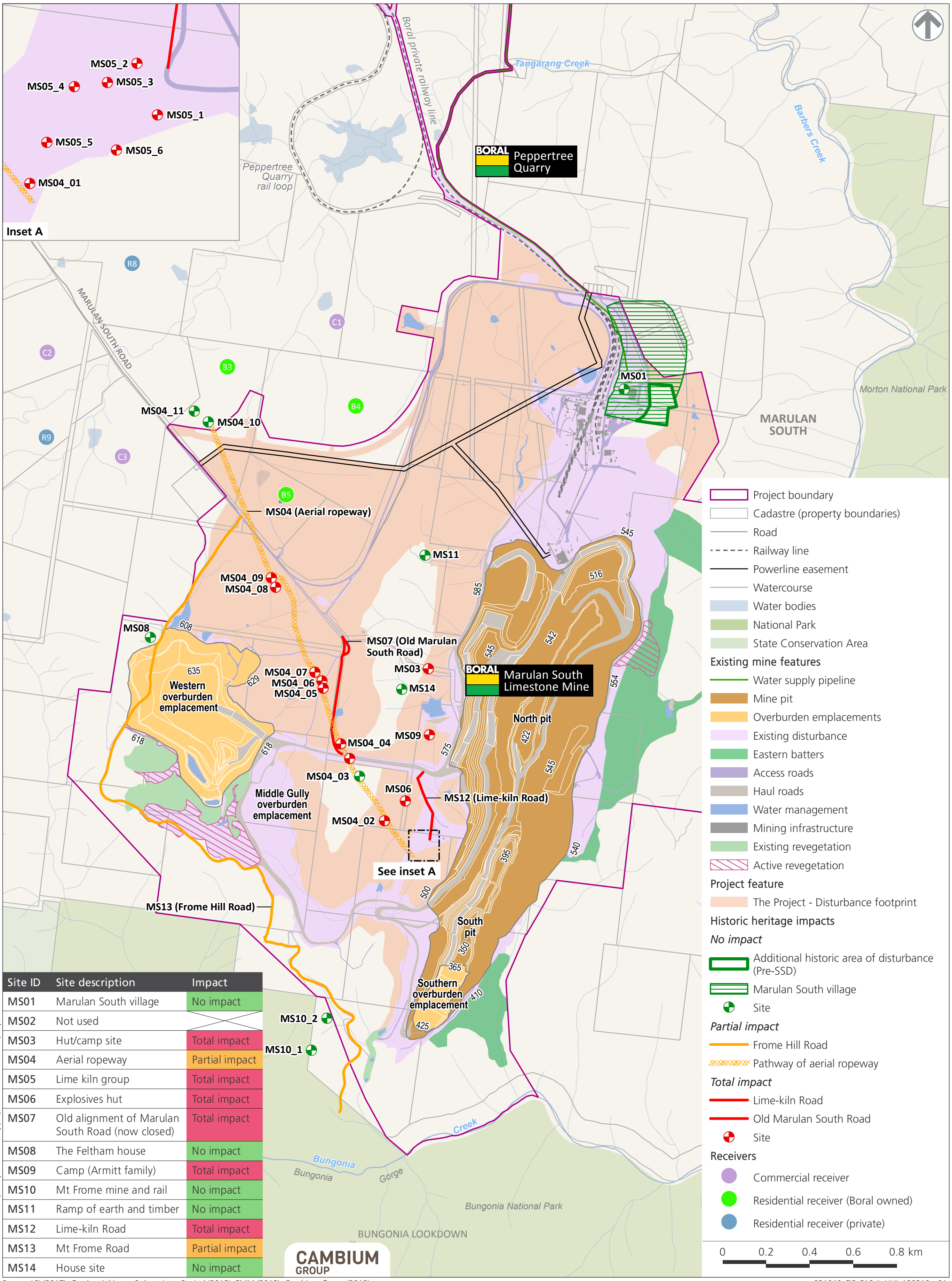
Item	Discussion
MS01/ MS02	Impacts to the former village will be avoided and the area will continue to operate as the mine administrative centre.
MS03	Not applicable.
MS04	The current design is considered to be optimal (refer to **Section 7.1**) and it is preferential not to alter the disturbance footprints associated with the Project to avoid a portion of the aerial ropeway.
MS05	The proposed 30-year pit design is considered by Boral to be the optimal design (refer to **Section 7.1**) and therefore altering the disturbance footprint associated with this 30 year pit to avoid the lime kiln group is not feasible.
MS09	Not applicable.
Is demolition essential at this time or can it be postponed in case future circumstances make its retention and conservation more feasible?	
MS01/ MS02	Not applicable.
MS03	Not applicable.
MS04	Only those portions of the aerial ropeway impacted by the Project will be removed and the timing of removal of those elements of the aerial ropeway will be based on the mining schedule (refer to **Section 4.5**).
MS05	The item will not be removed until after the first five years of the 30-year mine plan. However, it cannot be prevented and when operations reach their location the group will be removed.
MS09	Not applicable.
Is the development site on any known, or potentially significant archaeological deposits? If so, have alternative sites been considered? Why were they rejected?	
MS01/ MS02	Not applicable.
MS03	All the house and camp sites have archaeological potential although deposits may not be deep. The spatial arrangement of the habitation sites on an individual and collective scale is important from an archaeological perspective.
MS04	Not applicable.
MS05	The lime kiln group has been considered in the assessment of impacts and the management measures. As retention is not possible, it will be recorded by archaeological excavation, photographic recording and topographical recording.
MS09	All the house and camp sites have archaeological potential although deposits may not be deep. The spatial arrangement of the habitation sites on an individual and collective scale is important from an archaeological perspective.
Has the advice of a heritage consultant been sought? Have the consultant's recommendations been implemented? If not, why not?	
MS01/ MS02	A heritage consultant assessed historic heritage impacts. Archival recording will ensure that information is gathered and retained for posterity and will be a legacy of the Project and the lives of the former community. The recommendations will be implemented to record the former village as it is now.
MS03	Not applicable.
MS04	A heritage consultant assessed historic heritage impacts. Due to the impacts on portions of the aerial ropeway, a recommendation for archival recording of the aerial ropeway is made. The recommendations will be implemented progressively as impacts are proposed to the area and will form part of the mitigation measures for the Project.
MS05	A heritage consultant assessed historic heritage impacts. Archival recording will ensure that information from the lime kiln group is gathered to contribute to the understanding of early mining operations throughout the area. The recommendations will be implemented progressively as impacts are proposed to the area and will form part of the mitigation measures for the Project.
MS09	Not applicable.

Cumulative impacts

The cumulative impacts to historic heritage will be high as many items in the Project site will be removed. The current landscape is of a mixed industrial and residential nature and is rare in the local context. One of the most valuable aspects of the collective sites, however, is research potential. The Project will provide an opportunity to record further heritage aspects of the Project site.

Figure 16.1
Historic heritage impacts

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



Site ID	Site description	Impact
MS01	Marulan South village	No impact
MS02	Not used	
MS03	Hut/camp site	Total impact
MS04	Aerial ropeway	Partial impact
MS05	Lime kiln group	Total impact
MS06	Explosives hut	Total impact
MS07	Old alignment of Marulan South Road (now closed)	Total impact
MS08	The Feltham house	No impact
MS09	Camp (Armitt family)	Total impact
MS10	Mt Frome mine and rail	No impact
MS11	Ramp of earth and timber	No impact
MS12	Lime-kiln Road	Total impact
MS13	Mt Frome Road	Partial impact
MS14	House site	No impact

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

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16.4 Management measures

There is little opportunity to revise the proposed disturbance footprint to avoid impacts to heritage items due the shape and orientation of the limestone resource. Therefore, it will not be possible to avoid impacts to items in the proposed disturbance footprint and alternative management measures will be required. These alternative measures are described below and their application to the heritage items in the Project site is summarised in **Table 16.6** and **Figure 16.2**.

16.4.1 Photographic archival recording

Archival recording compiles information about the technical, environmental, historical and aesthetic information from heritage items for future generations and is carried out in accordance with the Heritage Council's *How to Prepare Archival Records of Heritage Items* (1998) and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006).

16.4.2 Archaeological recording

The following elements of archaeological recording of the landscape will occur prior to the disturbance of heritage items:

- topographic survey of all identified items so their relative location, elements and orientation can be mapped;
- archaeological excavation of representative structures of some items prior to their removal; and
- archaeological excavation of a sample of some items.

Any archaeological investigation involving excavation will be guided by a research design with relevant questions and other supporting information.

16.4.3 Demarcation and signposts

Treated timber poles, or similar, painted with high visibility paint will be installed around the visible extent of sites within 20 m of the disturbance footprint, with an approximate 5 m buffer from the edge of visible site fabric.

A suitably durable sign will be attached to the posts including words to the effect of:

> "Environmentally sensitive area; do not disturb; contact the Mine Manager for more information".

The location of historic heritage items that are not to be impacted by the Project will be identified in the historic heritage management section of the MOP, relevant CEMPs and will be included in operational and construction induction and training procedures.

16.4.4 Moveable heritage

Moveable items will be retrieved before impact and stored in a suitable location in the Project site.

16.4.5 Historic heritage management

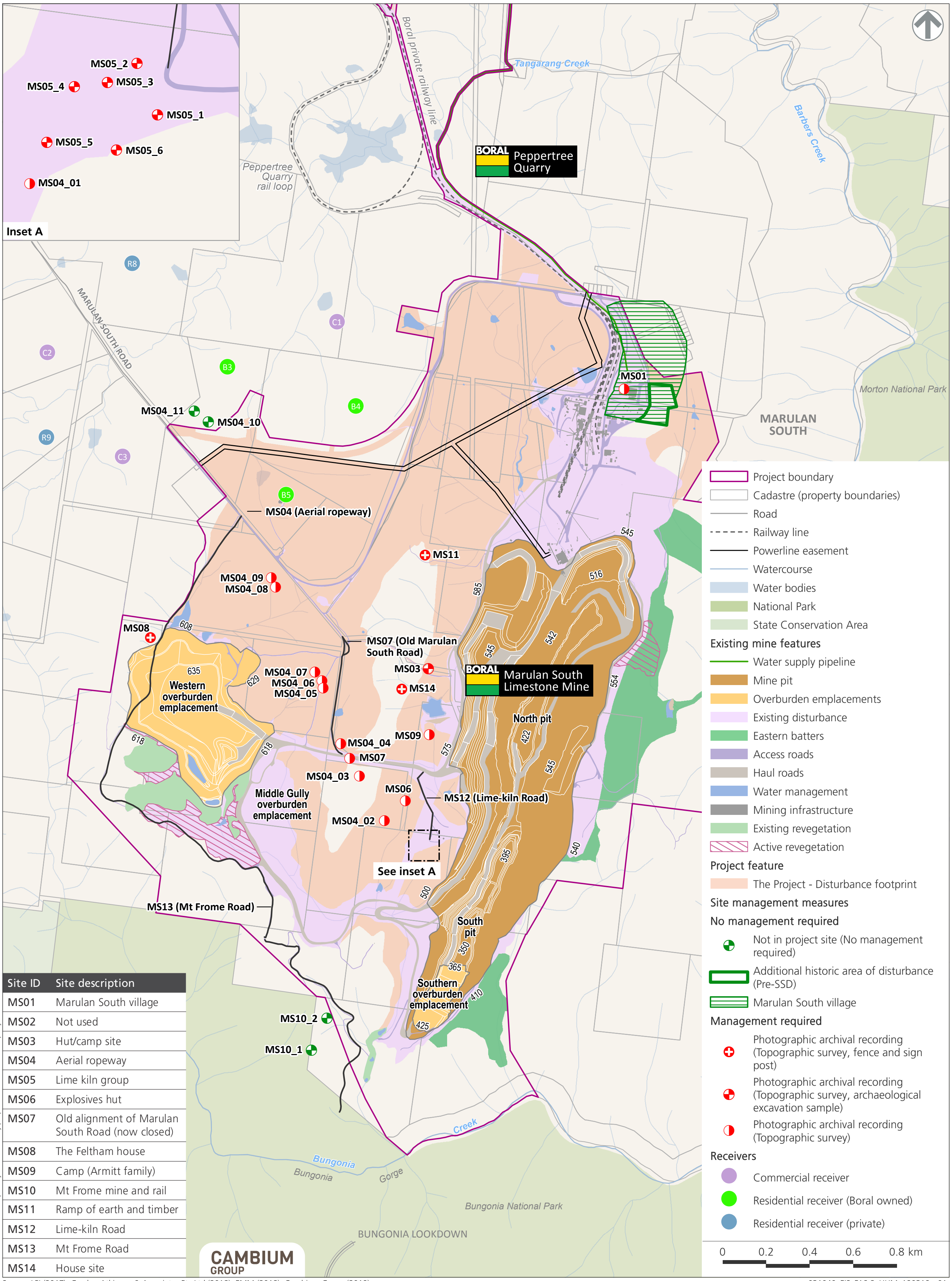
Historic heritage management including measures in Table 16.6 and **Figure 16.2** will be incorporated into the overarching operational environmental management to provide information on the historic heritage items in the Project site and surrounds and details of their management, including an unexpected finds protocol and human skeletal material finds protocol.

Table 16.6: Summary of management measures

Item	Management
MS01/MS02	Photographic archival recording. Archaeological recording through topographic survey.
MS03	Photographic archival recording. Archaeological recording through topographic survey. Archaeological excavation (sample area).
MS04	Photographic archival recording. Archaeological recording through topographic survey. Move metal buckets from former aerial ropeway for safekeeping. Buckets to be placed in locations that will not be impacted and are to remain in-situ.
MS05	Photographic archival recording. Archaeological recording through topographic survey. Archaeological excavation of one of each of the two types of kilns.
MS06	Photographic archival recording (detail not required). Archaeological recording through topographic survey.
MS07	Include in final spatial mapping of sites; data to be extracted from cadastre. Photographic archival recording of a representative sample.
MS08	Fence and signpost. Photographic archival recording. Archaeological recording through topographic survey. Record any artefacts and structures that occur in the area of impact.
MS09	Photographic archival recording. Archaeological recording through topographic survey.
MS10	No management measures required.
MS11	Fence and signpost. Photographic archival recording. Archaeological recording through topographic survey.
MS12	Photographic archival recording. Archaeological recording through topographic survey.
MS13	Photographic archival recording of a representative sample of the section of road to be removed. Include in spatial mapping of sites; data can be extracted from cadastre.
MS14	Fence and signpost. Photographic archival recording. Archaeological recording through topographic survey. Excavate if artefacts and structures occur in the area of impact.

Figure 16.2
Historic heritage management

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



Site ID	Site description
MS01	Marulan South village
MS02	Not used
MS03	Hut/camp site
MS04	Aerial ropeway
MS05	Lime kiln group
MS06	Explosives hut
MS07	Old alignment of Marulan South Road (now closed)
MS08	The Feltham house
MS09	Camp (Armitt family)
MS10	Mt Frome mine and rail
MS11	Ramp of earth and timber
MS12	Lime-kiln Road
MS13	Mt Frome Road
MS14	House site

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), EMM (2018), Cambium Group (2019).

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16.5 Residual impacts

As stated above and outlined in **Section 7.1** and **Chapter 28**, there is little opportunity to revise the proposed disturbance footprint to avoid impacts to heritage items due the shape and orientation of the limestone resource, and seven items of local heritage significance in the Project site will be completely or partially removed. However, there will be opportunities to implement management measures prior to development of the areas containing the items. This will enable data to be extracted which will be useful for future research on spatial analysis, comparative analysis and the material culture created by nineteenth and early twentieth century miners.

Chapter 17

Air quality

VOLUME 1

Air quality

Particulate matter, or dust, is the main air pollutant of concern from mining. Dust can be defined by the following sub-categories:

- total suspended particles (TSP), which comprises the total mass of all particles suspended in the air;
- particulate matter with an aerodynamic diameter of 10 µm or less (PM_{10});
- particulate matter with an aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$); and
- deposited dust, which is dust that has settled from the atmosphere onto surfaces.

Other air pollutants potentially associated with the Project are nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), which could be generated at the processing facilities, hydration plant and kiln.

Worst case pollutant generation scenarios over three of the mining stages were assessed (Stage 4 will have reduced operations and was not assessed) using emissions reduction factors, which assume the application of management measures.

The Project, in combination with other local emissions sources, will not result in exceedances of particulate matter and dust deposition criteria at any privately-owned sensitive receivers. The annual average PM_{10} criterion will be exceeded at a Boral owned receiver during Stage 1. Dust generated by the Project will not impact more than 25% of any privately owned property.

Stack emissions from the Project will be minimal and well below the criteria. When combined with background levels, cumulative levels will also be below the criteria.

Greenhouse gases will be generated by the following sources during construction and operation of the Project:

- fuel combustion by construction machinery and site vehicles;
- fuel combustion and electricity use during mining operations and lime production;
- lime production; and
- fuel combustion from transportation of the lime products off-site by road and rail.

The construction emissions of 14,179 tCO_2-e are substantially less than the operational emissions. Operational activities of the Project are estimated to generate 122,703 tCO_2-e per annum.

The Project's total construction GHG emissions of 14,179 tCO2-e (0.014179 $MtCO_2$-e) will equate to 0.095% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

The Project's annual operational GHG emissions of 122,703 tCO_2-e (0.122703 $MtCO_2$-e) will equate to 0.83% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

17 AIR QUALITY

17.1 Introduction

This chapter summarises the air quality impact assessment report, which is in **Appendix P**. It describes the air quality assessment criteria which apply to the Project, potential air emission sources, modelling method and results, potential impacts and mitigation measures where impacts are unavoidable.

17.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on air quality (**Table 17.1**).

Table 17.1: Air quality SEARs

Requirement	Section and appendix where addressed
▪ An assessment of the likely air quality impacts of the development in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* and the EPA's additional requirements, and having regard to the NSW Government's Voluntary Land Acquisition and Mitigation Policy: For State Significant Mining, Petroleum and Extractive Industry Developments*; and	17.2, Appendix P
▪ In extending the validity period of the SEARs, DP&E requested use of the Approved methods for the modelling and assessment of air pollutants in New South Wales (NSW EPA, 2017).	Appendix P

*The Voluntary Land Acquisition and Mitigation Policy (VLAMP) was first published in December 2014. In September 2018, the EPA has revised its policies for noise and air quality impacts. Therefore, the air quality and noise and blasting assessments have considered the revised VLAMP.

17.1.2 Overview of assessment methods

Particulate matter, or dust, is the main air pollutant of concern from mining. Dust can be defined by the following sub-categories:

- total suspended particles (TSP), which comprises the total mass of all particles suspended in the air;
- particulate matter with an aerodynamic diameter of 10 µm or less (PM_{10});
- particulate matter with an aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$); and
- deposited dust, which is dust that has settled from the atmosphere onto surfaces.

Other air pollutants potentially associated with the Project are nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), which could be generated at the processing facilities, hydration plant and kiln.

The CALPUFF model, an advanced 'puff' model that accounts for impact of complex local terrain on dispersion meteorology, was used to estimate the dispersion of air pollutants from the Project and resulting impacts on nearby sensitive receivers. The EPA was consulted on 15 November 2015 about the appropriateness of this approach for modelling dispersal around the complex site terrain, and advised the normal procedure should be followed.

The CALMET meteorological model was used to provide the meteorological conditions for the dispersion model based on January 2014 to December 2014 data from four weather stations around the Project area.

Scenarios

The following scenarios were modelled, which represented the worst-case impacts related to quantity of material extracted in each year and the locations of dust generating activities. These indicative worst-case dust generating scenarios are presented in Figures 8-1 to 8-3 in the air quality impact assessment (**Appendix P**):

- Stage 1, which is representative of overburden emplacement in the WOE, SOE and NOE, and comprises:
  - overburden transported to the lower benches of the southern half of the WOE, south-eastern (in-pit) portion of the SOE or the southern portion of the NOE;
  - 31% of the overburden distributed to the WOE, 53% to the SOE and 16% to the NOE; and
  - emplacement of overburden from the Peppertree Quarry in the NOE at a rate of 3.1 Mtpa.
- Stage 2, which is representative of maximum overburden emplacement in the WOE, and comprises:
  - overburden transported to the upper benches of the southern half of the WOE or south-eastern (out-of-pit) portion of the SOE;
  - overburden is distributed 87% to the WOE and 13% to the SOE; and
  - the NOE is complete and emplacement from the Peppertree Quarry has ceased.
- Stage 3, which is representative of maximum overburden emplacement in the WOE area north of Marulan South Road, and comprises:
  - overburden transported to either the northern half of the WOE or the central portion of the SOE; and
  - 74% of the overburden is distributed to the WOE and 26% to the SOE.

Each scenario includes extraction of limestone from the pit and transportation to the primary crusher; and the entire processing plant being operational.

Stage 4 was not assessed as operations will be reduced during this period compared to other stages and it would not represent a worst-case operating scenario.

Emissions estimates

The dust generated by mine sources during each modelled stage was estimated using Australian and United States EPA emissions factors. The estimates assumed use of best practice dust mitigation measures, which are summarised in **Table 17.2**.

Some of the emission reductions achieved by applying management measures to mine activities were:

- hauling on unsealed roads – 80% from watering trafficked areas;
- primary and secondary crushing – 50% from enclosure and dust cyclone;
- conveyor and transfer points – 70% from enclosure;
- stockpiles – 50% from water sprays; and
- revegetation – 70% from partial rehabilitation of exposed areas.

Table 17.2: Best practice dust management measures

Activity	Dust controls
Hauling on unsealed roads	▪ Watering roads ▪ Use the largest practical truck ▪ Road edges to be clearly defined by bunding and road width ▪ Obsolete roads to be ripped and revegetated

Activity	Dust controls
	▪ Enforce 40 kmh speed limit
Hauling on sealed roads	▪ Maintain roads ▪ Regularly sweep road ▪ Cover departing loads ▪ Enforce 40 kmh speed limit ▪ Wheel wash/full truck wash with auto cut-off
Drilling	▪ Maintain dust filtration systems ▪ Cease operations if resulting in excessive visible dust ▪ Do not disturb drill cuttings
Blasting	▪ Only blast during appropriate weather ▪ Adequate stemming
Bulldozing	▪ Dozers to travel on watered routes between work areas ▪ Modify operations if resulting in excessive visible dust ▪ Modify activities during high wind
Loading/unloading materials	▪ Minimise drop heights ▪ Modify operations if resulting in excessive visible dust ▪ Modify activities during high wind
Crusher	▪ Regular cleaning and housekeeping in and around buildings ▪ Regular servicing and inspection of dust cyclone ▪ Water sprays at tipping hopper

Predicted dust emissions associated with Modification 5 to Peppertree Quarry's consent (described in **Section 2.2.1**) were included in the model to assess potential cumulative impacts. An additional cumulative assessment was made by adding the unaccounted fractions of background dust levels, assumed to be from non-mine or Peppertree Quarry sources, to the annual average model predictions. The unaccounted background level was estimated by modelling the 2014 mine and Peppertree Quarry activities and comparing the results with the measured data from the corresponding monitors. The average difference was considered the contribution from the other sources (**Table 17.3**).

Table 17.3: Estimated average contribution from other non-modelled sources around Project site

Pollutant	Background level
TSP	27.0 µg/m^3
PM_{10}	11.0 µg/m^3
$PM_{2.5}$	3.5 µg/m^3
Deposited dust	2.8 g/m^2/month

To represent a worst-case scenario, lime hydration plant and kiln NO_2 and SO_2 emissions were estimated by applying the average plus standard deviation of measured levels from stack testing at these sources between 2013 and 2016 to all hours of the year. For the cumulative assessment, background NO_2 and SO_2 levels were conservatively estimated from monitoring stations at Bargo and Wollongong, which are more densely populated areas.

Criteria

The air quality goals for dust in (NSW EPA, 2017) that are relevant to the Project are summarised in **Table 17.4**, which relate to the total dust in the air, not only dust from the Project (ie cumulative). Background dust levels need to be considered when using these goals to assess impacts.

Table 17.4: NSW EPA air quality impact assessment criteria – dust

Pollutant	Averaging period	Impact	Criterion
TSP	Annual	Total	90 µg/m^3

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

The air quality goals for NO_2 and SO_2 in (NSW EPA, 2017) relevant to the Project are summarised in **Table 17.5**.

NO_2 forms when fuel is burned at high temperatures or from blasting, and is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lowers resistance to respiratory infections such as influenza.

SO_2 commonly arises in industrial emissions due to the sulphur content of the fuel and can have impacts upon human health and the habitability of the environment for flora and fauna.

Table 17.5: NSW EPA air quality impact assessment criteria – NO_2 and SO_2

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

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceed the criteria in **Table 17.6** from the VLAMP (NSW Government, 2018), at any residence, workplace or on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 17.6: Particulate matter acquisition criteria

Pollutant	Averaging period	Criterion	Impact type
TSP	Annual	90 µg/m^{3*}	Amenity
PM_{10}	Annual	20 µg/m^{3**}	Human health
	24 hour	50 µg/m^{3**}	
$PM_{2.5}$	Annual	8 µg/m^{3*}	Human health
	24 hour	25 µg/m^{3**}	
Deposited dust	Annual	2 g/m^2/month**	Amenity
		4 g/m^2/month*	

* Cumulative impact (increase in the concentration due to the development plus background concentrations due to all other sources).
** Incremental impact (increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

17.2 Impact assessment

17.2.1 Incremental (Project-only) impacts

The maximum predicted incremental (Project-only) particulate matter and dust deposition concentrations at the most affected Boral owned, private residential and private commercial receivers for the worst-case operating scenarios for Stages 1, 2 and 3 are summarised in **Table 17.7** and shown on **Figure 17.1**. As described in **Section 17.1.2**, there is only an incremental criterion for dust deposition, which is not exceeded at any receiver for any of the stages.

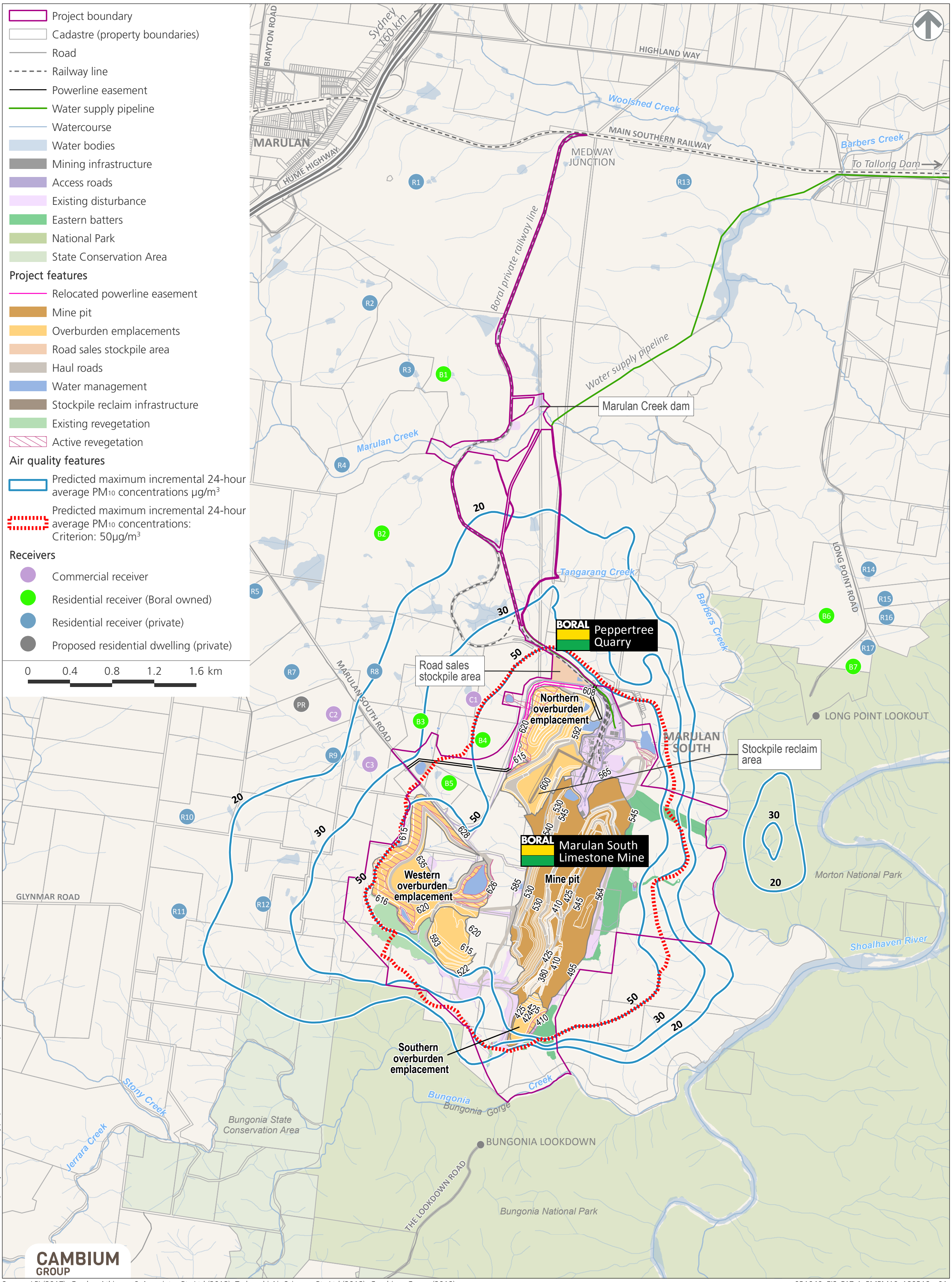
Table 17.7: Maximum particulate matter and deposition rates – incremental

Scenario	Maximum predicted concentration (µg/m^3) – all receivers					Annual average dust deposition (g/m^2/month)
	Annual average TSP	24 hour average PM10	Annual average PM10	24 hour average PM2.5	Annual average PM2.5	
	Air quality impact criteria					
						2
Stage 1	18.8 (B5) 8.1 (R12) 9.9 (C1)	56.0 (B4) 25.6 (R12) 45.3 (C1)	10.2 (B4, B5) 4.5 (R12) 5.8 (C1)	9.5 (B5) 5.9 (R12) 6.9 (C1)	2.0 (B5) 0.9 (R12) 1.1 (C1)	0.31 (B4) 0.12 (R12) 0.17 (C1)
Stage 2	21.5 (B5) 9.5 (R12) 9.6 (C1)	55.4 (B4) 32.4 (R12) 45.8 (C1)	10.9 (B5) 5.0 (R12) 5.4 (C1)	8.1 (B5) 6.0 (R12) 6.8 (C1)	1.7 (B5) 0.9 (R12) 0.9 (C1)	0.40 (B5) 0.16 (R12) 0.17 (C1)
Stage 3*	19.6 (B4) 8.2 (R12) 9.9 (C3)	55.9 (B4) 23.3 (R12) 45.2 (C1)	10.5 (B4) 4.5 (R12) 5.6 (C1)	8.5 (B4) 5.3 (R12) 6.8 (C1)	1.8 (B4) 0.8 (R12) 1.0 (C1, C3)	0.35 (B4) 0.13 (R9, R12) 0.19 (C3)

*Note: Boral owned receiver B5 no longer exists as has been subsumed by WOE.

Figure 17.1
Predicted maximum incremental 24-hour average PM_{10} concentrations (μg/m³) – Stage 1

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Todoroski Air Sciences Pty Ltd (2018), Cambium Group (2019).

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17.2.2 Cumulative (Project and other sources) impacts

The maximum predicted cumulative annual average particulate matter and dust deposition rates at the most affected Boral owned, private residential and private commercial receivers for the worst-case operating scenarios for Stages 1, 2 and 3 are summarised in **Table 17.8** and presented in **Figure 17.2**, **Figure 17.3** and **Figure 17.4**). The results show no exceedances of criteria at any of the privately-owned residential or commercial receivers. Boral owned receiver B4 is predicted to exceed the annual average PM_{10} criteria in Stage 1.

Table 17.8: Maximum annual particulate matter and deposition rates – cumulative

Scenario	Maximum predicted concentration (µg/m³) – all receivers			Annual average dust deposition (g/m²/month)
	Annual average TSP	Annual average PM_{10}	Annual average $PM_{2.5}$	
	Air quality impact criteria			
	90	25	8	4
Stage 1	60.4 (B4) 39.4 (R8) 52.2 (C1)	27.5 (B4) 17.7 (R8) 23.7 (C1)	6.5 (B4) 4.6 (R8) 5.6 (C1)	3.4 (B4) 3.1 (R17) 3.0 (R8, R9)) 3.3 (C1)
Stage 2	49.7 (B5) 36.9 (R12) 40.4 (C1)	22.7 (B5) 16.2 (R12) 18.6 (C1)	5.3 (B5) 4.4 (R12) 4.7 (C1)	3.2 (B5) 3.0 (R12, R15, R16, R17) 3.0 (C1, C3)
Stage 3*	48.8 (B4) 35.5 (R12) 40.7 (C1)	22.8 (B4) 15.7 (R8, R12) 18.8 (C1)	5.5 (B4) 4.4 (R12) 4.8(C1)	3.2 (B4) 3.0 (R8, R15, R16, R17) 3.0 (C1, C3)

*Boral owned receiver B5 no longer exists as has been subsumed by Western Overburden Emplacement.

Figure 17.2
Predicted cumulative annual average PM_{10} concentrations (μg/m³) – Stage 1

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

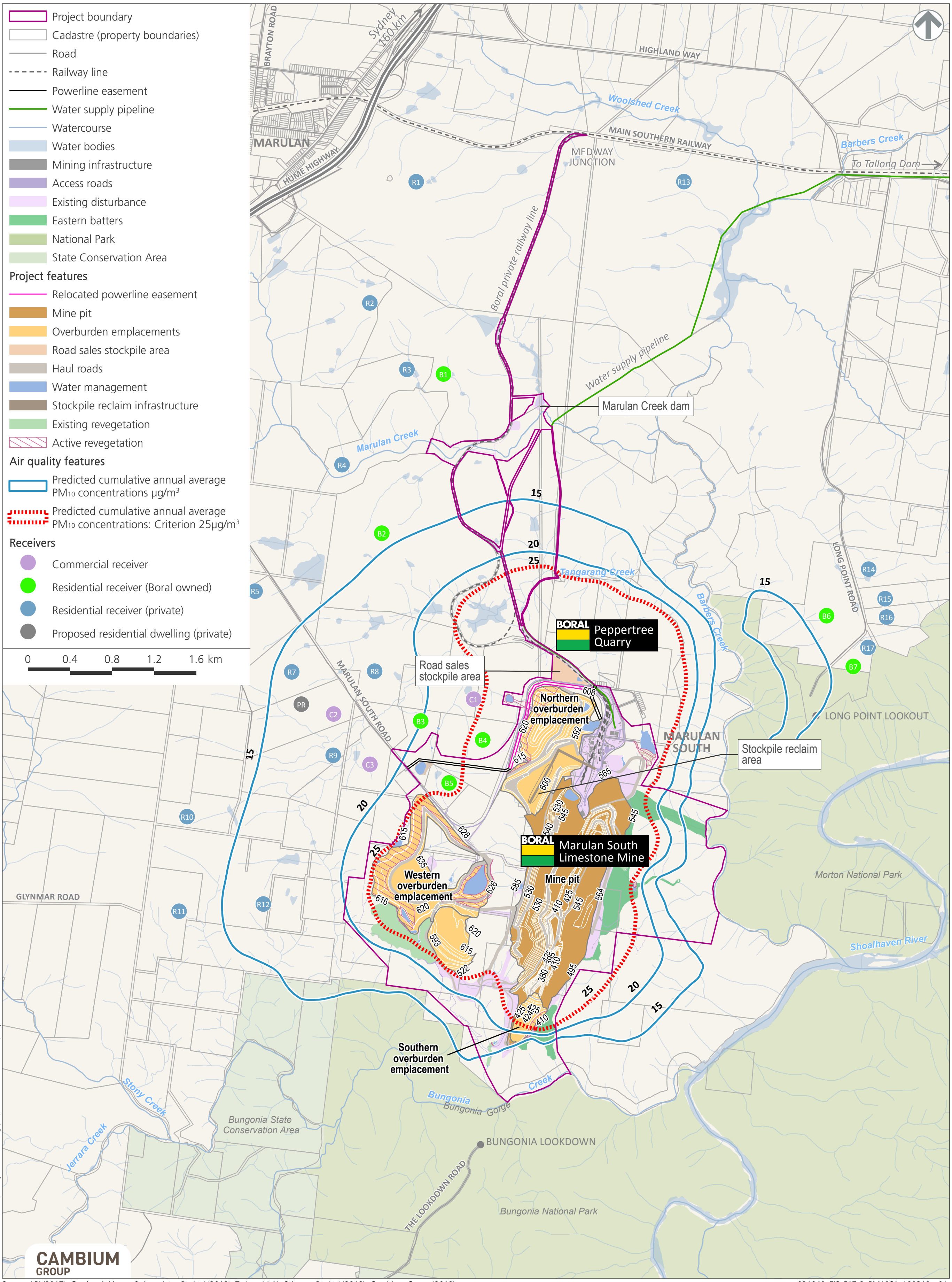

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Figure 17.3
Predicted cumulative annual average PM_{10} concentrations (μg/m³) – Stage 2

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ENVIRONMENTAL IMPACT STATEMENT

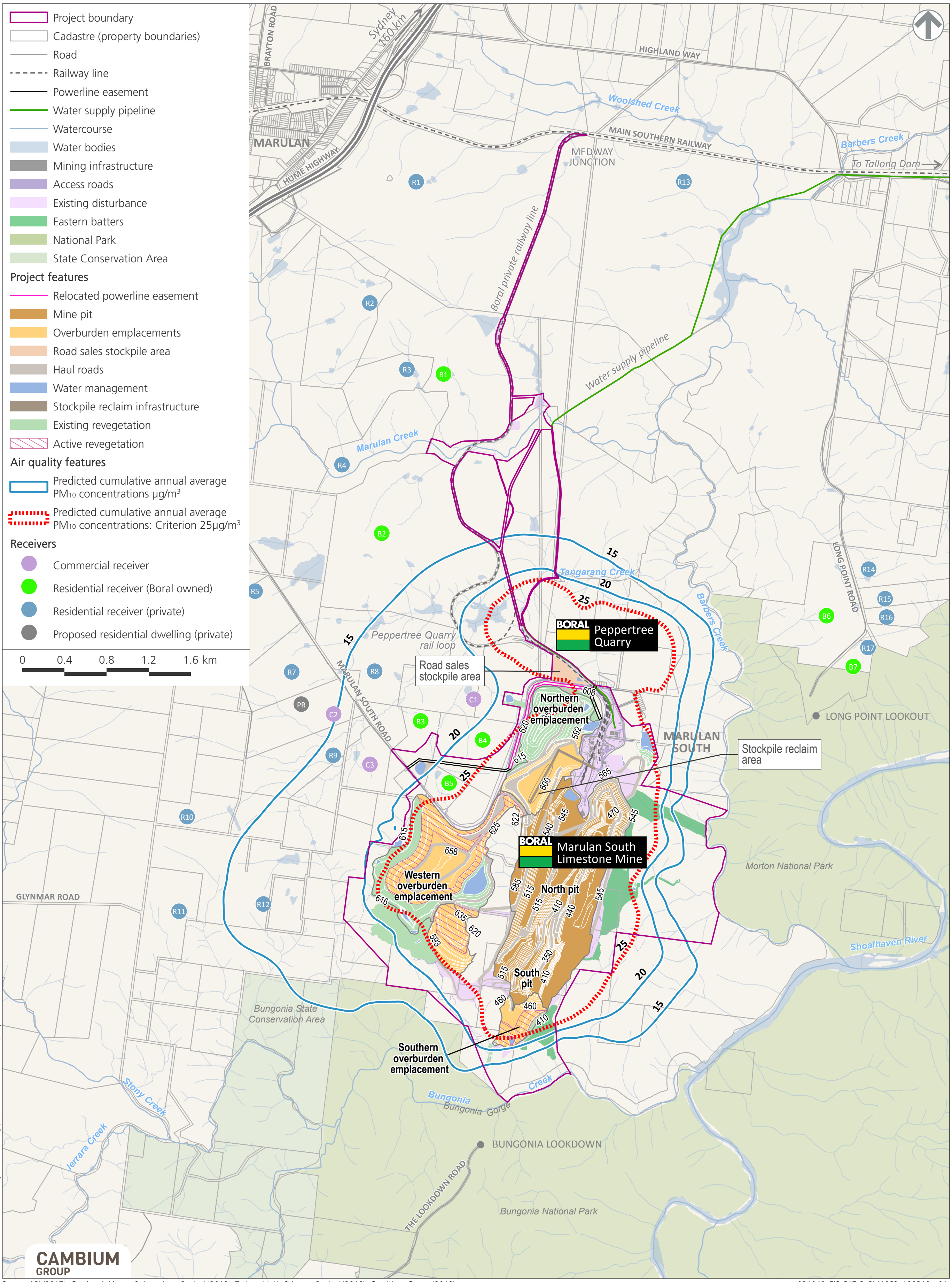

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Figure 17.4
Predicted cumulative annual average PM_{10} concentrations (µg/m³) – Stage 3

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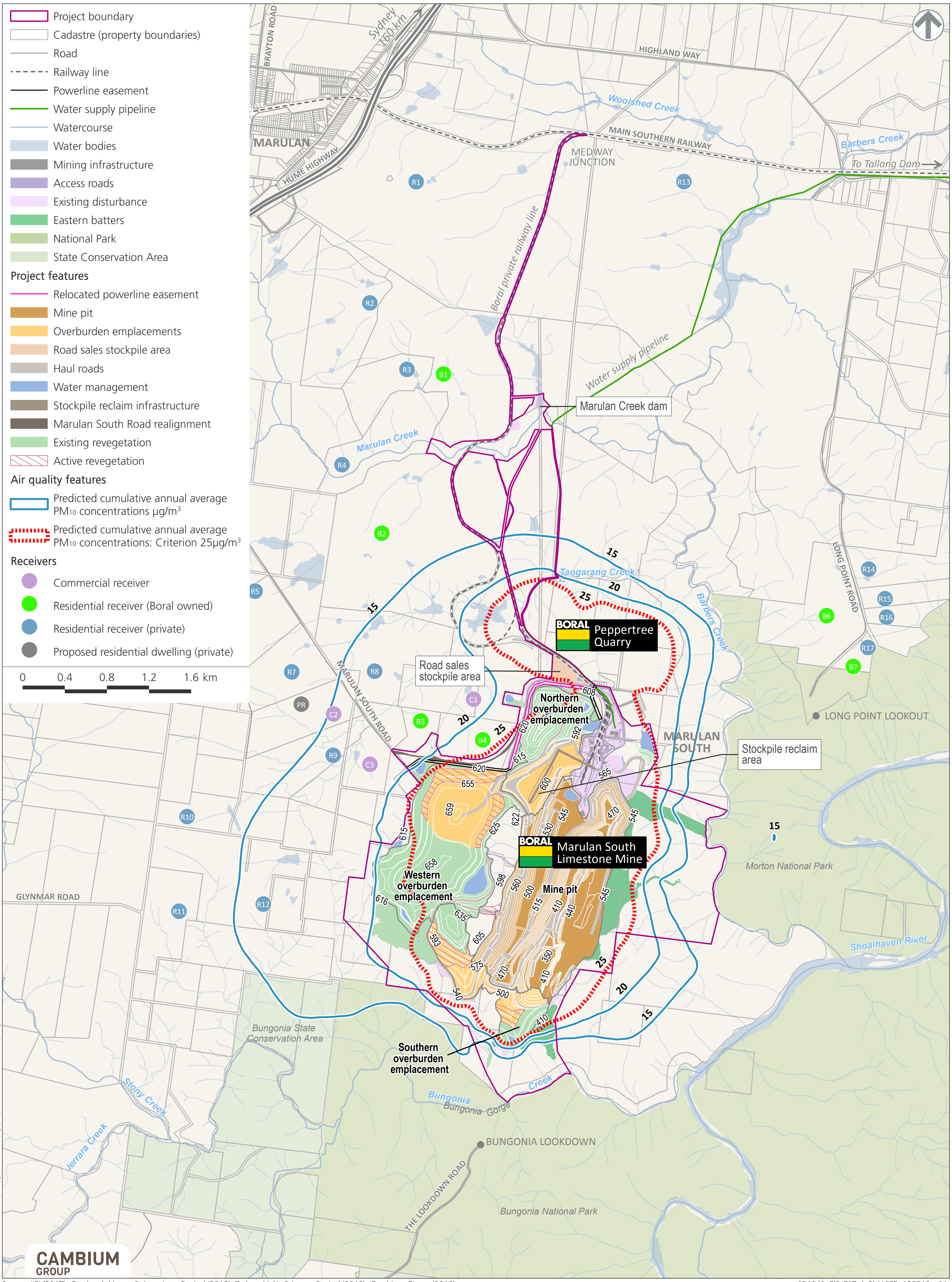
ENVIRONMENTAL IMPACT STATEMENT



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Todoroski Air Sciences Pty Ltd (2018), Cambium Group (2019).

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17.2.3 Total cumulative 24 hour average $PM_{2.5}$ and PM_{10} assessment

Cumulative 24 hour average $PM_{2.5}$ and PM_{10} impacts at the closest and most potentially impacted privately-owned receivers are of most interest in this assessment.

Assessment of cumulative $PM_{2.5}$ impacts

Local background $PM_{2.5}$ levels were estimated from the HVAS data and Wollongong AWS as there is no local monitoring of these parameters. Two different approaches were used of adding the maximum background and maximum incremental level together:

- criteria ratio approach, where it assumed the maximum ambient $PM_{2.5}$ level is 32% of the maximum ambient PM_{10} levels recorded at the HVAS; and
- Victorian EPA approach using the 2014 Wollongong AWS data, where 70th percentile of one year's hourly concentrations are added to the predicted maximum incremental concentration.

As the HVAS already accounts for the mine's and Peppertree Quarry's contributions, using the criteria ratio approach conservatively estimates that the maximum $PM_{2.5}$ level is 16.1 µg/m^3. This value was added to the maximum predicted incremental $PM_{2.5}$ level, which indicated the maximum cumulative impact would not exceed the 25 µg/m^3 criterion at privately owned receivers.

Using the Wollongong AWS data for the Victorian EPA approach is conservative as the data represent an area with higher anthropocentric influences on air quality. Applying this approach resulted in an ambient $PM_{2.5}$ level of 8.2 µg/m^3, which indicated the maximum cumulative impact would be well below the criterion at privately owned receivers.

Assessment of cumulative PM_{10} impacts

As monitored background PM_{10} levels have approached the 24 hour average criterion in the past, adding maximum background levels to maximum predicted incremental levels from the Project would result in exceedances of the criterion. The NSW EPA requires a more thorough assessment when the criterion is likely to be exceeded due to background levels, where the measured background level on a given day is added contemporaneously to the predicted incremental level using the same day's weather. This method has limits in predicting short term impacts, so impacts are described as 'systemic', or over five or more days.

Ambient dust data from the HVAS between January 2014 and December 2014 and corresponding weather data were used for a contemporaneous assessment. As the HVAS data represented dust from the mine and Peppertree Quarry for that period also, the incremental impact from those sources was predicted and subtracted from the total HVAS measurements so that impacts were not double counted. However, to be conservative and because models tend to overestimate source contributions, no level lower than the 25th percentile of the measured HVAS results was used.

Further, the 70th percentile of the HVAS data from July 2011 to June 2017 was used to fill the data gaps resulting from occasions the HVAS did not record data and to account for the fact the HVAS data are only available every sixth day.

The contemporaneous assessment showed it is unlikely there will be any systemic (ie greater than five days) cumulative impacts at the nearest privately owned receivers. The highest predicted cumulative PM_{10} concentration at the nearest affected receiver (R12) is 48 µg/m^3, which is 2 µg/m^3 below the 24-hr average PM_{10} criterion of 50 µg/m^3.

17.2.4 Dust impacts on more than 25 percent of privately owned land

The potential for more than 25% of privately owned land to be impacted by dust was approximated by observing the intersection of the 24 hour average PM_{10} contours, which had a greater extent than the other modelled parameters, with property boundaries. This demonstrated that the Project will not impact more than 25% of any privately owned property (refer to Figure 9-8 of **Appendix P**).

17.2.5 Process stack emissions

The maximum predicted incremental (Project-only) particulate matter and dust deposition concentrations at the most affected Boral owned, private residential and private commercial receivers for the worst-case operating scenarios for Stages 1, 2 and 3 are summarised in **Table 17.9**, which shows the stack emissions from the Project will be minimal and well below the criteria. When combined with background levels, it is predicted cumulative levels will also be below the criteria.

Table 17.9: Predicted maximum stack emissions for the Project

NO_2 (µg/m^3)		SO_2 (µg/m^3)			
24 hour average	Annual average	10 minute average	1 hour average	24 hour average	Annual average
Air quality impact criteria					
246	60	712	570	228	60
80.5 (B5) 54.0 (R8) 101.8 (C1)	1.79 (B4) 0.37 (R9) 1.04 (C1)	1.23 (B5) 0.83 (R8) 1.56 (C1)	0.72 (B5) 0.48 (R8) 0.91 (C1)	0.11 (B4) 0.06 (R17) 0.04 (R8) 0.08 (C1)	0.0160 (B4) 0.0041(R17) 0.0033 (R9) 0.0093 (C1)

17.2.6 Blast fumes

Blasting has potential to generate noxious gases such as NO_2. Modelled blast fume emissions form Hunter Valley coal mines were considered to determine the likelihood that blasts at the Project would impact receivers.

The potential for blast fume impacts are unlikely when blasting is in the daytime with the likely extent of worst-case impacts in the range of 1.5 to 2 km for the scale of blasts at the coal mines.

In comparison, the expected blast size for the Project is much smaller at approximately one tenth of the scale of the coal mines with typical blasting hours at the Project between 10:00 am to 4:00 pm. Based on this, the likelihood of a blast impact occurring at the Project would be low and unlikely to reach the nearest privately-owned receivers.

17.3 Management measures

Operations are carried out in accordance with the existing Boral (2015) *CMT-ENV-002 Marulan Dust Management Plan*, which has enabled the mine to generally operate in compliance with air quality criteria. As demonstrated above, continued operations of the mine are unlikely to result in a significant change in dust levels at private receivers.

Where it does not already contain these, the management measures in **Table 17.2** and supplementary measure in **Table 17.10** will be incorporated into a revised air quality management plan for the Project.

The dust deposition gauges to the west of the mine will be compromised by the new overburden emplacements. New locations for these gauges will be determined in consultation with a suitably qualified air quality specialist and they will be moved prior to overburden operations in those parts of the Project area.

Table 17.10: Air quality management measures

Activity	Dust controls
General operations	▪ Temporarily cease operations when high visible dust is being generated. ▪ Consider weather forecasting in daily planning to anticipate adverse weather and revise operations accordingly.
Hauling on unsealed roads	▪ Trucks to use wash station, especially prior to leaving site. ▪ Train truck drivers to identify elevated dust generation and request water cart.
Hauling on sealed roads	▪ Enforce 40 km/h truck speed limit when carrying covered load. ▪ Enforce 20 km/h truck speed limit when carrying uncovered load. ▪ Trucks with uncovered loads to be filled to maximum 300 mm below the freeboard.
Drilling and blasting	▪ All drill rigs will be fitted with dust suppression/filtration, which will be inspected before use to ensure they are fully operational.
Crushing	▪ Regular maintenance of water sprays.
Conveyor and transfer points	▪ Regular cleaning and collection of spilt material at transfer points. ▪ Adjust belt speed to optimum level to minimise material loss.
Stockpile management	▪ Continuous water spraying at stockpile stacking points.

17.4 Residual impacts

The dispersion modelling predictions show that the Project with the application of suitable dust mitigation and management strategies would not lead to any air quality levels above the relevant criteria at any privately-owned sensitive receivers.

The assessment of cumulative 24 hour average PM_{10} concentrations found that the Project, in conjunction with operations at the Peppertree Quarry, would not result in any additional days above the 24 hour average PM_{10} criterion at the privately owned sensitive receiver locations.

Boral owned receiver B4 is predicted to exceed the annual average PM_{10} criteria in Stage 1.

Chapter 18

Greenhouse gases

VOLUME 1

Greenhouse gases

Particulate matter, or dust, is the main air pollutant of concern from mining. Dust can be defined by the following sub-categories:

- total suspended particles (TSP), which comprises the total mass of all particles suspended in the air;
- particulate matter with an aerodynamic diameter of 10 µm or less (PM_{10});
- particulate matter with an aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$); and
- deposited dust, which is dust that has settled from the atmosphere onto surfaces.

Other air pollutants potentially associated with the Project are nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), which could be generated at the processing facilities, hydration plant and kiln.

Worst case pollutant generation scenarios over three of the mining stages were assessed (Stage 4 will have reduced operations and was not assessed) using emissions reduction factors, which assume the application of management measures.

The Project, in combination with other local emissions sources, will not result in exceedances of particulate matter and dust deposition criteria at any privately-owned sensitive receivers. The annual average PM_{10} criterion will be exceeded at a Boral owned receiver during Stage 1. Dust generated by the Project will not impact more than 25% of any privately owned property.

Stack emissions from the Project will be minimal and well below the criteria. When combined with background levels, cumulative levels will also be below the criteria.

Greenhouse gases will be generated by the following sources during construction and operation of the Project:

- fuel combustion by construction machinery and site vehicles;
- fuel combustion and electricity use during mining operations and lime production;
- lime production; and
- fuel combustion from transportation of the lime products off-site by road and rail.

The construction emissions of 14,179 tCO_2-e are substantially less than the operational emissions. Operational activities of the Project are estimated to generate 122,703 tCO_2-e per annum.

The Project's total construction GHG emissions of 14,179 tCO2-e (0.014179 $MtCO_2$-e) will equate to 0.095% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

The Project's annual operational GHG emissions of 122,703 tCO_2-e (0.122703 $MtCO_2$-e) will equate to 0.83% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

18 GREENHOUSE GASES

18.1 Introduction

Greenhouse gases (GHG) include carbon dioxide (CO_2), methane, nitrous oxide, sulphur hexafluoride, a hydroflurocarbon, a perfluorocarbon, or a prescribed gas (as defined under the NGER Act). These atmospheric gases contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. Although GHG occur naturally in the atmosphere, elevated levels of CO_2 and methane in particular have been observed in recent decades.

Australia produces around 1.8% of the total world GHG emissions, which is approximately 28 tonnes of CO_2 equivalent per person per year, making Australian among the highest emitters per capita in the world.

GHG emissions in NSW were reported to be 130.274 million tonnes in 2016, representing 24% of the Australian total GHG emissions of 532.971 million tonnes (Australian Greenhouse Emissions Information System).

GHG emissions are a growing concern for the wider community. GHG emissions are becoming more regulated in all industries and this is exemplified through more stringent requirements in development applications and in corporate reporting.

This chapter summarises the greenhouse gas emissions assessment which is in **Appendix Q** and quantifies the increase in GHG emitted as a result of the Project.

The SEARs require an assessment of the likely greenhouse gas impacts of the Project (**Table 18.1**).

Table 18.1: Greenhouse gas SEARs

Requirement	Section and appendix where addressed
▪ An assessment of the likely greenhouse gas impacts of the development, having regard to the EPA's requirements.	18.3, Appendix Q

18.1.1 Objectives and methodology

The objective of the GHG assessment is to estimate the CO_2 emissions associated with the construction and operation of the Project and identify actions to manage and minimise these emissions where feasible.

The GHG assessment calculates the emissions from each applicable Project source using factors and methods outlined in the National Greenhouse Accounts (NGA) Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2012), the GHG Protocol (World Business Council for Sustainable Development) and the BPIC/ICIP Project's Methodology Guidelines for the Materials and Building Products Life Cycle Inventory Database.

The scoping processes used within the GHG assessment for the operation of the mine are adapted from 'The Greenhouse Gas Protocol'. Under this protocol, the Project's direct and indirect emissions sources can be delineated into three 'scopes' (scope 1, scope 2 and scope 3) for GHG accounting and reporting purposes. This method of scoping helps to improve transparency and assists in setting emissions reduction objectives.

The GHG protocol definitions for each scope are described in further detail below.

Scope 1 (direct GHG emissions): direct emissions that occur from sources on-site. This would include emissions arising from the combustion of fuels in equipment (e.g. generators, vehicles, machinery, fugitive emissions etc.);

Scope 2 (electricity indirect GHG emissions): emissions which account for GHG emissions arising from the generation of purchased electricity consumed on-site. Scope 2 emissions are considered indirect as they occur at an off-site facility where electricity is generated; and

Scope 3 (other indirect GHG emissions): an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities on, but occur away from the site and are not under Boral's control.

The GHG assessment has been undertaken using the best available current and historical data. Assumptions have been made and outlined within the assessment where appropriate to maintain transparency.

Quantification of scope 1, 2 and 3 GHG emissions has been undertaken in relation to CO_2. The generation of other GHG is not anticipated for the Project.

18.2 Existing environment

As previously outlined in the *Marulan South Limestone Mine Air Quality Impact Assessment* (PAE Holmes, 2009), the mine currently emits approximately 0.13 - 0.15 metric tonnes of carbon dioxide equivalent ($MtCO_2$-e) per annum, contributing to approximately 0.09% of the then 2007 NSW GHG emissions.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released its fourth assessment report (AR4) on climate change. In 2013, the IPCC released its fifth assessment report (AR5), which states that annual global GHG emissions have continued to grow since AR4 and conclude that it is extremely likely that human influence has been the dominant cause of the observed warming since the mid 20th century'.

In Australia and NSW, there are a number of policies, guidelines and regulations, which have been developed to manage and reduce GHG emissions. These include the following:

- the Australian Government has committed to reduce its emissions by between 5 and 15 or 25% below 2000 levels by 2020. The 5% target is unconditional, whilst the up to 15% and 25% targets are conditional on the extent of international action. The Government has also committed to a long term emissions reduction target of 80% below 2000 levels by 2050;
- the NSW Department of Infrastructure, Planning and Natural Resources – Department of Energy, Utilities and Sustainability Guidelines for Energy and Greenhouse in EIA provides guidance on the consideration of energy and greenhouse issues when developing projects and when undertaking environmental impact assessment (EIA) under the EP&A Act; and
- the DoEE publishes National, State and Territory Greenhouse Gas Inventories annually. This provides an overview of the latest available estimates of GHG emissions for the Australian States and Territories based on a Kyoto accounting basis.

Table 18.2 outlines the best available emissions estimates for Australia for the economic sector relating to the Project.

Table 18.2: National emissions by economic sector in 1990, 2015 and 2016

ANZSIC Code	Industry Classification	Emissions ($MtCO_2$-e)			Change in Emissions (%)	
		1990	2015	2016	1990 - 2016	2015 - 2016
08 - 10	Metal ore and non-metallic	4.0	14.7	14.8	269.1	0.5

ANZSIC Code	Industry Classification	Emissions ($MtCO_2$-e)			Change in Emissions (%)	
		1990	2015	2016	1990 - 2016	2015 - 2016
	mineral mining and quarrying					

Source: Australian Greenhouse Emissions Information System

The Project contributes to the ‘Metal ore and non-metallic mineral mining and quarrying’ sector for construction and operational emissions.

As outlined further below, the quantity of GHG emissions from both the construction and operation of the Project are trivial compared to the national totals in this sector.

18.2.1 Construction based greenhouse gas inventory

The construction activities associated with the Project will include the transport of materials to and from site, decomposition of vegetation waste and the use of machinery and vehicles for preparation of the site and civil and construction works. These activities require the use of fuels and electricity, which will result in the release of associated GHG emissions.

Accurately quantifying emissions in the planning phase of the Project requires a number of assumptions to be made including distances travelled and hours of use for vehicles and machinery. Other factors which will affect GHG emissions during the construction phase include construction methods, timetable, sources of consumed materials and transport methods.

Emissions were calculated by estimating fuel use, electricity consumption and vegetation decomposition using available data. Emissions in tonnes of carbon dioxide equivalent (tCO_2-e) were calculated using factors and methods from the Australian Government National Greenhouse Accounts Methods and Factors Workbook. Specific assumptions made with regard to fuel use, electricity consumption, construction schedules, material quantities, material transport and waste decomposition are outlined in detail in Section 2.1 of the GHG assessment.

The total estimated emissions from construction activities associated with the Project is 14,179 tCO_2-e. This includes emissions associated with the following construction activities:

- vegetation clearing to prepare the site for construction;
- spreading of mulched vegetation;
- lost carbon sink due to land clearing;
- site office operations;
- Marulan Creek dam;
- Marulan South Road realignment;
- powerline relocation;
- road sales stockpile area; and
- stockpile reclaim area relocation.

The scope 1, 2 and 3 emissions associated with all fuel and electricity use during construction are outlined in **Table 18.3**.

Table 18.3: Summary of GHG emissions from Project construction activities

Construction Activity	Scope 1 Estimated Emissions (tCO_2-e)	Scope 1 Estimated Emissions (tCO_2-e)	Scope 2 Estimated Emissions (tCO_2-e)	Total Estimated Emissions (tCO_2-e)
Land clearing – low condition vegetation	175.17	-	12.88	188.05
Land clearing – moderate condition vegetation	1,832	-	135	1,967

Construction Activity	Scope 1 Estimated Emissions (tCO2-e)	Scope 1 Estimated Emissions (tCO_2-e)	Scope 2 Estimated Emissions (tCO_2-e)	Total Estimated Emissions (tCO_2-e)
Land clearing – access road realignment	70	-	5	75
Spreading mulched vegetation	6	-	-	6
Disturbed vegetation removal - lost carbon sink	11,240	-	-	11,240
Site office – site preparation	-	1	-	1
Marulan Creek dam – wall fill	139	-	10	149
Marulan Creek dam – rip rap	45.70	-	3.36	49.06
Marulan Creek dam - spillway excavation	41	-	3	44
Marulan Creek dam - spillway surface area (concrete)	55	-	4	59
Marulan South Road realignment - cut and fill	111	-	8	119
Marulan South Road realignment - road construction	196	-	14	210
Marulan South Road realignment - drainage construction	1	-	-	1
Road Sales Stockpile Area - weighbridge & wheel wash area construction	4.40	-	-	4.40
Stockpile Reclaim Area relocation - concrete footings	13.19	-	1	14.19
Stockpile Reclaim Area relocation - tunnel	5.49	-	-	5.49
Stockpile Reclaim Area relocation - crane	32.64	-	2	34.64
Stockpile Reclaim Area relocation - elevated work platform	-	2.65	-	2.65
Site office - construction	-	4.16	1	5.16
HV powerline relocation - concrete foundations	3.85	-	-	3.85
HV powerline relocation - stringing of cables	0.20	-	-	0.20
Total	**13,971.64**	**7.81**	**199.24**	**14,178.69**

It is evident that lost carbon sink from vegetation for disturbed land is estimated to be the most significant GHG emission contributor associated with the construction activities. Emissions from land clearing and the realignment of Marulan South Road are the next most significant emissions sources.

The National Greenhouse Accounts Methods and Factors workbook (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2012) also provides guidance on estimating scope 3 emissions associated with fuel and electricity use. Scope 3 emissions are the indirect emissions associated with fuel or electricity being used on-site. The scope 1, 2 and 3 emissions associated with all fuel and electricity use during construction are outlined in **Table 18.4**.

Table 18.4: Emissions associated with fuel and energy use in Project construction activities

Construction Activity	Electricity Consumption (kWh)	Diesel Consumption (L)	Scope 1 Estimated Emissions (tCO_2-e)	Scope 2 Estimated Emissions (tCO_2-e)	Scope 3 Estimated Emissions (tCO_2-e)
Site preparation	-	765,861	2,083.17	-	152.88
Vegetation removal - lost carbon sink	-	-	11,240	-	-
Construction	3,197	238,341	648.47	2.65	46.36
Site office	6,266	-	-	5.16	1
Total	**9,462**	**1,004,202**	**13,971.64**	**7.81**	**199.24**

18.2.2 Operational based greenhouse gas inventory

The total estimated emissions from the operation of the Project is 122,703 tCO_2-e.

The predominant source of emissions from continued operation of the mine are expected to be from electricity and fuel use. These emissions would be generated by the following activities:

- overburden removal;
- limestone mining;
- clay shale mining;
- hauling of limestone and clay shale to processing/stockpile facility;
- hauling of overburden to emplacements;
- limestone processing;
- kiln stone grade limestone processing;
- clay shale and white clay processing;
- water use; and
- transport of product to customers by rail and road (external to the Project site).

Specific assumptions used in calculating operational emissions of the Project are outlined in Section 3.2 of the GHG assessment.

The projected GHG emissions associated with the predicted consumption of electricity, fuel and other sources during operation of the Project are outlined in **Table 18.5**.

Table 18.5: Projected operational electricity and fuel use and GHG emissions

Operation Source	Annual Electricity Consumption (kWh)	Annual Fuel Consumption (L or GJ)	Scope 1 Estimated Emissions (tCO_2-e)	Scope 2 Estimated Emissions (tCO_2-e)	Scope 3 Estimated Emissions (tCO_2-e)
Electricity	19,011,934	-	-	15,780	2,281
Natural Gas (GJ)	-	664,979	34,180	-	9,443
Sub-bituminous coal	-	210	3,918	-	-

Operation Source	Annual Electricity Consumption (kWh)	Annual Fuel Consumption (L or GJ)	Scope 1 Estimated Emissions (tCO_2-e)	Scope 2 Estimated Emissions (tCO_2-e)	Scope 3 Estimated Emissions (tCO_2-e)
Diesel – Automotive (L)	-	2,697,000	7,336	-	539
Lime Production	-	-	49,226	-	-
Total	**19,011,934**	**N/R[1]**	**94,660**	**15,780**	**12,263**

[1]Not Relevant

It is evident that lime production is estimated to be the most significant source of emissions during the operation of the Project, followed by emissions from natural gas use and electricity use.

18.3 Potential impacts

Key sources of GHG emissions during construction and operation of the Project would include the following:

- fuel consumption by construction machinery and site vehicles;
- fuel and electricity consumption during mining operations and lime production;
- lime production; and
- fuel consumption from transportation of the lime products off-site by road and rail.

Table 18.6 compares the estimated emissions from the construction and operation of the Project.

Table 18.6: Overall emissions summary

Phase of Project	Scope 1 Estimated Emissions (tCO_2-e)	Scope 2 Estimated Emissions (tCO_2-e)	Scope 3 Estimated Emissions (tCO_2-e)	Total Estimated Emissions (tCO_2-e)
Construction	13,791.64	7.81	199.24	14,178.69
Operation	94,660	15,780	12,263	122,703

The construction emissions of 14,179 tCO_2-e are substantially less than the operational emissions. Operational activities of the Project are estimated to generate 122,703 tCO_2-e per annum. The Project construction emissions are therefore 11.6% of one year of operational GHG emissions.

The Project's total construction GHG emissions of 14,179 tCO_2-e (0.014179 $MtCO_2$-e) equates to 0.095% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

The Project's annual operational GHG emissions of 122,703 tCO_2-e (0.122703 $MtCO_2$-e) would equate to 0.83% of the national 'Metal ore and non-metallic mineral mining and quarrying' sector's 14.8 $MtCO_2$-e of annual GHG emissions.

The GHG assessment demonstrates that estimated construction and operational GHG emissions associated with the Project are negligible compared to the total GHG emissions from the national 'Metal ore and non-metallic mining and quarrying' sector.

As such, the increase in GHG emissions resulting from the Project will not substantially increase the total Australian GHG emissions.

It is important that any increase in total annual GHG emissions is minimised and that the emission metric per tonne of Boral product is kept constant or reduced. As such, irrespective of the small contribution to national GHG emissions, management strategies have been recommended in **Section 18.4** in order to assist in the reduction of GHG emissions generated by both construction and operation of the Project.

18.3.1 Cumulative Impacts

Other land uses within the vicinity of the mine include the adjacent Peppertree Quarry and other extractive and agricultural industries in the Marulan district. It is assumed that these operations would generate GHG emissions and also be subject to regulatory reporting requirements and implementation of management strategies as dictated in conditions of consent and other legislative requirements. As such, practices would be implemented at these nearby land uses to ensure a reduction of GHG emissions wherever feasible, thereby minimising the potential for cumulative impacts arising from operation of the mine, coupled with these similar industries.

18.4 Management and mitigation measures

The carbon management principles presented in Chapter 5 of the GHG assessment provide a robust framework for the management and reduction of GHG emissions.

Recommended actions to further reduce emissions should be prioritised according to the carbon management principles as follows:

- **avoid:** Actions which avoid emissions, in the first instance, should be considered as a priority;
- **reduce:** Actions which result in a reduction of emissions should be considered next;
- **switch:** Actions which switch energy sources to reduce emissions should be the next considered;
- **sequester:** Actions which sequester GHG emissions do not reduce emissions but store them; and
- **offset:** Offsetting of emissions through the purchase of offsets. This should be considered as a last resort.

The current mine management reduction strategy includes the following initiatives:

- a program to reduce idling time for haul trucks and mobile equipment through timer based automatic shut off of the engines;
- replacement of lighting throughout site with energy efficient lighting;
- efficiency improvements in fixed crushing equipment have reduced the operating hours from 96 per week to 62 over the course of the last four years;
- training programs for operators of heavy equipment, particularly front end loaders and haul trucks, to minimise movement of the equipment in the loading area in an attempt to reduce fuel consumption by between 5 - 11%, and improve loading times with the added benefit of idling time reduction; and
- full planned maintenance program for all plant, fixed and mobile to maintain a level of efficiency and serviceability.

Possible additional GHG management actions to be investigated by Boral would include:

- implementation of day/night sensors for lighting control;
- regular monitoring of emissions throughout the Project to assess the effectiveness of emissions mitigation actions;
- use locally sourced construction materials to reduce emissions associated with transport;
- recycle/compost waste wherever possible;
- plan construction and operational works to avoid double handling of materials and minimise haulage distances, thereby minimising the use of fuel;

- make use of recycled or low impact materials to reduce emissions associated with embodied energy (not estimated in the GHG assessment);
- investigate the procurement of energy efficient equipment for the site (e.g. office and floodlighting, front end loaders and trucks etc.). Consider the procurement of equipment that uses lower GHG intensive fuel (e.g. gas, ethanol);
- sourcing electricity and fuels with low GHG intensity, where practical;
- maximise efficiency of operations through logistical planning; and
- Incorporate energy efficiency design aspects into existing buildings wherever possible to reduce energy demand. Examples could include energy efficient lighting systems, natural ventilation, insulation and other renewable forms of energy.

It is recommended that any future GHG emission reduction initiatives implemented at the mine focus on lime production, natural gas consumption and electricity consumption in operations, as these are the largest GHG emission sources.

18.5 Residual impacts

Despite the inevitable generation of GHG emissions by the Project, implementing the proposed GHG management actions will assist in emission reductions in both the construction and operational phase, and are recommended to minimise GHG impacts from the continued operation of the mine.

Chapter 19

Noise and blasting

VOLUME 1

Noise and blasting

There will be vehicle and plant noise, and blasting noise and vibration, associated with the Project which could impact sensitive receivers. Two worst case scenarios were assessed using the Environmental Noise Model:

- all fixed and mobile equipment operating 24 hours a day including four haul trucks transporting limestone to the crusher and two haul trucks transporting overburden; and
- all fixed and mobile equipment operating 24 hours a day including six haul trucks transporting overburden.

Noise trigger levels were determined in accordance with the *Noise Policy for Industry* and noise impacts assessed to determine if there were residual impacts. The significance of residual impacts were rated as negligible, marginal, moderate and significant. Negligible impacts are a less than or equal to 2 dBA difference between the predicted noise and trigger level and significant impacts are a greater than 5 dBA difference.

'Modifying factors' were also determined for noise sources in accordance with the *Noise Policy for Industry* to determine if low frequency noise will be generated.

Maximum noise level events were also considered as these could interrupt sleep.

As there will be minor increase in traffic associated with the Project, traffic noise was assessed in accordance with RMS's *Road Noise Policy*. Two scenarios were assessed; the worst case of houses 75 m from the road and typical case of houses 180 m from the road.

Construction noise was assessed in accordance with the *Interim Construction Noise Guidelines*, which included derivation of noise management levels which apply to standard construction hours.

Operational and maximum noise levels will be below the noise trigger levels, and low frequency noise will be below thresholds, at all sensitive receivers during all mine stages and time periods. Therefore, there will be no residual operational noise impacts.

Noise from vehicles associated with the Project travelling on Marulan South Road will increase by 2 dBA during the day and 1 dBA during the night for both scenarios, which complies with the traffic noise criterion.

Construction noise will comply with criteria during standard construction hours at all sensitive receivers.

Predicted blast vibration and overpressure levels are below the human annoyance and discomfort, and building damage criteria, at all sensitive receivers. The vibration from blasting would be below the structural damage criterion at all non-mine-owned infrastructure, including the Jemena gas pipeline that supplies the mine with gas.

19 NOISE AND BLASTING

19.1 Introduction

The potential operational noise, blasting, construction noise and road traffic noise impacts of the Project have been identified and assessed. The noise and blasting assessment was completed by Wilkinson Murray and is in **Appendix R,** with the main findings of the assessment summarised in this chapter.

19.1.1 Assessment guidelines and requirements

The noise and blasting assessment directly addresses the SEARs (Table 19.1), which identify noise and blasting as a key issue.

Table 19.1: Noise and blasting related SEARs

Requirement	Section and appendix where addressed
▪ an assessment of the likely operational noise impacts of the development (including construction noise) under the NSW Industrial Noise Policy, including the obligations in chapters 8 and 9 of the policy, and having regard to the NSW Government's Voluntary Land Acquisition and Mitigation Policy: For State Significant Mining, Petroleum and Extractive Industry Developments	19.3, Appendix R
▪ if a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the Interim Construction Noise Guideline	19.2.3, 19.3.2, Appendix R
▪ an assessment of the likely road noise impacts of the development under the NSW Road Noise Policy	19.3.3, Appendix R
▪ an assessment of the likely rail noise impacts of the development under the Rail Infrastructure Noise Guideline	19.3.4, Appendix R
▪ an assessment of the likely blasting impacts of the development on people, livestock, buildings, infrastructure, and significant natural features, having regard to the relevant ANZECC guidelines.	19.3.5, Appendix R

Noise from ongoing operations, construction, blasting and traffic generation has been assessed against the current policies and guidelines including the Noise Policy for Industry (NSW Environment Protection Authority , 2017) (NPfI), which sets appropriate noise trigger levels for operational noise assessment. The NPfI replaced the NSW Industrial Noise Policy.

Key elements of the assessment approach are identified below:

- Noise trigger levels at surrounding residential receivers were derived from a review of all noise monitoring undertaken to date around the mine, as well as available data from the nearby Peppertree Quarry.
- Based on a review of meteorological data from the Peppertree Quarry weather station, noise was assessed under standard meteorological conditions as described in the NPfI.
- Noise modelling was done over the life of the mine based on the typical worst-case equipment locations at the start of Stage 1 and at the end of Stages 1 - 4.
- Noise source levels were based in part on extensive noise surveys at the mine.

19.1.2 Overview of assessment methods

Operational noise from the continued operation of the mine over 30 years has been predicted for each stage of the mine development using noise modelling software. The Environmental Noise Model (ENM) a proprietary computer program from RTA Technology Pty Ltd is recommended by the NPfI and has been previously accepted by the EPA for use in environmental noise assessments. The assessment models the total noise at each receiver from the operation of the Project. Total predicted operational noise levels are then compared with the Project noise trigger levels presented in **Section 19.2.3**.

The following two worst case operating scenarios were modelled at the start of the Stage 1 and at the end of Stages 1 – 4:

- All fixed and mobile equipment operating 24 hours including four (4) haul trucks transporting blasted limestone to the crusher and two (2) haul trucks transporting overburden material to the active overburden emplacement areas. This scenario is referred to as ‘4+2’; and
- All fixed and mobile equipment operating 24 hours including six (6) haul trucks transporting overburden material to the active overburden emplacement areas. This scenario is referred to as ‘6’.

A list of the fixed and mobile equipment used in the noise modelling and their associated sound power levels is presented in Table 8-1 of **Appendix R**. The location of all fixed and mobile equipment during each of the modelled stages is presented in Appendix D of **Appendix R**.

19.2 Existing environment

19.2.1 Sensitive receivers

Surrounding land uses include mining, grazing, rural properties, including an agricultural lime manufacturing facility, fireworks storage facility, turkey farm and rural residential. Seventeen residential receivers (including one proposed new private residence) were identified for assessment and are shown in Figure 2.9.

Boral were advised during consultation with the community that a new residential dwelling is proposed to the northwest of the mine site on the same property and to the west of C2 (see receiver identified as ‘PR’ in Figure 2.9).

Although this noise assessment has focused on existing noise-sensitive receivers surrounding the Project site, as the proposed residence will be located further away from the site than a number of other residences identified within this assessment, the potential impacts on this proposed residence can be assumed to have been fully assessed.

19.2.2 Background noise levels

The adopted rating background levels (RBL) used for assessment are shown in **Table 2.10**.

19.2.3 Assessment criteria

Noise trigger levels

Noise trigger levels were determined in accordance with the NPfI. In determining the Project noise trigger levels, a comparison has been made between the amenity and intrusiveness noise levels, and the lowest noise level was selected for each period (day, evening and night). Table 19.2 shows the adopted Project noise trigger levels.

Table 19.2: Project noise trigger levels

Receiver	$L_{Aeq, period}$ dB(A)		
	Daytime	Evening	Night
R1	40	39	38
R2	40	39	38
R3	40	39	38
R4	40	38	38
R5	40	38	38
R6	40	38	38
R7	40	38	38
R8	40	39	38
R9	40	39	38
R10	40	39	38
R11	40	39	38
R12	40	39	38
R13	40	36	35
R14	40	36	35
R15	40	36	35
R16	40	36	35
R17	40	36	35
Commercial	63	63	63

Residual noise significance

Residual noise is the predicted noise level minus the Project noise trigger level. The NPfI acknowledges the potential for residual noise impacts after reasonable and feasible mitigation has been applied and provides guidance as to the significance of these impacts as outlined in Table 19.3.

Table 19.3: Significance of residual noise impacts

Predicted noise level minus trigger level	Cumulative industrial noise level	Significance of residual noise level
<= 2 dBA	Not applicable	Negligible
>=3 but <=5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
>=3 but <=5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1dB	Moderate
>5 dBA	=< recommended amenity noise level	Moderate
>5 dBA	> recommended amenity noise level	Significant

The NPfI also gives examples of noise mitigation measures or noise treatments that can be applied to address residual noise impacts. The NPfI states that where the significance of the residual noise level is ‘negligible’, the exceedance would not be discernible by the average listener and therefore would not warrant receiver-based treatment or controls.

Maximum Noise Level Events

Noise sources of short duration and high level may cause disturbance to sleep if occurring during the night time. The approach recommended by the NPfI is to apply the following initial screening noise levels:

- $L_{Aeq,15min}$ 40 dBA or the prevailing RBL + 5 dB, whichever is the greater; and/or
- L_{AFmax} 52 dBA or the prevailing RBL + 15 dB, whichever is the greater.

Based on the RBL, the sleep disturbance screening levels for the Project are:

- $L_{Aeq,15min}$ 40 dBA; and
- L_{AFmax} 52 dBA.

Where the screening noise levels cannot be met, a detailed maximum noise level event assessment should be undertaken.

Low frequency noise

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, the noise may cause greater annoyance. The NPfI refers to these potentially annoying characteristics as 'modifying factors'. The NPfI recommends correction factors to be applied to the source noise level at the receiver before comparison with the criteria to account for the additional annoyance caused by these modifying factors.

The only relevant characteristic for noise from the mine is the potential for dominant low-frequency content.

The NPfI recommends investigating whether a modifying factor for low-frequency noise is applicable.

The adopted modifying factors for low frequency noise are explained in **Appendix R**.

Construction noise goals

The Interim Construction Noise Guidelines (ICNG) (NSW Department of Environment and Climate Change , 2009) recommends noise management levels (NMLs) to reduce the likelihood of noise impacts arising from construction activities. **Table 19.4** provides the Project construction NMLs based on the ICNG. There are five proposed construction activities required as a part of the Project, including the construction of vehicle access roads, realignment of Marulan South Road and HV powerlines, and the construction of stockpile areas.

The ICNG recommended standard construction hours are:

- 7am to 6pm Monday to Friday;
- 8am to 1pm Saturday; and
- No work on Sunday or public holidays.

Outside these hours, the NMLs are the same as the Project noise trigger levels.

Table 19.4: Construction noise management levels ($L_{Aeq,\ 15min}$ – dB(A))

Receiver	Standard hours	Outside Standard Hours		
	Daytime	Daytime	Evening	Night
R1	45	40	39	38
R2	45	40	39	38
R3	45	40	39	38
R4	45	40	38	38

Receiver	Standard hours	Outside Standard Hours		
	Daytime	Daytime	Evening	Night
R5	45	40	38	38
R6	45	40	38	38
R7	45	40	38	38
R8	45	40	39	38
R9	45	40	39	38
R10	45	40	39	38
R11	45	40	39	38
R12	45	40	39	38
R13	45	40	36	35
R14	45	40	36	35
R15	45	40	36	35
R16	45	40	36	35
R17	45	40	36	35
Commercial	75	75	75	75

Road traffic noise criteria

The NSW Road Noise Policy (RNP) (NSW Department of Environment, Climate Change and Water, 2011) sets out criteria for assessment of noise from vehicles on public roads. The applicable criteria for Marulan South Road are set out in Table 19.5.

Table 19.5: Traffic noise criteria

Road category	Type of Project / Land Use	Assessment Criteria – dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing arterial / sub-arterial roads generated by land use developments	$L_{Aeq15hr}$, 60 (external)	L_{Aeq9hr}, 55 (external)

The RNP also states that where predicted noise levels exceed the traffic noise criteria, an assessment of all feasible and reasonable mitigation options should be considered. The RNP states that an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person.

Rail noise criteria

The Rail Infrastructure Noise Guideline (RING) (NSW Environment Protection Authority, 2013) states that where a non-network rail line exclusively servicing one or more industrial sites extends beyond the boundary of the industrial premises, noise from this section of track should be assessed against the recommended acceptable L_{Aeq} noise level from industrial noise sources for the relevant receiver type and indicative noise amenity area, as shown in Table 2.1 of the INP (Table 2.2 of the NPfI) reproduced in Table 19.6.

Table 19.6: Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Noise Amenity Area	Time of Day	Acceptable L_{Aeq} Noise Level (dBA)
Residence	Rural	Day	50
		Evening	45

Type of Receiver	Noise Amenity Area	Time of Day	Acceptable L_{Aeq} Noise Level (dBA)
		Night	40

Blasting criteria

Annoyance and discomfort criteria

For assessment of annoyance due to blasting, the EPA (and most similar authorities in Australia) adopt (Australian and New Zealand Environment Council, 1990). The fundamental criteria are that at any residence or other sensitive location:

- the maximum overpressure due to blasting should not exceed 115 dBLin for more than 5% of blasts in any year, and should not exceed 120 dBLin for any blast; and
- The maximum peak particle ground velocity should not exceed 5 mm/sec for more than 5% of blasts in any year and should not exceed 10 mm/sec for any blast.

Additionally, the ANZEC guideline recommends a long-term regulatory target of 2mm/sec maximum peak particle ground velocity.

Structural damage criteria

At sufficiently high levels, blast overpressure may in itself cause structural damage to some building elements, such as windows. However, this occurs at peak overpressure levels of about 133dBLin and above, well in excess of criteria for annoyance.

For assessment of damage due to ground vibration, Australian Standard AS2187.2-1993 *Explosives – Storage, Transport and Use* contains an appendix specifying recommended levels for peak particle vibration velocity to protect typical buildings from damage. These are:

- Structures that may be particularly susceptible to ground vibration – 5 mm/sec;
- Houses and low-rise residential buildings; commercial buildings not included below – 10 mm/sec; and
- Commercial and industrial buildings or structures of reinforced concrete or steel construction – 25 mm/sec.

Blasting impacts on livestock

There are no generally accepted guidelines for the impact of blasting noise and vibration on livestock or other animals. The Noise and Blasting Assessment (Section 14.4), outlines the results of various studies into the effects of blasting on livestock. These studies suggest that the worst case human comfort vibration criterion of 5mm/s and the overpressure level of 125dBLin could be adopted for the purposes of assessing impacts of blasting on livestock.

19.3 Potential impacts

19.3.1 Operational noise

Predicted noise levels

The predicted daytime, evening and night noise levels from the proposed continuation of mining operations for each stage of the 30-year mine life are shown in Table 19.7, Table 19.8 and Table 19.9 respectively and presented on **Figure 19.1**.

Compliance with Project noise trigger levels is predicted at all receivers during all stages and during all time periods. As outlined in Section 9.4 of the Noise and Blasting Assessment, (NSW Government, 2014) does not apply to the Project.

Table 19.7: Predicted noise levels – Daytime ($L_{Aeq, 15min}$ – dB(A))

Receiver	Overburden removal, emplacement and limestone mining ('4+2')					Overburden removal and emplacement ('6')					Noise Trigger Level	Complies?
	Stage					Stage						
	1 Start	1 End	2	3	4	1 Start	1 End	2	3	4		
R1	17	16	17	16	16	18	18	17	17	16	40	Yes
R2	24	22	23	22	22	25	24	24	23	22	40	Yes
R3	29	24	26	26	24	29	26	27	27	24	40	Yes
R4	25	21	23	23	21	25	24	25	24	21	40	Yes
R5	26	22	25	24	22	27	27	27	27	21	40	Yes
R6	25	21	25	23	20	26	28	28	26	20	40	Yes
R7	29	24	29	28	24	30	31	31	30	24	40	Yes
R8	31	26	30	31	26	32	32	32	34	26	40	Yes
R9	30	27	32	29	26	33	36	34	32	26	40	Yes
R10	26	23	27	25	23	29	30	30	27	23	40	Yes
R11	27	24	27	23	22	31	30	30	26	22	40	Yes
R12	29	26	30	26	24	33	33	32	29	24	40	Yes
R13	23	23	23	23	23	24	23	23	23	22	40	Yes
R14	31	31	31	31	31	31	31	31	31	30	40	Yes
R15	31	31	32	31	31	32	32	32	32	31	40	Yes
R16	30	30	31	30	30	31	31	31	31	30	40	Yes
R17	29	29	29	29	29	29	30	30	29	29	40	Yes
C1	35	31	34	36	31	35	35	35	38	31	63	Yes
C2	30	26	31	29	26	32	34	33	31	25	63	Yes
C3	32	29	34	31	28	35	38	36	33	28	63	Yes

Table 19.8: Predicted noise levels – Evening ($L_{Aeq, 15min}$ – dB(A))

Receiver	Overburden removal, emplacement and limestone mining ('4+2')					Overburden removal and emplacement ('6')					Noise Trigger Level	Complies?
	Stage					Stage						
	1 Start	1 End	2	3	4	1 Start	1 End	2	3	4		
R1	18	17	18	17	17	19	18	18	17	17	39	Yes
R2	25	23	25	23	23	26	24	25	24	23	39	Yes
R3	30	26	30	27	26	31	27	28	28	26	39	Yes
R4	26	22	26	23	22	27	24	25	25	22	38	Yes
R5	28	23	28	26	23	29	27	28	28	23	38	Yes
R6	26	22	26	25	22	27	28	29	27	21	38	Yes
R7	30	25	30	29	25	31	31	32	31	25	38	Yes
R8	32	27	32	32	27	33	32	33	35	27	39	Yes
R9	31	28	31	30	27	34	36	35	33	27	39	Yes
R10	28	25	28	26	25	31	30	31	28	25	39	Yes
R11	28	25	28	25	24	32	30	31	27	24	39	Yes
R12	30	27	30	27	25	34	33	33	30	25	39	Yes
R13	24	24	24	24	24	25	25	25	25	24	36	Yes

Receiver	Overburden removal, emplacement and limestone mining ('4+2') Stage					Overburden removal and emplacement ('6') Stage					Noise Trigger Level	Complies?
	1 Start	1 End	2	3	4	1 Start	1 End	2	3	4		
R14	32	32	32	32	32	33	33	33	33	32	36	Yes
R15	33	33	33	33	32	33	33	33	33	32	36	Yes
R16	32	32	32	32	32	32	32	32	32	31	36	Yes
R17	30	30	30	30	30	30	30	30	30	30	36	Yes
C1	36	31	36	36	32	36	35	36	39	31	63	Yes
C2	31	27	31	30	27	33	34	34	32	26	63	Yes
C3	33	30	33	32	29	35	37	37	34	29	63	Yes

Table 19.9: Predicted noise levels – Night ($L_{Aeq,\ 15min}$ – dB(A))

Receiver	Overburden removal, emplacement and limestone mining ('4+2') Stage					Overburden removal and emplacement ('6') Stage					Noise Trigger Level	Complies?
	1 Start	1 End	2	3	4	1 Start	1 End	2	3	4		
R1	18	17	18	17	17	19	18	18	17	17	38	Yes
R2	25	23	25	23	23	26	24	25	24	23	38	Yes
R3	30	26	30	27	26	31	27	28	28	26	38	Yes
R4	26	22	26	23	22	27	24	25	25	22	38	Yes
R5	28	23	28	26	23	29	27	28	28	23	38	Yes
R6	26	22	26	25	22	27	28	29	27	21	38	Yes
R7	30	25	30	29	25	31	31	32	31	25	38	Yes
R8	32	27	32	32	27	33	32	33	35	27	38	Yes
R9	31	28	31	30	27	34	36	35	33	27	38	Yes
R10	28	25	28	26	25	31	30	31	28	25	38	Yes
R11	28	25	28	25	24	32	30	31	27	24	38	Yes
R12	30	27	30	27	25	34	33	33	30	25	38	Yes
R13	24	24	24	24	24	25	25	25	25	24	35	Yes
R14	32	32	32	32	32	33	33	33	33	32	35	Yes
R15	33	33	33	33	32	33	33	33	33	32	35	Yes
R16	32	32	32	32	32	32	32	32	32	31	35	Yes
R17	30	30	30	30	30	30	30	30	30	30	35	Yes
C1	36	31	36	36	32	36	35	36	39	31	63	Yes
C2	31	27	31	30	27	33	34	34	32	26	63	Yes
C3	33	30	33	32	29	35	37	37	34	29	63	Yes

Maximum noise level assessment

Noise is predicted to be less than the NPfI sleep disturbance screening level at all receivers for all stages of the mine operations. Therefore, the Project is not predicted to result in sleep disturbance at sensitive receivers.

The most potentially impacted receivers are Receiver 9 and Receiver 12, and the impact would arise when tipping occurs at the western extents of the Western Overburden Emplacement. The worst case for those two receivers would occur at the start of Stage 1 but would still be at least 3 dB(a) L_{AFmax} below the screening level.

Operational noise from Marulan Creek dam

During operation, the only equipment operating at the Marulan Creek dam would be a submersible pump. No noise emissions are expected from the submersible pump that would be perceptible at the closest receivers.

Low frequency noise

Predicted low-frequency noise levels are below the low-frequency noise threshold. The low-frequency noise assessment indicates that it is unlikely that any of the receivers surrounding the Project would be subject to low-frequency noise and therefore no modifying factor correction for low-frequency noise is warranted for the Project. Boral is committed to ameliorating any low frequency noise issues if they arise for the Project consistent with the most recent low frequency noise assessment process from the NPfI.

Figure 19.1
Predicted operational noise levels

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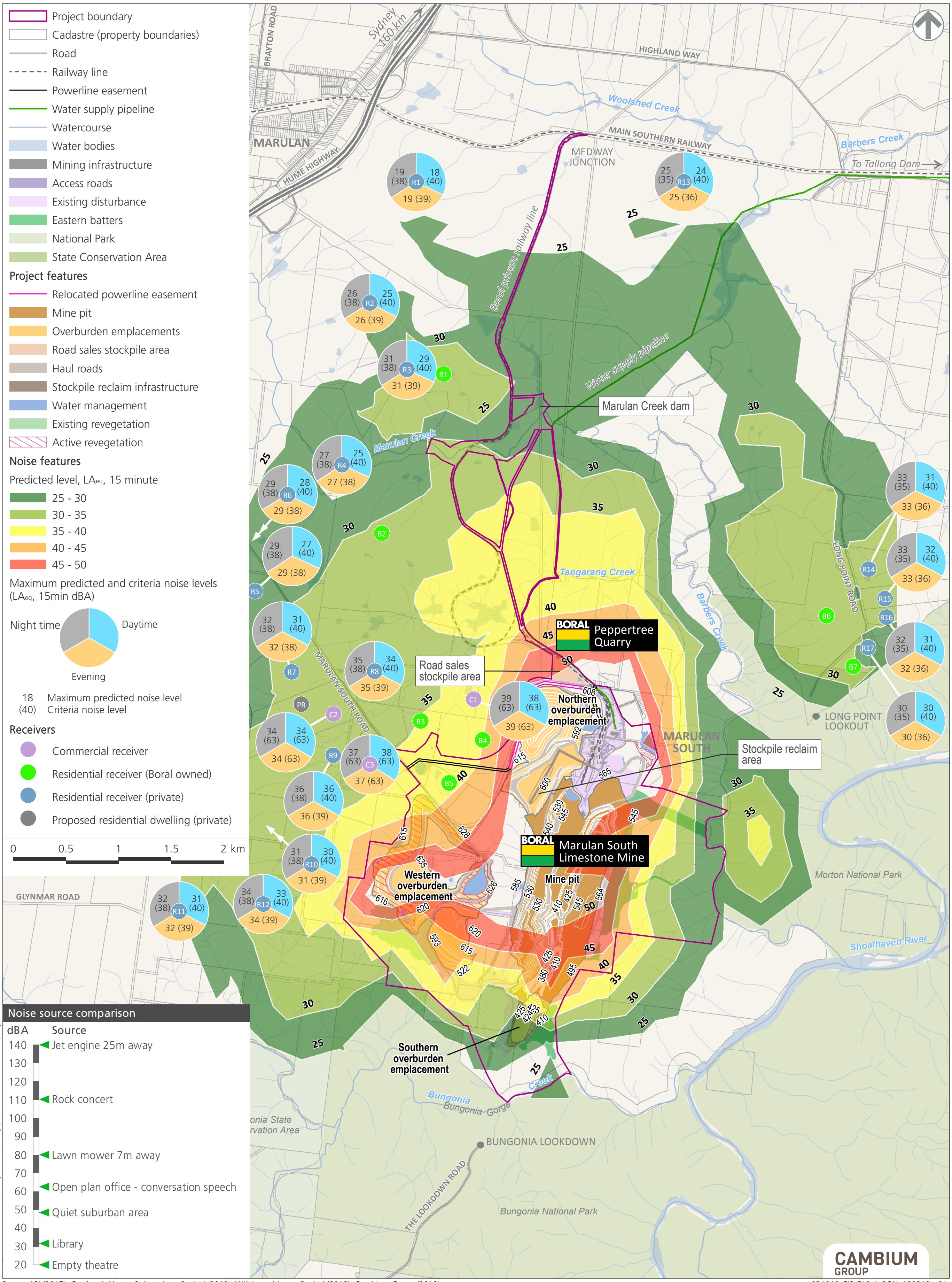

Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Wilkinson Murray Pty Ltd (2018), Cambium Group (2019).

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19.3.2 Construction noise

Five construction activities are proposed to support the continued operation of the mine, all of which will be conducted during recommended standard construction hours. These are:

- Marulan Creek dam and vehicle access tracks (Stage 1, 3 months).
- Relocation of the stockpile reclaim area (Stage 1, 3 months).
- Shared road sales stockpile area (Stage 1, 2 months).
- Marulan South Road realignment (Stage 1, 4 months).
- Relocation of the HV powerline (Stage 1, 4 months).

Further details of these construction activities are included in **Section 4.4** and Table 11-1 of the Noise and Blasting Assessment.

Noise emissions from these construction activities are predicted to comply with the relevant construction noise criteria during standard construction hours at all identified receivers as shown in Table 19.10.

Table 19.10: **Predicted construction noise levels ($L_{Aeq, 15min}$ – dB(A))**

Receiver	Marulan Creek dam	Marulan South Road realignment and relocation of the HV powerline	Road sales stockpile area earthworks	Stockpile reclaim area earthworks	Criterion	Complies?
R1	<25	<25	<25	<25	45	Yes
R2	26	28	<25	<25	45	Yes
R3	31	30	<25	<25	45	Yes
R4	<25	27	<25	<25	45	Yes
R5	25	35	<25	<25	45	Yes
R6	<25	29	<25	<25	45	Yes
R7	28	38	<25	<25	45	Yes
R8	31	43	<25	<25	45	Yes
R9	27	38	<25	<25	45	Yes
R10	<25	32	<25	<25	45	Yes
R11	<25	32	<25	<25	45	Yes
R12	<25	34	<25	<25	45	Yes
R13	<25	<25	<25	<25	45	Yes
R14	<25	26	<25	<25	45	Yes
R15	<25	26	<25	<25	45	Yes
R16	<25	26	<25	<25	45	Yes
R17	<25	27	<25	<25	45	Yes
C1	35	48	<25	<25	75	Yes
C2	27	44	<25	<25	75	Yes
C3	27	45	<25	<25	75	Yes

19.3.3 Road traffic noise

During operation of the mine there would be an increase in traffic volumes as outlined in detail in **Chapter 21**. As outlined in **Section 19.2.3**, road traffic noise is assessed against two operating periods, day (7am – 10-pm) and night (10pm – 7am). Existing and future day (15 hour) and night (9 hour) traffic volumes are provided in Table 19.11.

Table 19.11: **Existing and future weekday hourly traffic volumes – Marulan South Road**

		Light	Heavy	Total
Day 15 hour	Existing	29	11	40
	Future	29	17	46
Night 9 hour	Existing	12	2	13
	Future	12	3	15

Typically, residential houses are set well back (on average, approximately 180 m) from Marulan South Road while the nearest residential house to Marulan South Road between the mine and the Hume Highway is 75 m from the road. Traffic noise was therefore predicted at both the 'worst case' affected residence and the 'typical' affected residence. The results are provided in Table 19.12.

Table 19.12: **Predicted road traffic noise levels**

Location	Period	Predicted Level		Criterion	Complies?
		Existing	Future		
Worst Case (75 m from road)	Day $L_{Aeq,\ 15hr}$ dBA	51	53	55	Yes
	Night $L_{Aeq,\ 9hr}$ dBA	47	48	50	Yes
Typical (180 m from road)	Day $L_{Aeq,\ 15hr}$ dBA	47	49	55	Yes
	Night $L_{Aeq,\ 9hr}$ dBA	44	45	50	Yes

Traffic noise is predicted to increase during the day by up to 2 dBA and during the night by up to 1 dBA at both the worst affected and typical residence and will therefore comply with the traffic noise criterion at all receivers.

19.3.4 Rail noise

As outlined in **Section 4.4.3**, no changes are proposed to the existing rail infrastructure or to the maximum of six trains that depart the mine per day. Therefore, there will be no increase in rail noise associated with the Project.

The Noise and Blasting Assessment confirms that the rail noise from a combination of the mine (maximum of six) and Peppertree Quarry (maximum of four) trains using the Boral private rail line, is below the RING criteria for non-network rail lines during all time periods, as shown in **Table 19.13**.

Table 19.13: Estimated rail noise levels from Boral's private 'non-network' rail line

Receiver	Distance (m)	RING L_{Aeq} Noise Criteria (dB(A))		
		Day	Evening	Night
		50	45	40
R1	1250	23	22	22
R2	1220	23	22	22
R3	960	25	24	24
R13	1220	23	22	22
B2	800	27	26	26
B3	820	26	25	25
B5	1340	22	21	21
B6	2280	17	16	16

19.3.5 Blasting

The mine currently monitors its blasts near B5. Monitoring data between 2014 and 2018 indicates that no blast exceeded the 120dBLin maximum overpressure criterion and the 2mm/s long-term regulatory maximum peak particle ground velocity target. The 5% exceedance level for overpressure was 111dBLin which is below the 115dBLin criterion.

As the B5 location is significantly closer to the mine than the closest residential receiver it indicates historical compliance with the blasting criteria. The mine has not received any complaints due to blasting.

Predicted blast vibration and overpressure levels are well below the building damage criteria of 10 mm/s and 133 dB(Lin) respectively at all sensitive receivers.

Predicted blast vibration and overpressure levels are below the human annoyance and discomfort criteria of 2mm/s and 115 dB(Lin) respectively at all dwellings of sensitive receivers.

The highest predicted blast vibration level is 0.89 mm/s at R12 during Stage 2 (Year 7). The highest predicted overpressure level is 111 mm/s at R12 during Stage 2 (Year 7).

As the predicted vibration levels comply with the guidelines for human comfort (2mm/s) and the overpressure level of 125dBLin at the nearest grazing land, impacts on livestock are not expected.

The vibration from blasting would be below the structural damage criterion at all non-mine-owned infrastructure, including the Jemena gas pipeline that supplies the mine with gas.

19.4 Management and mitigation measures

The operations environment management plan will include noise and blast management and mitigation measures including:

- a noise compliance monitoring program which addresses compliance with trigger levels and measurement and assessment of maximum noise levels. The program will be based on attended noise monitoring which will measure $L_{A90,\ 15minutes}$ and $L_{AEQ15minute}$ noise levels. the noise contribution to measurements from the Project will be calculated and mitigation measures will be implemented if the trigger levels are exceeded;
- continued restriction of blasting to daylight hours and on weekdays, excluding public holidays;
- sounding warning sirens prior to blasting events;
- standard safe blasting procedures and additional procedures followed prior to any blasting event that may effect the public utilising the adjacent recreational reserves; and
- continuation and possible refinement of the existing blast monitoring program.

19.5 Residual impacts

Predicted noise emissions from the mine comply with the Project noise trigger levels at all receivers and during all operating periods (day, evening and night). Therefore, no specific noise management or mitigation measures are recommended over and above those already implemented at the mine.

Construction noise from the five main construction activities, road traffic noise from heavy vehicles travelling along Marulan South Road, rail noise from trains travelling along Boral's private rail line and overpressure and vibration levels from blasting in the pit, are all predicted to comply with relevant criteria.

Chapter 20

Visual

VOLUME 1

Visual

The Project will have low overall visual exposure to its visual catchment. Of the 24 assessed viewpoints, only two will have medium impacts and the remainder will have low impacts. The viewpoints with medium impacts are Bungonia Lookdown Lookout and near Long Point Lookout.

Views from the affected viewpoints will improve over time as overburden emplacements are rehabilitated. Bungonia Lookdown Lookout has the most significant views to the mine, which will substantially reduce by Year 30 when the Southern Overburden Emplacement (SOE) is complete and being rehabilitated.

20 VISUAL

20.1 Introduction

This chapter summarises the visual amenity technical study, which is in **Appendix S**. The nature, extent and significance of the potential visual impacts of the Project were considered with reference to the range of public and private places that could be affected.

20.1.1 Assessment guidelines and requirements

The visual impact assessment directly addresses the SEARs (Table 20.1), and relevant assessment recommendations from DRE and OEH, which identify visual considerations as a key issue.

Table 20.1: Visual related SEARs

Requirement	Section and appendix where addressed
Visual – including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to the temporary and permanent modification of the landscape during the various stages of the Project (overburden dumps, bunds, etc.), and minimising the lighting impacts of the development.	20.3, Appendix S

20.1.2 Method

The visual impact assessment used a systematic, explicit and comprehensive approach that aims to limit subjectivity. The approach is summarised below and in **Figure 20.1**, with key visual assessment terms explained in Table 20.2. The main components of the assessment method are:

- View analysis;
- Visual effects analysis;
- Visual impact evaluation; and
- Identification of mitigation measures and residual visual impacts.

The view analysis involved first developing an understanding of the regional and local visual context. The Project scale and visual arrangement was then considered, followed by three-dimensional modelling of terrain, simulation of views and a detailed field assessment which together allowed potential viewing locations and situations to be identified. The potential for views from 17 residential receivers and three commercial receivers were analysed using 3D graphics based on a digital terrain model. Twenty-five publicly accessible representative viewing places were also analysed and assessed. A sample of the large number of general viewing places assessed, which are representative of each relevant kind of viewing place, was adopted for detailed analysis (**Figure 20.2**). The potential visual catchment for the Project was identified during this stage. The view analysis concluded that:

- of the 17 residential receivers, 10 do not have any potential views of the Project from the dwellings. Of the remaining seven, with the exception of R7 (access to which could not be secured), the views were documented and compared to the views predicted by 3D modelling;
- receiver R8 has no potential view and Receivers R5 and R7 are unlikely to have a significant view of either the WOE or NOE following rehabilitation; and
- four remaining Residential Receivers (R10, R13, R14 and R15) have potential for a view of some part of the proposed WOE or NOE.

The visual effect analysis considered baseline factors (visual character, scenic quality, view place sensitivity, viewer sensitivity) and variable factors (view composition type, relative viewing level, viewing period, viewing distance, view loss or blocking effects) to draw conclusions as to the overall potential visual effect of the Project. As part of the visual effect analysis the likely visual effects of the Project on the most affected view were modelled and photorealistic photomontages were prepared.

The visual impact evaluation considered the significance of any visual impact associated with the visual effect at each viewing location. This was done by reference to the concepts of physical absorption capacity, visual compatibility and visual sensitivity, each of which addresses the acceptability of the visual effects and changes caused by the Project and how much weight ought to be given to them. An overall rating of visual impact was then determined.

Mitigation measures were then developed to address the potential visual impacts of the Project and any residual impacts were identified.

Figure 20.1
Visual impact assessment methodology flow chart

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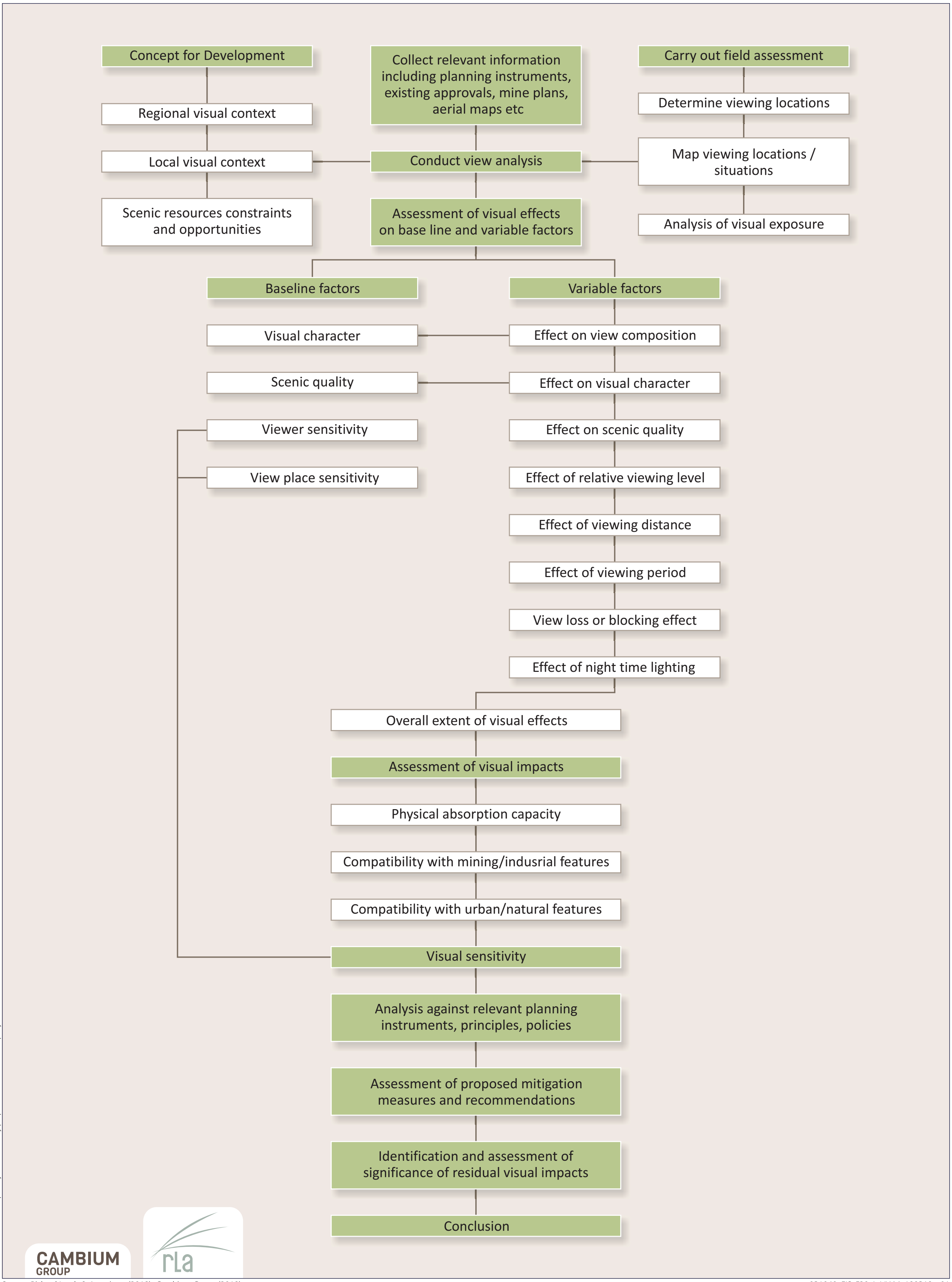

Source: Richard Lamb & Associates (2018), Cambium Group (2019).

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Table 20.2: Visual assessment terms

Term	Definition
Viewing location	Fixed place from which a view can be experienced. Viewing locations fall into two categories, a) public domain locations and b) private domain locations.
Viewing situation	The circumstance in which a view can be experienced. For example, a view from a road may be of single, or many different aspects of a view. It may also be fleeting but be experienced regularly by local users.
Visual catchment	The area within which there is enough detail including view of the surrounding visual context, for the proposed changes to the environment to be perceived as either positive or negative impacts.
Visual character	The setting in which the Project would be seen and includes topography, vegetation, natural systems, land use, settlement pattern, urban form, industrial and infrastructure elements.
Scenic quality	Considers scenic beauty, attractiveness, preference, or other criteria of landscape perception.
View place sensitivity	It is a measure of the public interest in the view as reflected by the relative number of viewers likely to experience the view, their expectations for the viewing experience and the public significance of the viewing location.
Viewer sensitivity	It is a measure of the private interests in the effects of the Project on views as reflected in the extent to which viewers, predominantly viewing from private residences, would perceive those effects.
View composition type	The organisation of the view (expansive, restricted, panoramic, focal or feature).
Relative viewing level	Location of the viewer in relative relief, compared to the location of the Project. Views are typically assessed from locations above, level with and below the relative location of the Project.
Viewing period	Time available for a viewer to experience the view.
Viewing distance	Distance between the viewer and the Project proposed. The greater the potential viewing distance, the lower the potential for a viewer to perceive and respond to the visual effects of the Project.
View loss/blocking	Measure of the extent to which the Project is responsible for view loss or blocking the visibility of items in the view.
Visual effect	Overall extent of visual effects for a viewing location considering baseline factors (visual character, scenic quality, view place sensitivity, viewer sensitivity) and variable factors (view composition type, relative viewing level, viewing period, viewing distance, view loss or blocking effects).
Physical absorption capacity	Ability of the landscape to hide, screen or disguise the Project.
Visual compatibility	Extent to which the Project can be constructed and used without the intrinsic scenic character of the locality being unacceptably changed. Visual compatibility with both industrial/mining features and rural/natural features was considered.

Figure 20.2
Viewpoint locations

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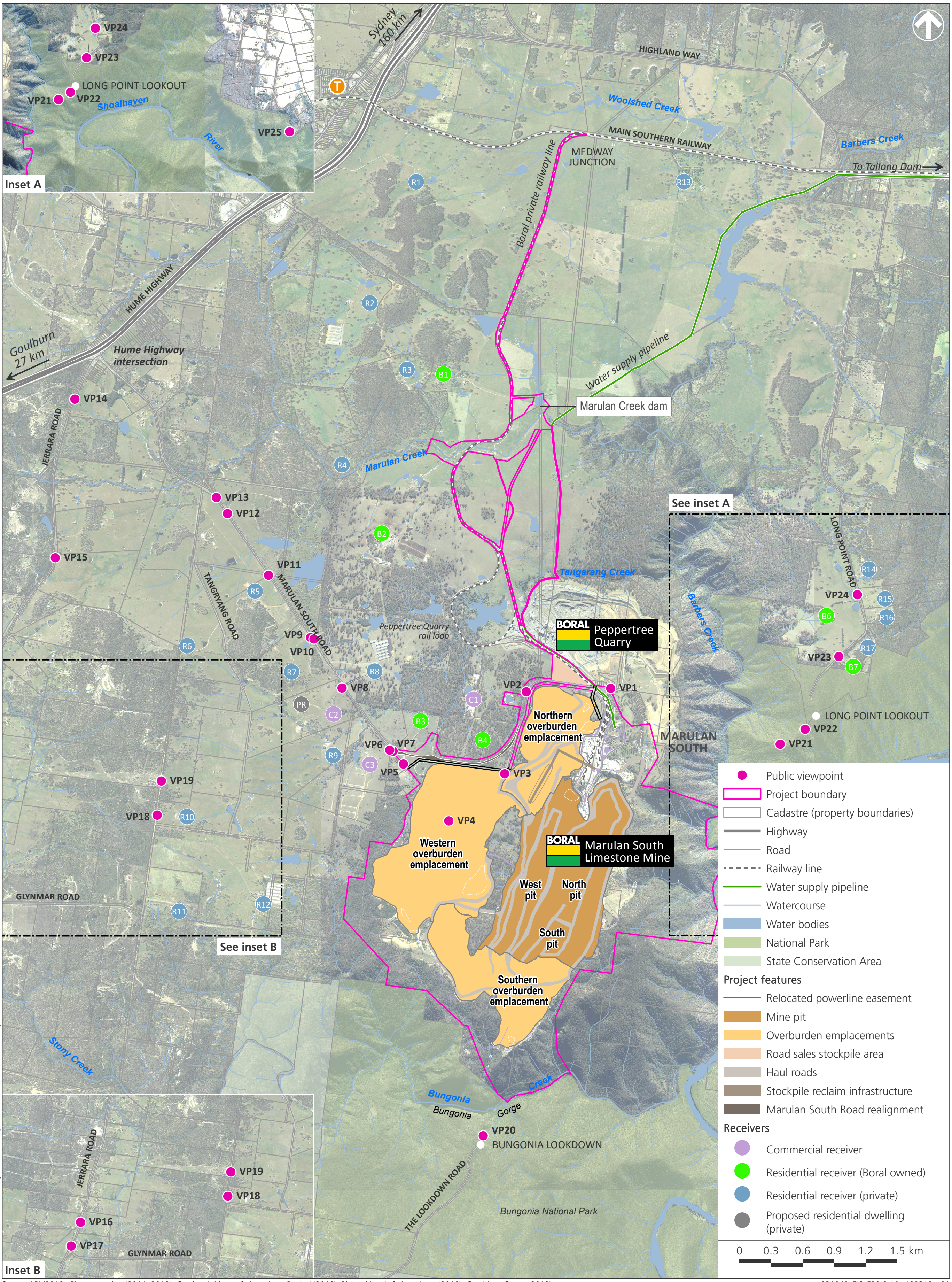

Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

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20.2 Existing environment

20.2.1 Regional and local visual context

The mine is situated on the edge of a dissected plateau, which is locally drained to the south and east by the Shoalhaven River and its tributaries, Bungonia and Barbers Creeks. Land use to the west and north is rural, while to the east and south, the landscape is dominated by the natural topography and vegetation of Morton NP, the Bungonia NP and the Bungonia SCA, respectively.

The mine is in a secluded area and not exposed to high intensity public domain features with large numbers of potential viewers such as main roads or urban areas. It is a significant distance (greater than 6 km) from the nearest highway (Hume Highway) and the nearest urban settlement (Marulan) and is not significantly exposed to either. The inundation area of the proposed Marulan Creek dam is not visible from publicly accessible places.

To the south and east the landscape is undeveloped and in a natural state in the Bungonia NP and SCA and Morton NP. In Bungonia NP directly south of the existing south pit and a minimum of approximately 900 m away, is the Bungonia Lookdown area and lookouts, from some of which the mine is visible.

The areas south-east and east of the existing pit are open to closed woodland above a sparse understorey on steep slopes of largely natural character. By contrast, the areas of native vegetation generally west of the existing pit are highly varied in appearance ranging from grassland with some emergent trees, to open woodland or open forest, above a shrubby, or grassy understorey. Pockets of land with a relatively natural appearance are interspersed among larger, disturbed or regenerating areas of vegetation. The most common vegetation form other than pasture in this area is grassy woodland, but with little visual consistency.

Due to the long history of using the resource, its shape and the constraints on expanding operations to the south and east, changes have occurred to the topography, form, line, colour and textures of the landscape that includes the Project site.

The Project site is of a very mixed visual character, but also contains little that is of original character. The adjacent rural land has also been significantly modified by historical processes of occupation, clearing, grazing and other land management practices.

20.2.2 Existing visual exposure

Visual exposure of the existing operations is low to the adjacent rural land to the south-west, west and north, where the greatest concentration of potential receivers exists, as the current operations are predominantly below the horizons of view. The site of the proposed Marulan Creek dam to the north of the Project site is not visible to publicly accessible viewing places.

Parts of the existing operations are of high exposure to medium to distant views from the east and south (part of the MCauleys Flat track south of the Long Point lookout (see **Plate 20.1**)), the Bungonia Lookdown area (see **Plate 20.2**) and parts of the Morton NP.

Plate 20.1: **View from a point west of the McCauleys Point track south of Long Point Lookout**

Plate 20.2: **The Bungonia Lookdown northern lookout, Bungonia NP**

20.2.3 Existing visual character, quality and sensitivity

Visual character

The landscape setting of the mine is within an area of intermediate character between the rural and semi-rural landscapes of the nearby tablelands to the west and north and the natural gorges and undeveloped landscapes of the Bungonia NP, SCA and Morton NP to the south and east.

The rural landscape is mainly cleared and of rolling topography but features some extensive areas of remnant vegetation on the plateau, steeper slopes and in drainage lines. The rural plateau landscape gives way to steep natural topography of the river valleys to the east and south. Remnant woodland and open grassland occurs most commonly on the plateau tops, whereas open and low open woodland, clothes the side slopes of Bungonia and Barbers Creeks and the Shoalhaven River gorge.

Between these two visually distinctive land systems sits the mine site. The pit and the processing area structures (beyond it to the north), dominate views to the north from the Bungonia Lookdown area but are less prominent in other lookout views such as the Adams lookout and adjacent tracks in the Bungonia NP and Badgerys lookout. Where these features of the mine are visible, the line, form, texture and colour of the pit, benches, roads and overburden emplacements if un-rehabilitated, significantly contrast with the natural and semi-natural adjacent landscape.

Scenic quality

The rural setting of the mine and its locality would typically be considered of moderate scenic quality. While it shows the presence in many views of slightly varied topography, managed landscape and vegetation, it does not contain significant water bodies, diversity, or areas of high scenic integrity (naturalness). It also exhibits factors which decrease scenic quality, such as cleared and unmanaged vegetation, lack of prominent topography and large-scale industrial structures.

Views of the unmodified landscapes from inside the natural reserves of Morton NP and Bungonia NP and SCA would typically be considered moderate-high in scenic quality, as they contain significant topographic variation, naturalness, complexity, diversity of forms and vegetation and some water bodies.

The visual quality of the mine site, in the context of its setting, which is composed of both moderate and moderate-high quality landscape, has been significantly degraded in the past and is at best of low to moderate scenic quality.

View place and viewer sensitivity

There are no public domain viewing locations with a clear view that are less than 500 m from the Project site and therefore no locations have a high view place sensitivity rating.

The view place sensitivity was rated as medium for locations between 500 and 3000 m from the Project site, with most viewing locations falling into this category. Viewing places close to or within the site (not public domain) (Viewpoints 1-6) were rated having low sensitivity. Two commercial locations were also considered to be low sensitivity while the Badgerys lookout (Viewpoint 25) and one residence in the distant class (Glenrock R13) were also categorised low sensitivity, being beyond 3000 m (at approximately 6 and 5 km distances, respectively).

There are no dwellings with a clear view that are less than 500 m from the Project site and therefore no dwellings have a high viewer sensitivity rating. Viewer sensitivity was rated medium for all dwellings between 500 m and 3000 m with all residential receivers other than Glenrock (R13 at a distance of 5 km) in this category.

20.3 Potential impacts

20.3.1 Visual exposure changes

In the medium range views from the east from isolated residences in the Long Point Road locality, the informal viewing places in the Morton NP accessed from the McCauleys Flat track, and the distant views from Badgerys lookout, there would be increased height and visual exposure of the emplacements west of the pit. While mining would occur deeper into the west faces of the pit which are partly visible from the east direction, the visible surface area of excavated faces would be similar to the existing. A minor change would occur in the mid-ground horizon of the view caused by increase in the height of the landscape caused by the WOE and NOE.

In the medium to long range views from the Bungonia Lookdown (VP20), where there has been high exposure of the operations for many years, the Project would be most exposed. There would be a direct view into the pit, exposing more of the northern floor and western walls and the setting of the processing area, which were not visible before the 'isthmus' (centre ridge) between the two former pits was removed. The increase in width of the pit proposed in the Project, toward the west, would also be evident, as would the increase in area occupied by overburden emplacements especially the closest; formed through the gradual backfilling of the former south pit by the eastern in-pit part of the SOE.

For a time, the increasing width of the pit would be evident in views from the Bungonia Lookdown and the areas proposed to be occupied by the parts of the WOE, SOE and NOE would also be visible. However, the SOE would, in Stage 3 and by the end of Stage 4, significantly decrease views into the pit as the surfaces of the overburden emplaced in the pit are sequentially rehabilitated. The SOE would gradually limit the view into the floor and of the extent of the pit to the north and would also block views of a significant part of the proposed increase in width of the pit toward the west.

20.3.2 Visual effects

The overall visual effects rating of the Project on its total visual catchment was assessed as low to medium. This is discussed below with reference to the following:

- Effect on view composition.
- Effect of relative viewing level.
- Effect of viewing period.
- Effect of viewing distance.
- View loss or blocking effects.
- Night time lighting.
- Cumulative effects.

The view from The Bungonia Lookdown (Viewpoint 20), was chosen as the viewing location that best illustrates the visual effects of the progress of the Project, as it is the only publicly accessible location that has views of each of the features and effects of the stages proposed. **Figure 20.3** to **Figure 20.11** illustrate the expected landform changes from existing to Stage 4 and the visual effect of revegetation from Stage 1 to the end of Stage 4.

Figure 20.3
Viewpoint 20 (Bungonia Lookdown): Existing view - Stage 0

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

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Figure 20.4
Viewpoint 20 (Bungonia Lookdown): Analytical landform photomontage - Stage 1

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ENVIRONMENTAL IMPACT STATEMENT

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-4_BLAS1_190319_v01

Figure 20.5
Viewpoint 20 (Bungonia Lookdown): Photomontage - Stage 1 revegetation

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

Figure 20.6

Viewpoint 20 (Bungonia Lookdown): Analytical landform photomontage - Stage 2

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-6_BLAS2_190319_v01

Figure 20.7
Viewpoint 20 (Bungonia Lookdown): Photomontage - Stage 2 revegetation

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

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-7_BLPS2_190319_v01

Figure 20.8
Viewpoint 20 (Bungonia Lookdown): Analytical landform photomontage - Stage 3

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

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-8_BLAS3_190319_v01

Figure 20.9

Viewpoint 20 (Bungonia Lookdown): Photomontage - Stage 3 revegetation

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION

ENVIRONMENTAL IMPACT STATEMENT

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-9_BLPS3_190319_v01

Figure 20.10
Viewpoint 20 (Bungonia Lookdown): Analytical landform photomontage - End of Stage 4

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-10_BLAS4_190319_v01

Figure 20.11

Viewpoint 20 (Bungonia Lookdown): Photomontage - End of Stage 4 + 5 years revegetation

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-11_BLPS4+5_190319_v01

Effect on view composition

The gradual changes in topography caused by construction of the overburden emplacements after Stage 1 would at the most have a low effect on view composition for almost the entire visual catchment. The exception would be for close views of the NOE in Stage 1 and the WOE in Stage 3 (**Figure 20.12** to **Figure 20.14**), which would affect the composition of views from a nearby short section of Marulan South Road. While the new topography would be higher than the existing landform, it would not become a feature element, block views of scenic items beyond, or dominate the view.

The effect on view composition would generally be low for views from the east, which are essentially confined to a short section of the McCauleys Flat track represented by viewpoint 21 and distant view from Badgerys lookout (viewpoint 25). The Project would be evident, but as it is mainly confined to activities on the west and south sides of the existing pit at distances of more than 2.5 km from the McCauleys Flat track and over 6 km from Badgerys lookout, the proposed change in topography would have a low effect on the existing view composition.

Effect of relative viewing level

The combination of rolling topography and large areas of vegetation means that there are very few locations which would provide significant viewing opportunities that are elevated above the surrounding countryside, or the Project site.

Two exceptions are the Bungonia Lookdown (viewpoint 20) and part of the McCauleys Flat track (viewpoint 21) which provide opportunities to view downward into and over parts of the Project site. The opportunity is more limited for the viewpoint 21, as the eastern batters and higher topography to the east of the pit prevent views into most of the pit and in particular, into the former south pit. Views from both these locations have an increased rating of medium for the extent of visual effects caused by viewing position.

Opportunities for views from below the landform proposed in the Project are confined to Marulan South Road between the proposed Marulan South Road realignment and the proposed terminus of the public road at the entrance to the agricultural lime manufacturing facility. The WOE and NOE would be visible from this section of road, which runs adjacent to a section of each emplacement. In this context, the effect of viewing level is increased for viewpoints 1, 2 and 6. Viewpoints 3, 4 and 5, which consider views on parts of the road before realignment, would be subsumed in the Project.

Figure 20.12
Viewpoint 6 (Marulan South Road): Existing - Stage 0

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

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-12_VP6ES0_190319_v01

Figure 20.13
Viewpoint 6 (Marulan South Road): Analytical landform photomontage - End of Stage 4

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

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-13_VP6AS4_190319_v01

Figure 20.14
Viewpoint 6 (Marulan South Road): Photomontage - End of Stage 4 + 5 years revegetation

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

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-14_VP6PS4+5_190319_v01

Effect of viewing period

The Project has very low overall exposure to views from dwellings, with only R10, R13, R14 and R15 potentially experiencing sustained views of some part of the final proposed landform of the Project, with views of part of the crest of the WOE and NOE (**Figure 20.15** to **Figure 20.23**). The rating for the potential effect of viewing period is therefore increased for these receivers.

The Project has very low exposure to public roads and no areas on roads from which there are sustained views. A fleeting and distant view is possible from viewpoints 14 and 15 on Jerrara Road, between areas of elevated topography and vegetation which otherwise block views. Views from Marulan South Road between viewpoints 7 and 13, where the road runs directly toward the centre of the Project site, are blocked in the foreground and middle distance by vegetation in the road reserve and on properties to the north-east and south-west.

Views of the Project, including the stanchions of the re-aligned high voltage powerline, would be largely confined to an area near the proposed realignment of the road to the east of its existing alignment. Views of the WOE and re-aligned power line would be possible over a short distance between this location and the entrance to receiver C1. The effect of viewing period is therefore only increased for views on this part of Marulan South Road.

Areas from which short term but sustained views are possible include viewpoint 20 (Bungonia Lookdown), Viewpoint 21 (McCauleys Flat track) and viewpoint 25 (Badgerys lookout). The effect of viewing period for views from lookouts and reserves is therefore increased for these public viewing places.

Effect of viewing distance

Except for viewing places in the last few hundred metres of Marulan South Road, no viewing places are in the close-range category and most are in the medium range category between 500-3000 m from the nearest part of the disturbance footprint of the Project.

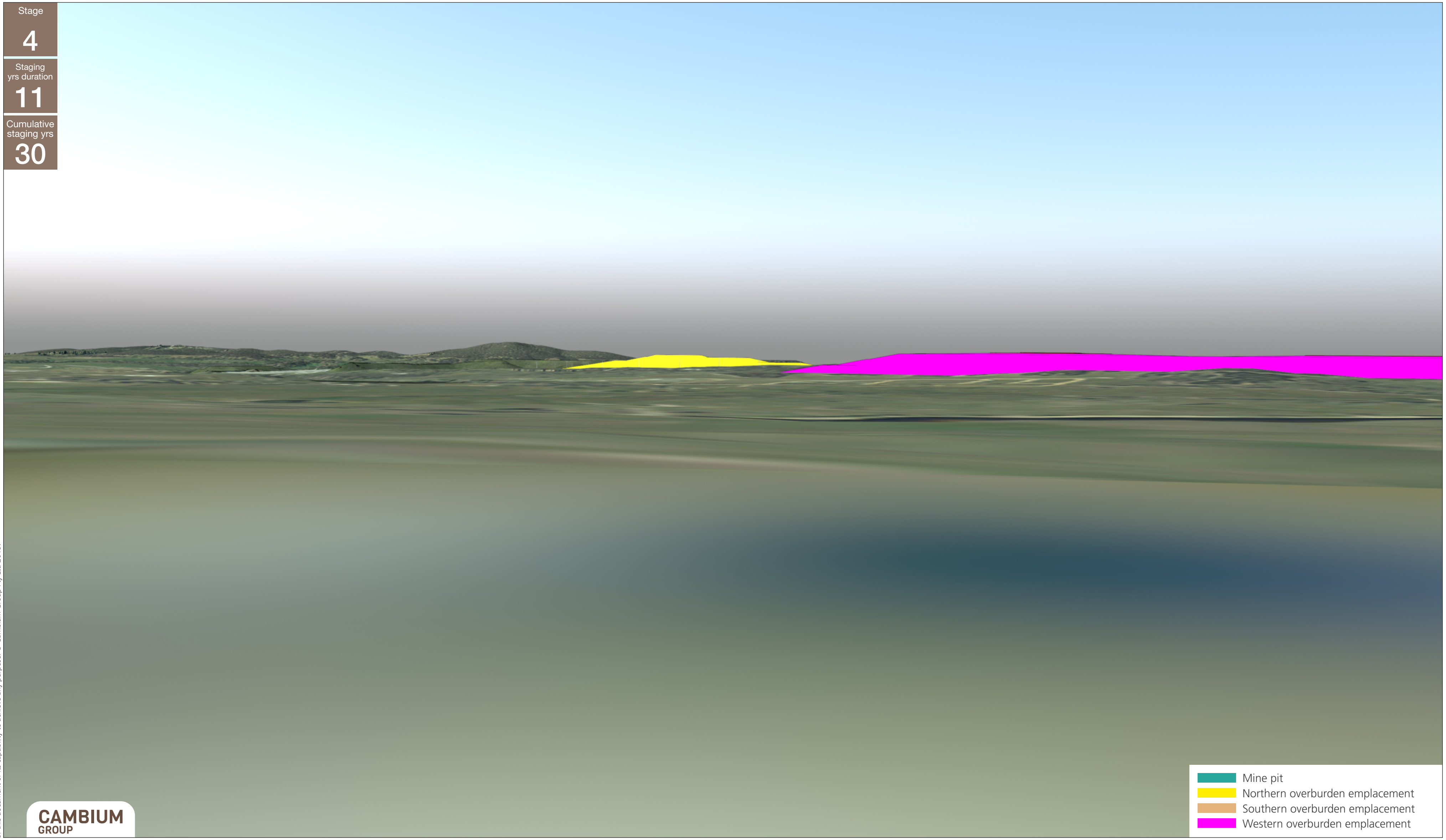
For residential receivers, the effect of viewing distance was not found to change the extent of visual effects.

Viewpoint 20 (Bungonia Lookdown) is the only viewing place that has views of those parts of the Project that span across two distance classes (medium to distant). It has views along the axis of the amalgamated pit extending from about 900 m from the nearest part of the rim of the south pit to about 3.8 m to the kilns of the processing area and medium distance views of the SOE.

Overall, viewing distance has either a neutral effect on the rating for the extent of visual effects or decreases it.

Figure 20.15
Viewpoint R10: Simulated terrain - End of Stage 4

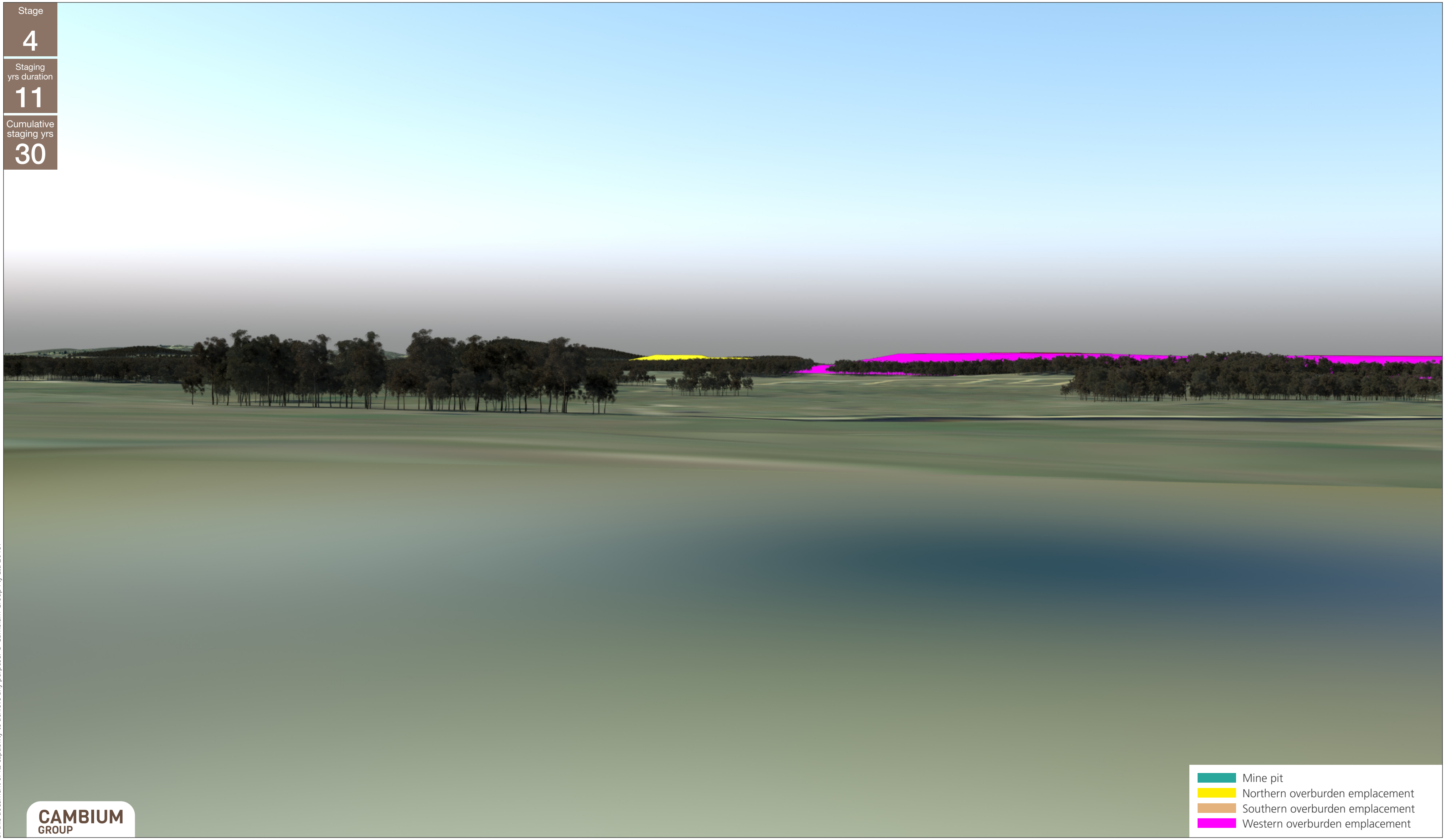
MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION
ENVIRONMENTAL IMPACT STATEMENT



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-15_R10TS4_190319_v01

Figure 20.16
Viewpoint R10: Simulated terrain with existing vegetation - End of Stage 4

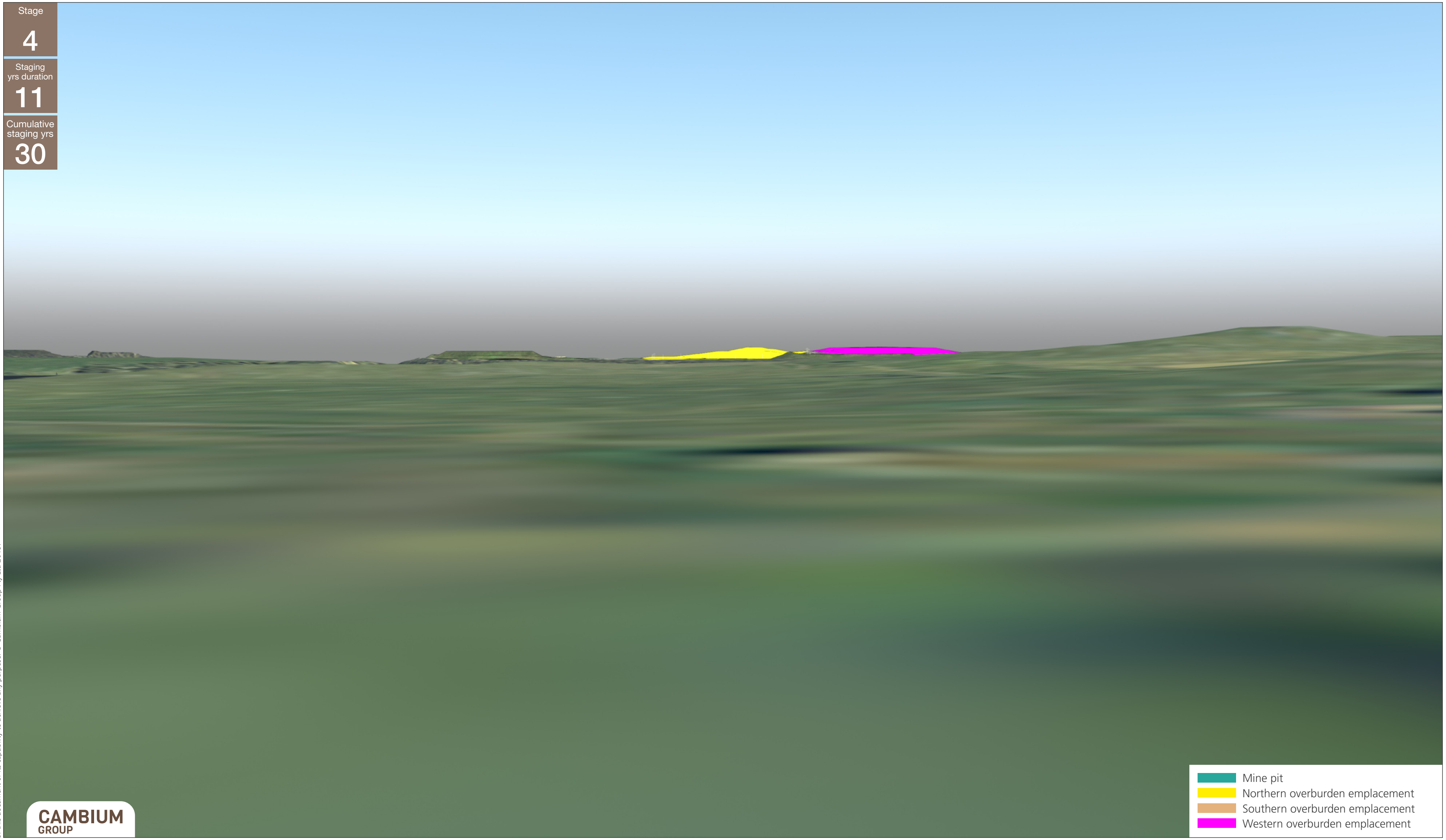


Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-16_R10VS4_190319_v01

Figure 20.17
Viewpoint R13: Simulated terrain - End of Stage 4

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



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

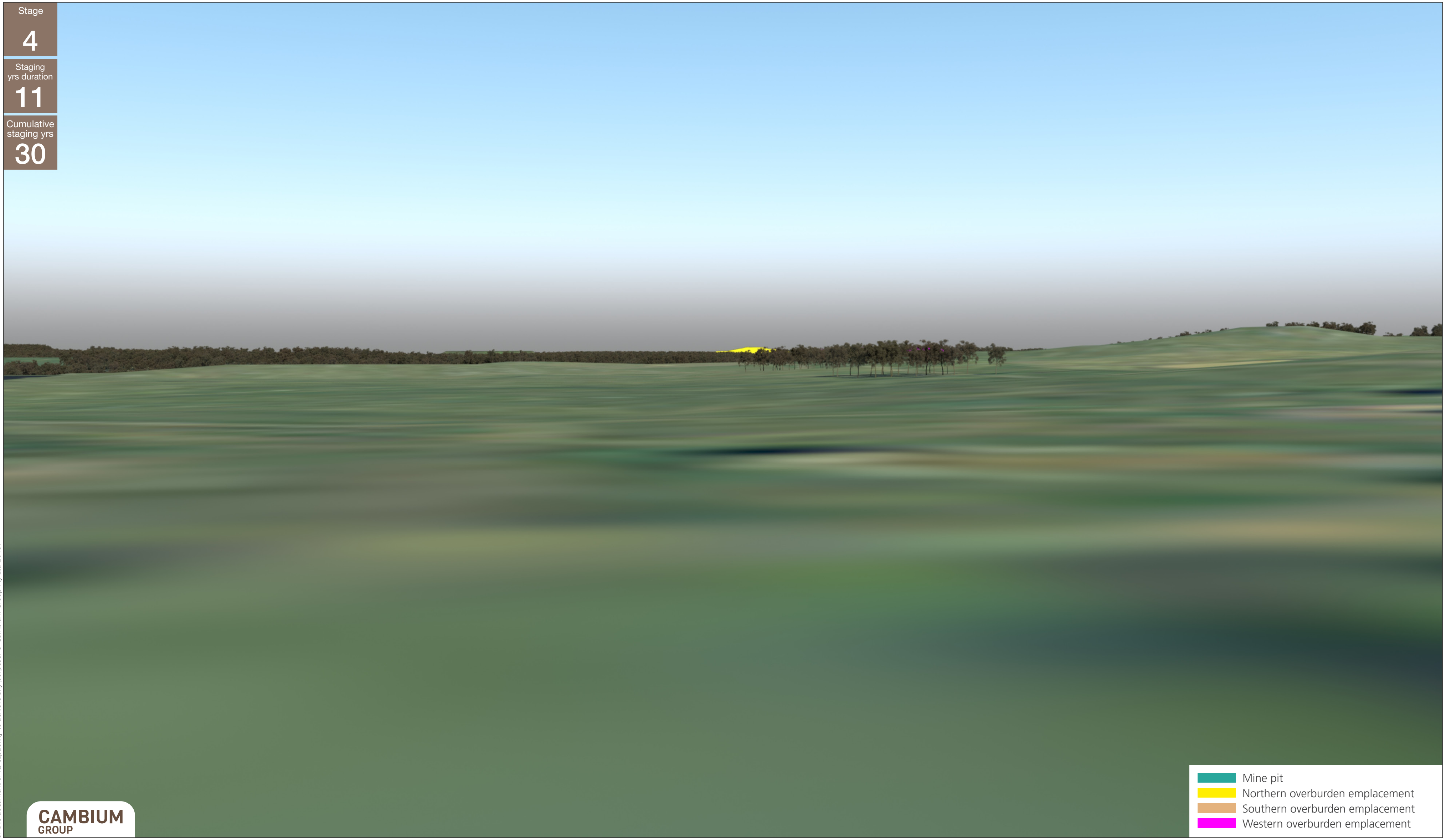
031040_EIS_F20-17_R13TS4_190319_v01

Figure 20.18

Viewpoint R13: Simulated terrain with existing vegetation - End of Stage 4

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION

ENVIRONMENTAL IMPACT STATEMENT



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

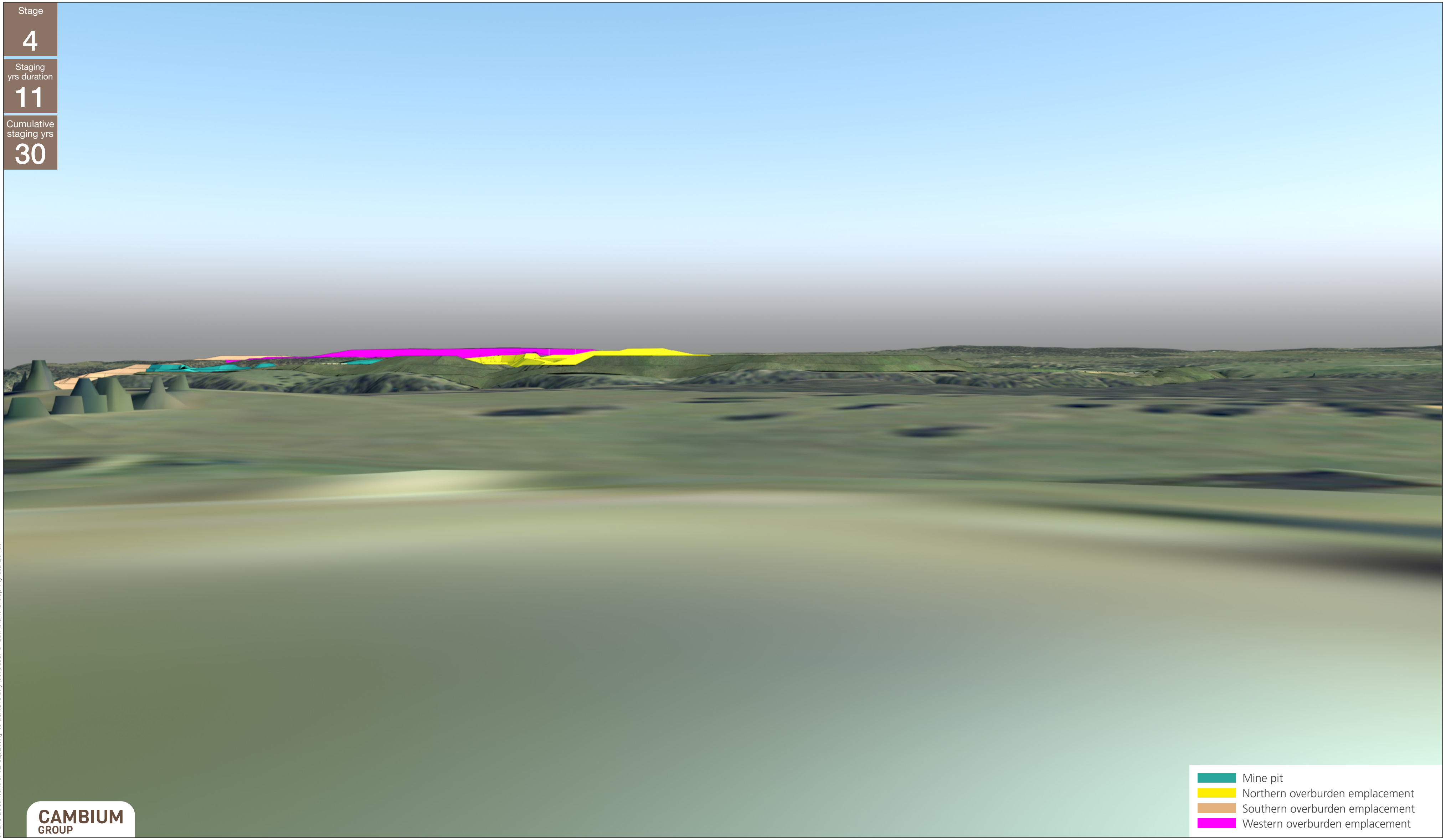
031040_EIS_F20-18_R13VS4_190319_v01

Figure 20.19

Viewpoint R14: Simulated terrain - End of Stage 4

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION

ENVIRONMENTAL IMPACT STATEMENT



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

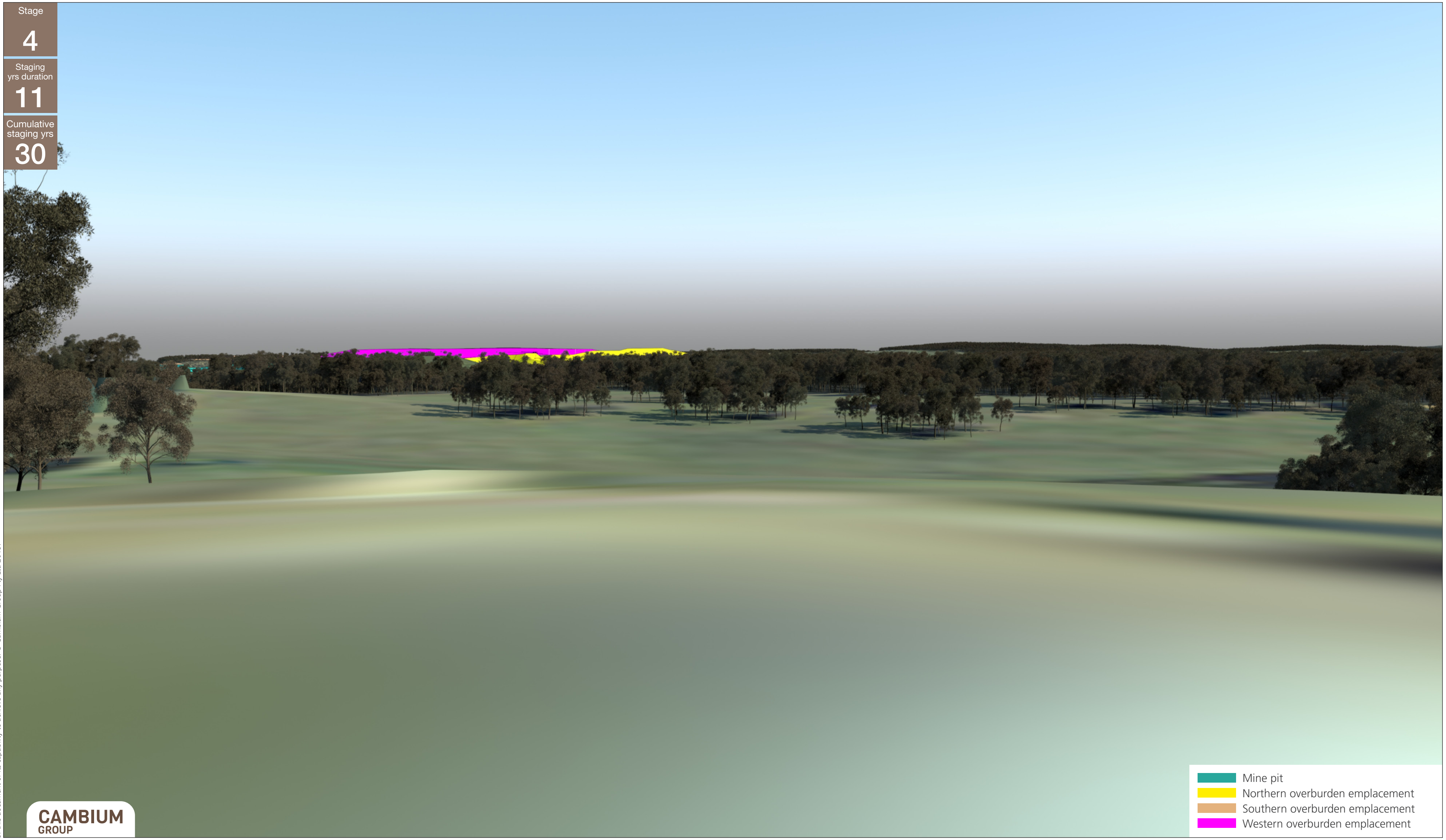
031040_EIS_F20-19_R14TS4_190319_v01

Figure 20.20

Viewpoint R14: Simulated terrain with existing vegetation - End of Stage 4

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION

ENVIRONMENTAL IMPACT STATEMENT



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-20_R14VS4_190319_v01

Figure 20.21
Viewpoint 15: Existing - Stage 0

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-21_V15ES0_190319_v01

Figure 20.22
Viewpoint 15: Analytical landform photomontage - End of Stage 4

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

Figure 20.23

Viewpoint 15: Photomontage - End of Stage 4 + 5 years revegetation

Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-23_V15PS4+5_190319_v01

View loss or blocking effects

As the Project has overall low visual exposure, proposed landform structures with a vertical component, such as the WOE, NOE and SOE, would not cause significant view loss or view blocking effects.

Some view blocking would occur for the views from viewpoint 20 (Bungonia Lookdown) and viewpoint 21 (McCauleys Flat track). For the Bungonia Lookdown, view blocking would occur as the SOE gradually blocks the existing views into the south pit and along its extent toward the north (see **Figure 20.24** to **Figure 20.27**). The WOE would be largely out of view as vegetation used in rehabilitation would screen the crest of the emplacement before the final lifts are completed.

Ultimately, the view blocking effects on views from the Bungonia Lookdown (viewpoint 20) would be beneficial as they would reduce the visual exposure of the disturbance footprint of the Project.

There would be minor blocking effects on existing views seen from viewpoint 21. Higher topography to the east of the existing pit and the eastern batters block views into the floor of the pit and the southern parts of the pit. The faces of part of the western wall of the pit are visible and therefore the extension of mining toward the west would be partly visible, however this would not cause any loss of views. The WOE and NOE would be partly visible but would not rise sufficiently above the existing topography to cause significant view loss to landscape beyond. No specific scenic items are visible that would be blocked by the increased height of the topography that is proposed.

Night time lighting

Existing general and security lighting would remain largely unchanged and would continue to have the same or similar visual effects.

The minor changes in visibility or topography of the proposed overburden emplacements are unlikely to cause any significant increase in visibility or effects of night time lighting.

The proposed Marulan South Road realignment is likely to slightly reduce the exposure of adjacent receivers to light from trucks using the road at night..

Cumulative effects

There is potential for some cumulative effects between the Project and further extraction and overburden emplacement associated with the adjacent Peppertree Quarry.

Both the Project and the proposed Modification 5 to the Peppertree Quarry development consent involve the NOE (referred to as the south-western overburden emplacement in Peppertree Quarry Modification 5), which is proposed to be completed and rehabilitated by the end of Stage 1 of the Project, and is also of low visibility from the visual catchment of both the mine and Peppertree Quarry. Therefore, the potential for cumulative impacts is limited.

Additionally, the effects of the two operations on each other would be largely neutral or positive for the Project, in that the approved overburden emplacements in the Peppertree Quarry would either have no effect or would add screening. This is illustrated by the SOE, approved under Modification 4 to the Peppertree Quarry development consent, which would screen the Projects proposed NOE in views from the Long Point Road area, R14 and R15 and from viewpoint 21. It would also likely screen the last lifts of the WOE, proposed to be constructed in Stage 3 of the Project, from views from the same direction.

20.3.3 Visual impacts

The overall visual impact rating of the Project on its total visual catchment has been assessed as low, with medium impacts on viewpoint 20 (Bungonia Lookdown) and viewpoint 21 (McCauleys Flat track). No residential receivers would be exposed to a medium visual impact or greater. **Table 20.3** shows the overall visual impact ratings for each viewpoint and receivers.

Table 20.3: **Overall visual impact ratings**

Receiver	Direct visibility?	Distance class	Visual effect	Physical absorption capacity	Compatibility (mining / industrial)	Compatibility (rural / natural)	Sensitivity	Visual impact
VP1	Y	Close	Low	High	High	High	Low	Low
VP2	Y	Close	Medium	High	High	Medium	Low	Low
VP3	Y	Close	Medium	High	High	Medium	Low	Low
VP4	Y	Close	Medium	High	High	Medium	Low	Low
VP5	Y	Close	Medium	High	High	Low	Low	Low
VP6	Y	Close	Low-medium	High	High	Medium	Low	Low
VP7	Y	Close	Low	High	High	Medium	Medium	Low
VP8	N	Medium	Low	High	High	High	Medium	Low
VP9	N	Medium	Low	High	High	High	Medium	Low
VP10	N	Medium	Low	High	High	High	Medium	Low
VP11	N	Medium	Low	High	High	High	Medium	Low
VP12	N	Medium	Low	High	High	High	Medium	Low
VP13	N	Medium	Low	High	High	High	Medium	Low
VP14	Y	Distant	Low	High	High	Medium	Low	Low
VP15	Y	Distant	Low	High	High	Medium	Low	Low
VP16	N	Distant	Negligible	High	High	High	Low	Low
VP17	N	Distant	Negligible	High	High	High	Low	Low
VP18	Y	Medium	Low	High	High	High	Medium	Low

Receiver	Direct visibility?	Distance class	Visual effect	Physical absorption capacity	Compatibility (mining / industrial)	Compatibility (rural / natural)	Sensitivity	Visual impact
VP19	Y	Medium	Negligible	High	High	High	Medium	Low
VP20	Y	Medium	Medium	Low	High	Medium	Medium	Medium
VP21	Y	Medium	Medium	Medium	High	Medium	Medium	Medium
VP22	N	Medium	Negligible	High	High	High	Medium	Low
VP23	N	Medium	Negligible	High	High	High	Medium	Low
VP24	N	Medium	Low	High	High	High	Medium	Low
VP25	Y	Distant	Low	High	High	Medium	Low	Low
R5	N	Medium	Low-medium	High	High	Medium	Medium	Low
R8	N	Medium	Low	High	High	High	Medium	Low
R10	Y	Medium	Low	High	High	Medium	Medium	Low
R13	Y	Distant	Low	High	High	Medium	Low	Low
R14	Y	Medium	Low	High	High	Medium	Medium	Low
R15	Y	Medium	Low	High	High	Medium	Medium	Low
C2	N	Medium	Low	High	High	Medium	Medium	Low
C3	N	Close	Low	High	High	Medium	Low	Low

Physical absorption capacity

The physical absorption capacity for the Project would be high for most of the visual catchment, the exceptions being viewpoint 20 and viewpoint 21. Of these, the view from viewpoint 20 (Bungonia Lookdown) would experience an initial low absorption capacity for the SOE and expansion of the existing pit to the west and north-west, increasing throughout the life of the Project as the SOE gradually obscures views into the pit. There would be high absorption capacity throughout the Project for the WOE and the NOE as seen from viewpoint 20 and this would be reinforced by proposed rehabilitation planting.

From viewpoint 21 (McCauleys Flat track), there would be medium absorption capacity for mining of the upper benches on the west side of the pit and for the WOE and NOE, as a significant part of both would be hidden by existing and emerging topography associated with approved overburden emplacements of Peppertree Quarry. As mine staging progresses, absorption capacity would generally increase.

Visual compatibility

The visual compatibility of the Project with mining/industrial features would be high for all viewing locations.

The Project would have low visibility from the adjacent rural landscapes, the exception being part of the WOE, visible from a short section of Marulan South Road and the re-aligned high voltage powerline nearby. The intended natural, grassed, woodland character of the rehabilitated emplacements would be compatible with the adjacent rural landscape. The powerline when re-aligned would also be compatible with the rural landscape, as it would have a similar appearance to the existing powerline.

The natural features of the adjacent landscape are of overall moderate quality in the area proposed for the expansion of the disturbance footprint. The Project is therefore of higher visual compatibility with those features than would be the case if the disturbance footprint was proposed to expand to the south and east. As a result of a more rigorous standard of rehabilitation in the Project compared to historical precedents, the visual compatibility for rehabilitation of overburden emplacements, where they are visible, would be medium, rather than medium to low, as in the past.

Visual sensitivity

The medium to low sensitivity zone applies to most viewing places assessed. Impacts on different visual sensitivity zones did not significantly change the ratings for overall visual impacts.

20.4 Management and mitigation measures

This part of the assessment considers whether the proposed mine plan design and environmental controls will satisfactorily mitigate visual impacts and provides specific management and mitigation recommendations.

20.4.1 Proposed landform

Assessment of proposed mitigation measures

Notwithstanding the low overall visibility of the final proposed landform to most of the visual catchment, the compatibility of the constructed landforms in the Project to existing and future landform has been carefully considered in regard to mitigation of visual impacts.

Two features of the Project are somewhat different from the existing environment, i.e. the location and scale of the proposed out-of-pit overburden emplacements. In most of the visual catchment, the visual character of the overburden emplacements is not a significant constraint and will not cause significant visual impacts. However, in views from the natural settings in the Bungonia Lookdown and McCauleys Flat track areas (VP20 and VP21), the visual effects of the overburden emplacements will be evident to varying degrees as a result of initial contrasts with colour, line, form and texture of the existing environment. While these changes will be seen in the context of a long history of change, which includes similar features, it is acknowledged that the current community is likely to expect a higher standard of visual impacts mitigation of permanent change to the environment. The proposed standard of rehabilitation in the Project will be substantially higher than has been demonstrated in the past, returning overburden emplacements to a woodland appearance compatible with natural landscape.

The final landforms proposed for the overburden emplacements have a significant benefit by comparison to the historical precedents of parts of the eastern batters, being primarily constructed on relatively flat land, or alternatively (e.g. the SOE), being primarily constructed on an existing concave base.

In addition, the proposed overburden emplacement landforms are compatible with the existing post-mining and natural topography, to the extent that is reasonably possible. The embankments of the overburden emplacements are compatible with the gradients of natural precedents in the vicinity and there is opportunity for minor variations in the topography of the embankments so as to prove a natural appearance, as set out in **Appendix I**. In other words, much thought has gone into designing the overburden emplacements to fit in with the existing landscape in which they are proposed e.g. the WOE is broad and has a more level top as it is on the flat plateau part of the existing landscape, while the SOE is more contoured with elevated ridges that mimic the transitional landscape between the flatter plateau and the Bungonia Creek gorge.

All the proposed new landform features in the Project will be subject to progressive rehabilitation as described in **Section 4.5** to achieve the final landform described in **Section 4.9** and the rehabilitation objectives outlined in **Section 26.1.2**.

Achieving these objectives will create appropriate landforms with vegetation that is compatible with existing natural environments and of an appropriate standard with regard to mitigation of the visual impacts of the proposed new landforms of the Project.

Recommended mitigation measures

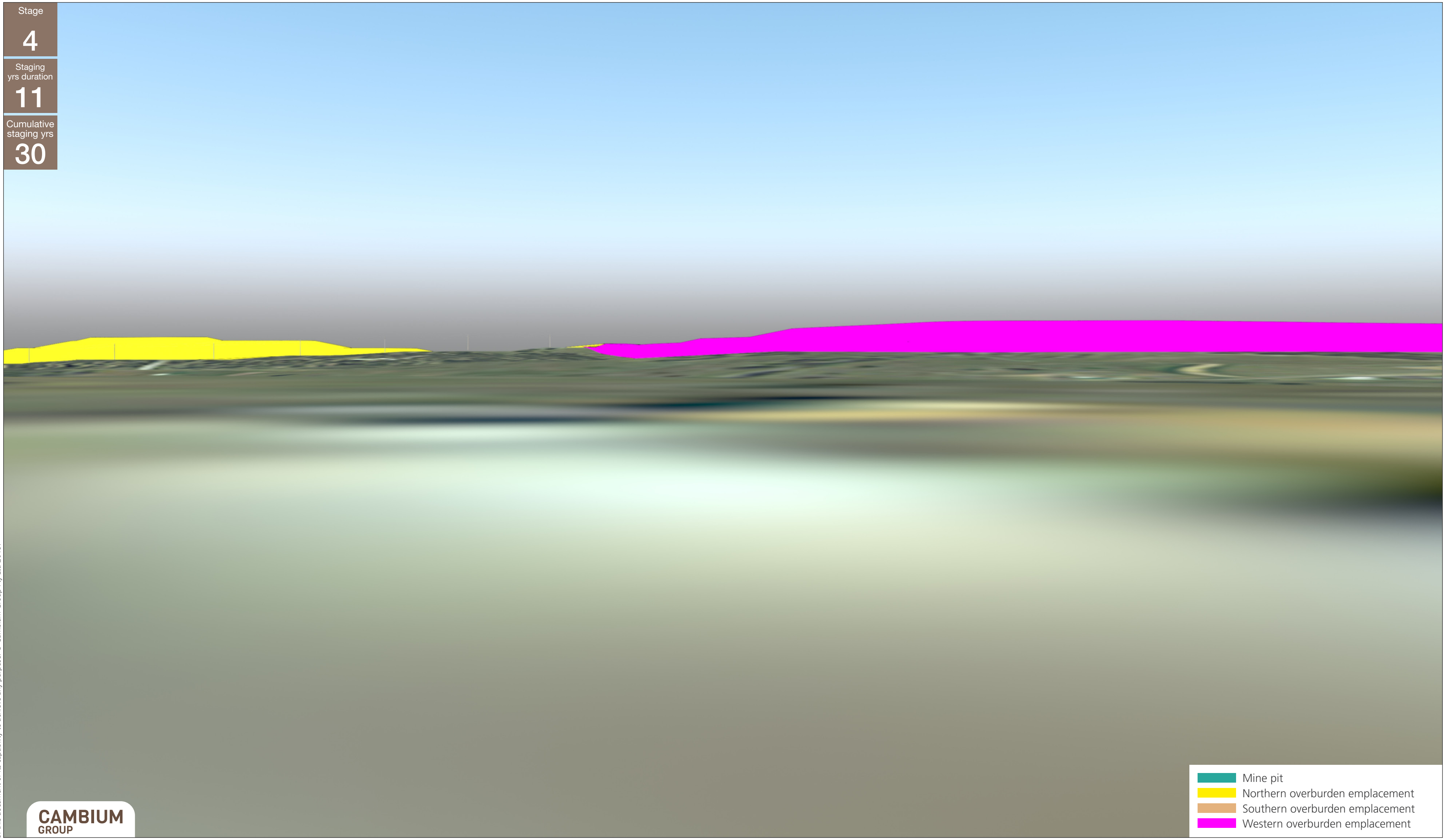
While the final landform is considered appropriate with regards to visibility and character, there may be some visibility and visual impacts of associated mining and overburden emplacement activities. The 3D graphics indicate that even close receivers such as C2 and C3 will not have significant views of the overburden emplacements and it will be receivers further away (such as R10, R13, R14 and R15) that may perceive some stages of activities associated with the Project. For most of the visual catchment, it will be many years until any evidence of the Project comes into view. As rehabilitation of the overburden emplacements is proposed to sequentially follow the construction of major lifts, only part of any overburden emplacement will be bare of vegetation at any point in time and in many cases the vegetation established from earlier rehabilitation will screen further emplacement of overburden behind.

The WOE in Stage 3 and the NOE in Stage 1 are likely to be of high visibility to part of Marulan South Road in the vicinity of VPs 1-6. However, VPs 3-5 will be subsumed by the WOE after the re-alignment of Marulan South Road and would no longer provide view opportunities. View opportunities will however be regained by other viewing places along the realigned section of Marulan South Road for a short distance from the point of re-alignment until it reaches its intended public terminus at the entry to the agricultural lime manufacturing facility.

So as to minimise the visibility of the overburden emplacements and associated development activities, in particular the WOE and NOE, the outer lip of the perimeter lifts should act as a visual barrier to emplacement activities behind when they rise high enough to be partly visible, from some limited locations. A procedure should be put in place to begin all new lifts on the margins relative to potential view directions (e.g. on the southwest and west sides of the WOE and the north margins of the NOE), progressing as sequential rows of tipped material away from the main view direction, so the initial emplacement area acts as a barrier to view. Together with pre-planting of a tree screen and rehabilitation of the final emplacement faces sequentially this will be effective in assisting in mitigating the impacts of developing these overburden emplacements.

Figure 20.24

Viewpoint C2: Simulated terrain - End of Stage 4

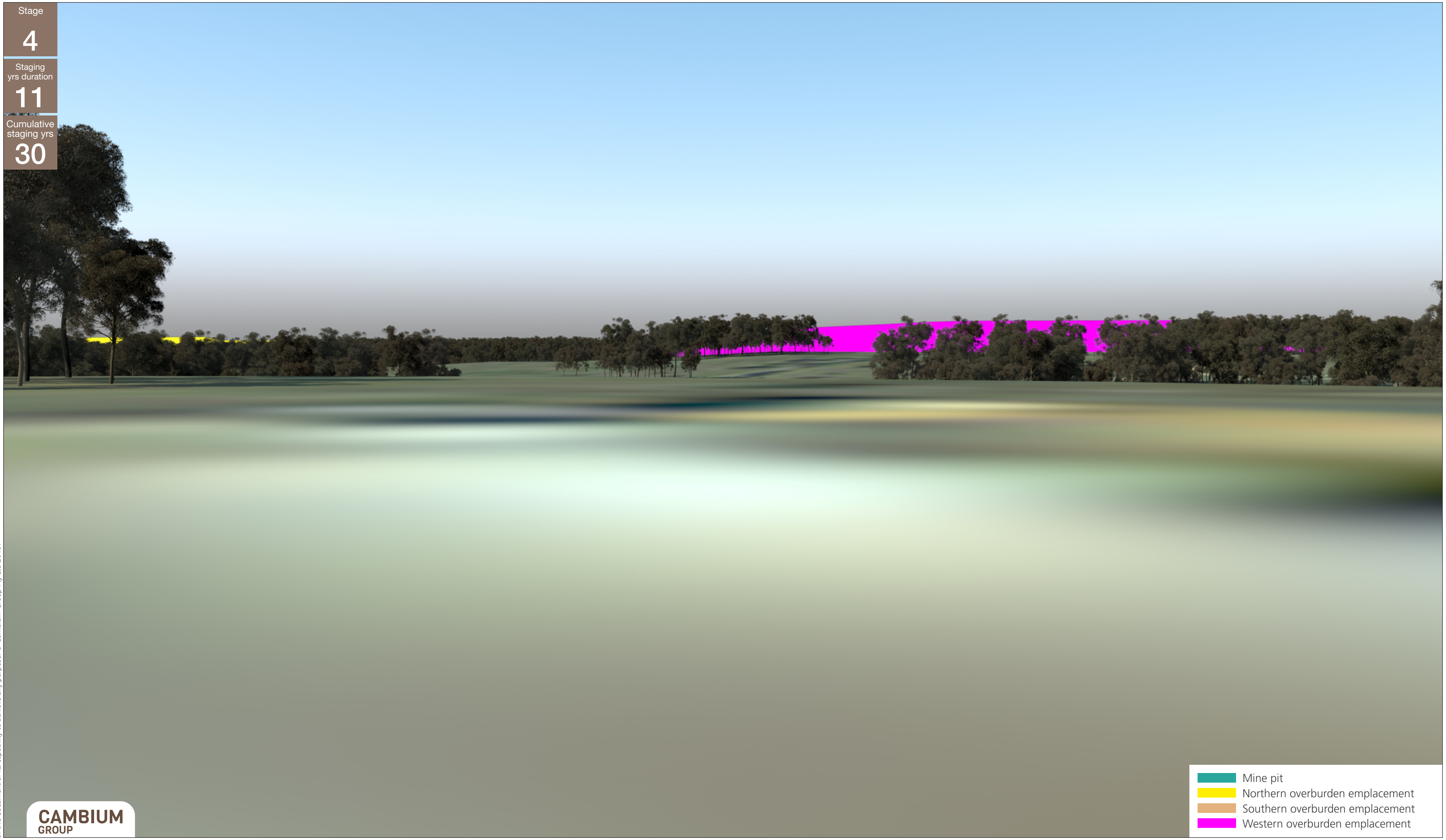


Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-24_C2TS4_190319_v01

Figure 20.25

Viewpoint C2: Simulated terrain with existing vegetation - End of Stage 4



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-25_C2VS4_190319_v01

Figure 20.26
Viewpoint C3: Simulated terrain - End of Stage 4

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION
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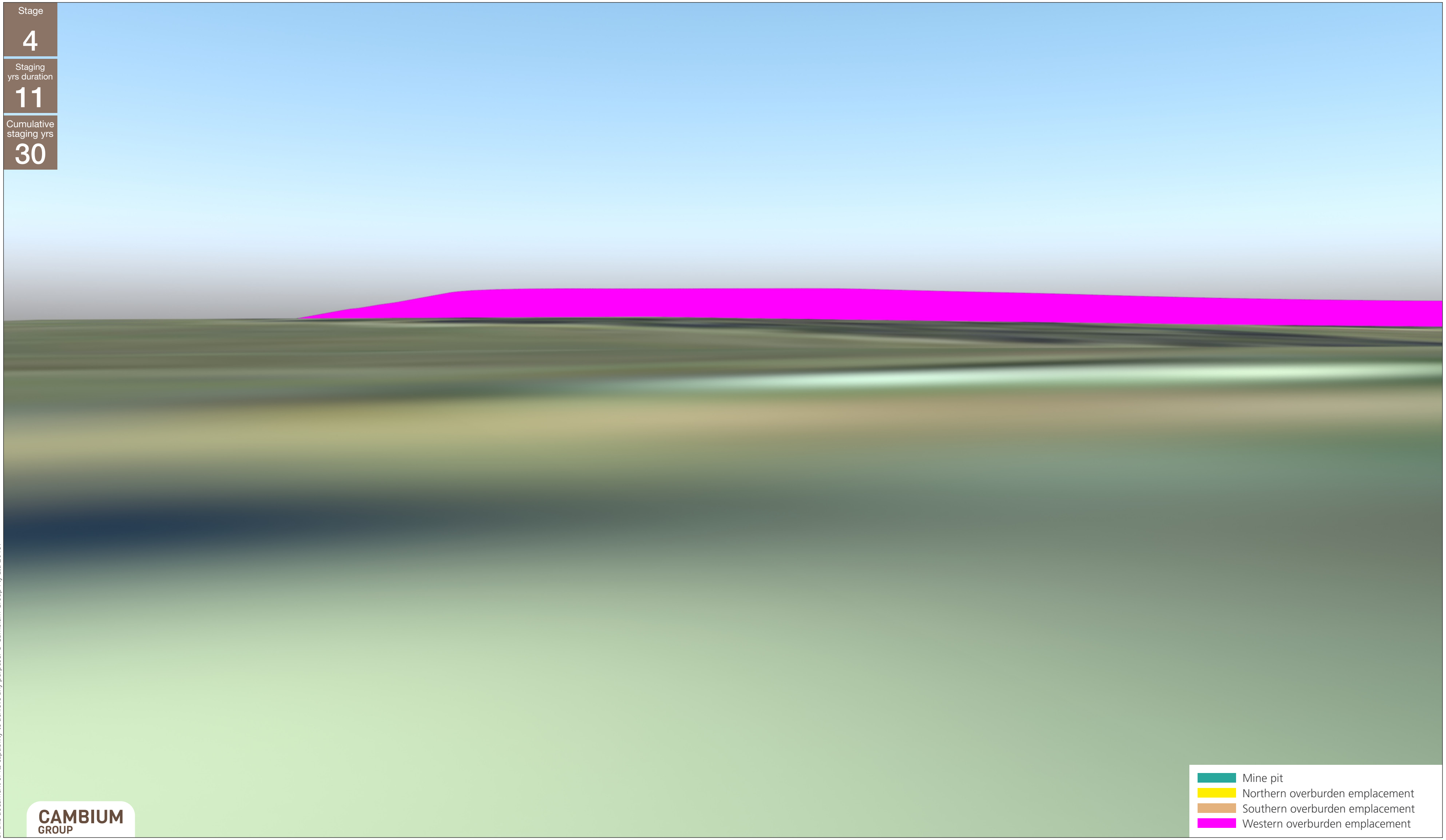
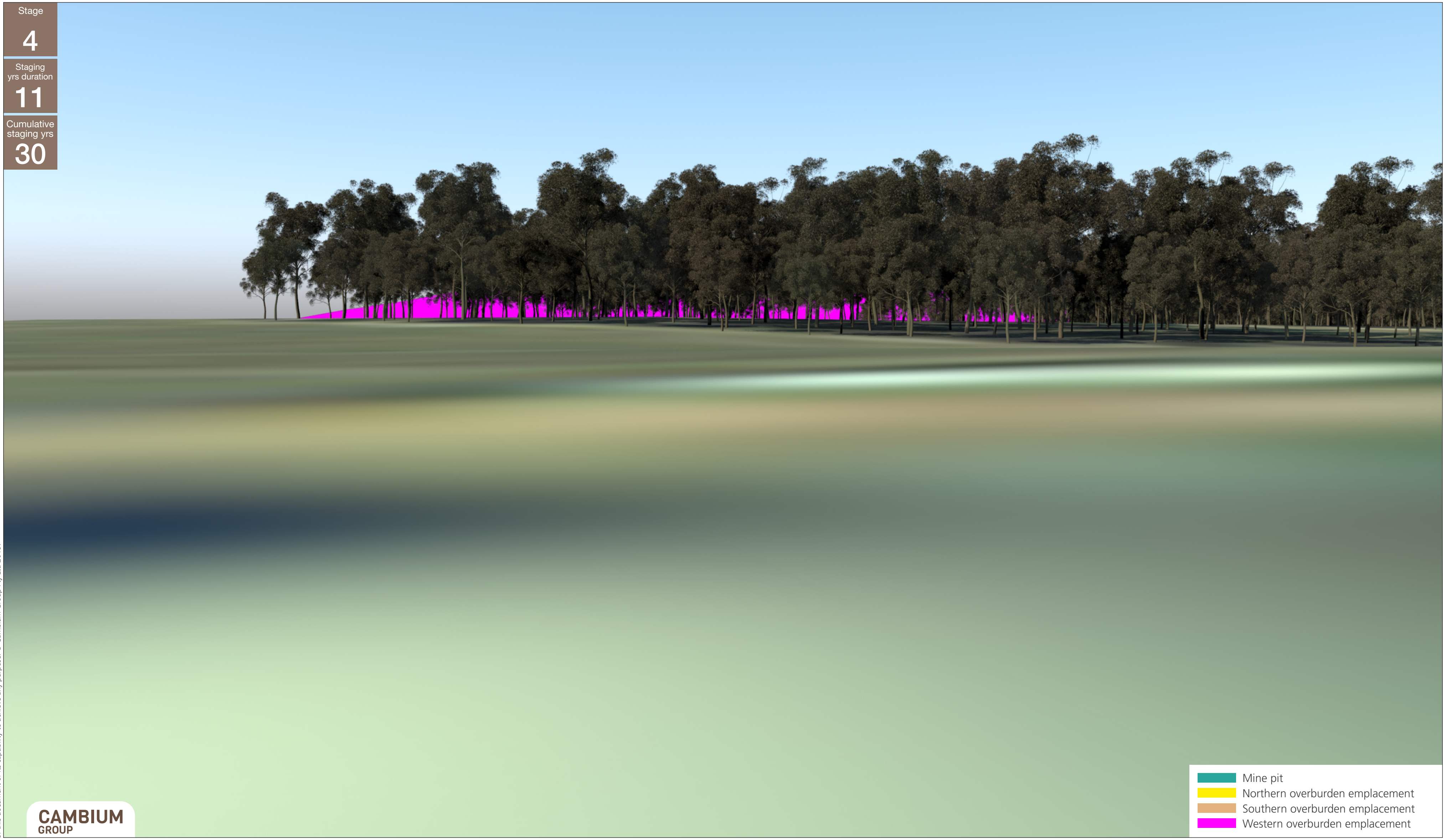


Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-26_C3TS4_190319_v01

Figure 20.27
Viewpoint C3: Simulated terrain with existing vegetation - End of Stage 4

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



Source: Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), Richard Lamb & Associates (2018), Cambium Group (2019).

031040_EIS_F20-26_C3VS4_190319_v01

20.4.2 Rehabilitation

Assessment of proposed mitigation measures

The proposed approach to rehabilitation is outlined in **Appendix I** and is summarised in **Chapter 26**.

Overburden emplacement embankments will be progressively rehabilitated through stabilisation and revegetation techniques with the final landform representing dense to moderately dense native woodland on all overburden emplacement areas on moderate to steep slopes, with more open native woodland established on the flatter tops of overburden emplacements.

Densification of tree cover on the eastern batters above Barbers Creek and Bungonia Creek will be investigated with the goal of blending the rehabilitated area with the surrounding Morton NP and Bungonia NP and SCA.

These rehabilitation objectives will create appropriate colour, texture and scenic quality, by providing a vegetation cover that is compatible with the existing and adjacent natural environment. In this way, the major contrasts of existing overburden material emplacements with the surrounding environment will be minimised. The process will be achieved sequentially as each of the overburden emplacement areas is established.

With regard to views from the few receivers affected, the overall low visibility of the overburden emplacements and the sequential rehabilitation proposed, will satisfactorily mitigate impacts and potentially block views of the construction of the upper and final levels before they are completed. This is because vegetation will likely grow into the horizon formed by the upper levels of the emplacements before the final landform is achieved. This will be particularly evident in close range views of the WOE and NOE when viewed from Marulan South Road. The upward viewing angle is such that as vegetation is established on the lower slopes, it will sequentially block the view of higher slopes, or the crest of the emplacements.

Initially, landscape structures for the stabilisation and drainage of the outer slopes of the overburden emplacements may be visible by way of their line and form, such as graded drains, benches and rock-lined water drop structures. Their visibility will decrease as vegetation establishes and forms a canopy. Because of shadows cast by even small individual plants, the visibility of surfaces and of most linear drainage structures will significantly decrease well before maturity of any of the canopy species. Larger horizontal structures such as benches on the SOE, noted in **Appendix I** as necessary to reduce slope lengths and erosion, will take longer to be visually absorbed in the medium distance views from the Bungonia Lookdown.

In general however, vegetation screening of individual landform structures in not critical to visual impacts mitigation, as they are predominantly seen either minimally, or from a distance, with the exception of views of the NOE and WOE from a short section of the realigned Marulan South Road and medium range views from VP20, VP21, R14 and R15.

Recommended mitigation measures

Although in a practical sense Marulan South Road is a low sensitivity location, because from the point of the proposed Marulan South Road realignment, it leads solely to industrial land (agricultural lime manufacturing facility), land owned by Boral, the mine, or Peppertree Quarry, it will remain a public road up to the agricultural lime manufacturing facility entrance.

An early tree screen should be established on the northern and western foot slopes of the WOE and NOE areas respectively, which are both potentially visible at close range from the realignment of Marulan South Road. Screening of the foot of the WOE and NOE adjacent to Marulan South Road, will assist in mitigating the visual impact of the early stages of emplacement development, containing light spill from vehicles (see below) and rapidly establishing a vegetated appearance, which will be carried upward as the lifts increase the heights of the emplacements. As mentioned above, vegetation will soon have the capability of disguising the future growth in height of the emplacements, as they are only seen in close view from the road and in an upward view direction.

Open to moderately dense woodland/forest form vegetation should be pre-planted and established for the crests of the overburden emplacements and should be compatible with the adjacent remnant and regrowth woodland, and with rehabilitation plantings proposed for the embankments of the overburden emplacements.

20.4.3 Lighting

Assessment of proposed mitigation measures

While visiting each of the residential receivers documented, the owners were asked by Richard Lamb and Associates whether they could perceive night lighting from the mine. Each owner had the opportunity without prompting, to express whether that lighting, if perceivable, was considered to be obtrusive, or otherwise. Some of the residents reported seeing light at night in some contexts, primarily as glimpses of security lights on the processing plant, seen while driving in the area. None of the residents expressed concern about brightness, glare or nuisance caused by night lighting. One resident to the west of the mine reported sometimes seeing a 'glow' at night in the general vicinity of the Peppertree Quarry processing area as distinct from individual lights visible at times associated with the mine processing area. This 'glow' is presumably a reference to reflected light or the illumination of the atmosphere by type 2 lighting in the processing area of the Peppertree Quarry, as the security lighting of the mine is of insufficient luminance, based on night time observations, to cause that visual effect. A distinction was made between the perceived colour of the 'glow' that was visible in the vicinity of the mine and of Peppertree Quarry. Mine light appeared yellow to orange, while the Peppertree Quarry light appeared bluish or white by comparison. Notwithstanding, residents also reported being generally unconcerned by lighting associated with the mine.

None of the residents reported seeing headlights of vehicles or directional lighting associated with the emplacement of material in the existing overburden emplacement areas at night. Boral have not received any complaints about lighting from the mine.

In recent community engagement associated with the proposed SSD application, receiver C2 raised concern that the beam from headlights of vehicles from the mine travelling west along the realigned section of Marulan South Road at night, may shine onto their property and towards the proposed residential dwelling (refer to 'PR' in Figure 2.9). A detailed design of the realigned section of Marulan South Road will be undertaken in consultation with Council post-approval of the SSD application. During this detailed design process and once the final vertical alignment of the realigned section of Marulan South road is known, Boral will undertake a heavy and light vehicle headlight assessment to determine whether the beam from headlights of vehicles travelling from the mine will impact on any of the residences to the south of Marulan South Road, where the realigned section of road merges with the existing road. Any vehicle headlight impacts will be addressed either through changes to the vertical alignment of the realigned section of the road so vehicles are essentially travelling downhill so the beam from their headlights does not spill onto private land to the south or through the construction of vegetated earth bunds along the southern road edge.

Recommended mitigation measures

The following mitigation measures are recommended to reduce night time light impacts from the Project:

- During the course of the Project a strategy relating to lighting should be introduced to reduce lighting to the lowest level possible that also maintains an appropriate standard of safety and security and to minimise obtrusive lighting.
- Mobile lighting for in-pit works should use lamps that produce light in the red or yellow areas of the spectrum rather than the blue or white and be shrouded and directed downwards to reduce lateral spread and excess reflection of light.
- For each new lift on the western and south-western edges of the WOE, or the northern margins of the NOE, emplacement should begin at the margins of the lift relative to potential view directions and then progress in rows behind the margin, providing a light barrier to vehicle headlights.
- Design adjustments to change the vertical alignment of the realigned section of Marulan South Road or the construction of vegetated earth bunds on the southern side of the road, will be investigated during detailed design, in consultation with the potentially affected land owners, to avoid or at least minimise visual impacts from vehicles from the mine travelling west on the realigned section of Marulan South Road at night.

20.4.4 Southern Overburden Emplacement

Assessment of proposed mitigation measures

Retaining the southern lip of the south pit as recommended by the OEH in response to SEARs for the Project, is a fundamental principle of mitigation of impacts on views from the Bungonia Lookdown and will achieve the OEH's recommendation in that regard. However, the construction of the SOE will also be more beneficial to views from tracks in the vicinity of the Lookdown where the overall landform created will decrease or eliminate views of mining operations in the pit well before the end of mine life. The Adams Lookout has significantly less exposure to the visual effects of mining, but views into part of the pit are possible, which will be mitigated by the construction of the SOE.

The SOE and its extension to the west fulfils two different objectives of the Project. It allows for a significant proportion of the total overburden emplacement volume from the mine itself and it is also the most profound mitigation measure for the visual impacts of the pit in views from the Bungonia Lookdown (VP20) and adjacent areas such as Adams Lookout that would ever have been enacted.

Backfilling of the southern-most portion of the former south pit will be substantial in stage 3 and completed by Stage 4, significantly blocking views into the pit from Bungonia Lookdown.

Recommended mitigation measures

Out of all proposed overburden emplacement areas on the Project site, the southern slopes of the SOE should be the most carefully considered when planning, implementing and monitoring the rehabilitation of these embankments.

Due to the visibility of the SOE to the Bungonia Lookdown to the south and the proximity of this emplacement area to the Bungonia Gorge and Creek, the outer slopes of this emplacement should be stabilised with woodland vegetation as early as possible.

20.5 Residual visual impacts and conclusions

The Project is quite remarkable, as despite the scale of the disturbance footprint, it has a low overall visual exposure to its visual catchment. Despite there being a number of rural properties and commercial operations within 3 km of the closest part of the Project, (medium viewing distance and sensitivity classes) there is low visual exposure of the Project to those receivers and most have no views of it.

The Project is not exposed to view from roads that carry either through traffic or significant numbers of viewers and is not in a destination that would attract visitation by tourists. The road to the mine, Marulan South Road, reaches a dead end in the vicinity of the Boral owned Peppertree Quarry and mine entrances.

The Project features a number of out-of-pit overburden emplacements to ensure the greatest possible flexibility in the operation of the mine over the 30 year period. With the assistance of proposed rehabilitation methods, these overburden emplacements will have only minor effects and impacts on the visual environment.

However, parts of the Project are exposed to views from two reserves of natural landscape, Bungonia NP and Morton NP. There would be some residual visual impacts on these locations, as mitigation will reduce, but not eliminate impacts, especially during the construction of the overburden emplacements and during the establishment of vegetation on the emplacement slopes.

VP20 is the only viewing location assessed that has a substantial view of the proposed extension of the mine pit to the west and of parts of most of the overburden emplacements. However, views of the WOE and NOE would be minimal.

By the end of the 30 year mine life, the view into the mine pit would have been significantly and sequentially reduced as the SOE and its extension to the west occludes the view and replaces it with a rehabilitated infill landform of a natural appearance, vegetated with native woodland species that help blend the emplacement with the surrounding natural landscapes of the Bungonia NP and Morton NP. The final landform of the SOE will be the most profound mitigation work that has ever been implemented to reduce visual impacts of the mine on views from the Bungonia Lookdown.

The visual exposure of night time lighting has been considered. No change is proposed in the Project in the use and purpose of lighting. The security and general lighting would be unchanged and will be of low visual exposure. The use of lighting for mining activities and to guide vehicles being used at night is also proposed to be unchanged.

A policy of minimising unnecessary or potentially obtrusive light sources and gradually replacing existing luminaires and lamps with those producing light in the most appropriate colour spectrum and lowest practical luminance levels is recommended. An objective will be to reduce the ‘glow’ effect of type 2 lighting (flood lighting) on the atmosphere.

Night time lighting of mining operations in the pit would be most visible from the Bungonia Lookdown (VP20) and McCauleys Flat track (VP21), however night time use of the reserves would be minimal. As a result, the impacts of night lighting on such viewing locations is considered to be minor.

The realignment of a section of Marulan South Road has the potential to result in headlights of vehicles from the mine shining onto neighbouring properties to the south. Design adjustments to change the vertical alignment of the realigned section of road or the construction of vegetated earth bunds on the southern side of the road, will be investigated during detailed design, in consultation with the potentially affected land owners. This will avoid or at least minimise visual impacts from vehicles from the mine travelling west on the realigned section of Marulan South Road at night.

This visual assessment finds that while there are some residual visual impacts, these are minor in significance. The visual impacts have also been considered in relation to the extensive and to some extent permanent changes to the visual environment that have occurred in the past. The residual impacts that will occur are considered compatible with both the mining/industrial and the rural/natural visual environment.

Chapter 21

Traffic and transport

VOLUME 1

Traffic and transport

Impacts on traffic were assessed as the Project will include an increase in vehicle numbers over current levels, realignment of a section of Marulan South Road and construction of an intersection on Marulan South Road at the Road Sales Stockpile Area.

There will be an extra 34 truckloads (68 vehicle movements) on an average week day, and up to 58 truckloads (116 vehicle movements) on a busy day along Marulan South Road. This will equate to up to three one-way trips in an average hour on an average day and up to five one-way trips in a busy hour on a busy day.

The additional traffic will have a relatively small impact on the level of service and average vehicle delay along Marulan South Road, and will not change average vehicle delays at the minor intersections along the road. Similarly, there will be a very small impact to traffic conditions on the Hume Highway.

Two intersection scenarios were assessed for the Road Sales Stockpile Area, with stop signs and with traffic signals. In both scenarios the level of service at the proposed intersection was A, which is the best possible intersection performance. The average vehicle delays were low, with a maximum of 13.5 seconds. The sight distances to and from the intersection will be longer than the guideline values.

Construction could result in up to 40 additional inbound and outbound vehicle trips (80 additional two-way trips) on some days. These will consist of light vehicle trips associated with additional construction workers, as well as heavy vehicle trips associated with the delivery of materials and equipment.

The Project is not expected to result in any negative impacts to other road users, including school buses, which use Marulan South Road in the morning and afternoon periods on school days. Upgrades to Marulan South Road will improve road safety and provide school bus stopping and turning facilities.

21 TRAFFIC AND TRANSPORT

21.1 Introduction

This chapter summarises the traffic impact assessment report, which is in **Appendix T**. It describes the existing traffic conditions on the nearby road network, describes potential impacts of continued Mine operations on this network and provides measure to minimise and manage these impacts.

21.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the Project on the local and State road and rail network (**Table 21.1**).

Table 21.1: Traffic SEARs

Requirement	Section and appendix where addressed
▪ Accurate predictions of the road and rail traffic generated by the project.	22.2.2, 22.2.9, Appendix T
▪ An assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the local and State road and rail network.	21.2, Appendix T
▪ A detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the development, having regard to Transport NSW's and Goulburn Mulwaree Council's requirements.	21.3, Appendix T

The SEARs recommend use of the following guidelines, which were used during the assessment:

- *Guide to Traffic Generating Development* (Roads and Maritime Services, 2002);
- *Road Design Guide* (Roads and Traffic Authority, N.D.); and
- *Guide to Road Design* (Austroads, 2015).

21.1.2 Overview of assessment methods

Existing roads and their alignments/widths, speed limits, intersections, rail crossings and school bus routes were described. The road network is shown on Figure 2.1.

Traffic was counted at several points along Marulan South Road between 12 and 19 November 2014. Traffic was counted at the Marulan South Road and Jerrara Road intersection, and the northbound and southbound Hume Highway on and off ramp, during the AM/PM peak and business hours on 11 June 2014. The traffic and intersection count locations are shown on Figure 5 of the traffic impact assessment.

Data on crashes between 1 July 2011 and 30 June 2014 along Marulan South Road were analysed to comment on the safety record of the road.

The Signalised and Unsignalised Intersection Design and Research Aid (SIDRA) program was used to predict the impact of continued mine operations on performance of the existing Hume Highway intersection for existing plus Project traffic. The AM and PM peak hours were also modelled for a 2025 traffic scenario based on additional traffic from Gunlake Quarry for cumulative assessment. SIDRA was also used to inform the design and assess the performance of the proposed intersection on Marulan South Road, to allow access for trucks to the proposed road sales stockpile area and for trucks from Peppertree Quarry to haul overburden to the proposed NOE (as outlined in **Section 4.4.8**).

The SIDRA results are expressed as level of service (LoS), degree of saturation (DoS) and average vehicle delay (AVD). The (Roads and Maritime Services, 2002) intersection criteria are summarised in **Table 21.2**. A LoS D or better is the desirable design criteria for intersections.

Table 21.2: LoS criteria for intersections

LoS	AVD (seconds per vehicle)	Traffic signals, roundabout	Give way and stop signs
A	<14	Good operation.	Good operation.
B	15 to 28	Good with acceptable delays and spare capacity.	Acceptable delays and spare capacity.
C	29 to 42	Satisfactory.	Satisfactory, but accident study required.
D	43 to 56	Operating near capacity.	Near capacity and accident study required.
E	57 to 70	At capacity; at signals, incidents will cause excessive delays. Roundabouts require other control mode.	At capacity, requires other control mode.
F	>70	Intersection is oversaturated.	Oversaturated, requires other control method.

The (Austroads, 2015) warrants for turn treatments on a major road at unsignalised and signalised intersections were compared to predicted traffic volumes to determine the appropriate turn lane design at the proposed intersection. Sight distances along Marulan South Road to the proposed intersection were considered.

The LoS of the new intersection was predicted for the following scenarios, assuming stop signs on the northern and southern approaches to Marulan South Road:

- overburden trucks travelling to and from the east along Marulan South Road; and
- overburden trucks crossing over Marulan South Road using both the road sales stockpile area and NOE area access roads.

The LoS was also predicted for the potential addition of signals to the proposed intersection.

21.2 Results

21.2.1 Existing traffic

Daily and hourly vehicle volumes

Two-way traffic along Marulan South Road was averaged over five days to give week day volumes and over seven days to give daily traffic for sections of Marulan South Road south of the Hume Highway and just to the west of the mine. The average traffic is in Table 21.3.

Table 21.3: Daily Marulan South Road two-way traffic

Day	Vehicles per day	Heavy vehicles
South of Hume Highway		
Week day	666	30.5%
Daily	544	28.3%

Day	Vehicles per day	Heavy vehicles
West of mine		
Week day	538	35.3%
Daily	521	34.0%

Hourly two-way traffic along Marulan South Road was averaged as above for daily traffic. The periods with the highest traffic are in **Table 21.4**.

Table 21.4: Hourly Marulan South Road two-way traffic

Week day	Vehicles per hour
South of Hume Highway	
6-8 am	67-70
3-4 pm	55-58
Other hours between 5 am and 8 pm	25-46
West of mine	
6-8 am	59-65
3-6 pm	44-46
Other hours between 5 am and 8 pm	15-33

These averages show that traffic volumes are lower in the vicinity of the mine.

Hume Highway interchange

The interchange comprises a roundabout intersection and a cross junction intersection connected by a bridge over the highway. The traffic using the interchange during the AM and PM peak hours is summarised in **Table 21.5**.

Table 21.5: Hume Highway interchange peak hour traffic

Location	Vehicles per hour
AM (6.30-7.30 am)	
Roundabout	154
Cross junction	145
PM (4.30-5.30 pm)	
Roundabout	120
Cross junction	108

These volumes are relatively low peak hour intersection traffic volumes and are consistent with other intersections in rural areas.

Mine traffic

The mine and Peppertree Quarry generate the two-way vehicle trips in **Table 21.6**.

Table 21.6: Mine and Peppertree Quarry traffic generation

Vehicle	Two-way trips per day
Mine and Peppertree Quarry	
Light	348

Vehicle	Two-way trips per day
Rigid truck	56
Articulated truck	134
Total	**538 (270 in, 268 out)**
Mine	
Light	278
Heavy	150

Not all heavy vehicles end up on the wider road network as there are 28 trips to the agricultural lime manufacturing facility, which is only 1 km from the mine.

Heavy vehicles transporting product from the mine travel via Marulan South Road to the Hume Highway, where 70% travel to and from the north and 30% travel to and from the south.

Heavy vehicles travel to and from the mine 24 hours per day with the majority of trips occurring between 4 am and 11 pm.

Approximately 92% of heavy vehicle trips are on weekdays and 8% on weekends.

There are 33,333 yearly heavy vehicle trips carting 500,000 tpa of limestone sand to Peppertree Quarry via an internal haul road which crosses Marulan South Road east of the main truck entrance to the mine.

Road safety

There was one accident during the assessment period, which comprised a vehicle running off the road 6 km from the Hume Highway during foggy weather and did not result in injury. This section of road is proposed to be realigned.

21.2.2 Future operational traffic

Approximate road transport volumes associated with the continued operation of the mine are outlined in **Section 4.5**.

The mine will continue to operate 24 hours per day and 365 days per year, and will continue to generate the traffic described above.

Product trucks (articulated truck and dog combination, tankers and rigid trucks) will continue to transport around 330,000 tpa of limestone and clay shale products to the Hume Highway via Marulan South Road, as well as the existing 120,000 tpa of lime transported to the nearby agricultural lime facility, which is located 1 km west of the mine, along Marulan South Road.

Boral proposes to transport the following additional product volumes to the Hume Highway along Marulan South Road from the road sales stockpile area:

- 120,000 tpa of limestone and clay shale from the mine, which will generate an additional 4,086 truckloads (8,172 vehicle movements) per year; and
- 150,000 tpa of aggregate and sand from Peppertree Quarry, which will generate an additional 5,000 truckloads (10,000 vehicle movements) per year.

Heavy vehicles from the mine will travel east along Marulan South Road and enter the road sales stockpile area at the new intersection west of the existing entrances to the mine and Peppertree Quarry. Heavy vehicles from Peppertree Quarry will access the road sales stockpile area via internal access roads.

Boral also proposes to increase transport of limestone sand from the mine to Peppertree Quarry via the dedicated haul road by 500,000 tpa to 1,000,000 tpa, which will generate an additional 16,667 truckloads (33,333 movements) per year.

Boral may seek to purchase and close the public roads in Marulan South up to the entrance to the agricultural lime manufacturing facility. However, for the purposes of this traffic assessment and to assess the worst case operating scenario, it has been assumed that no public roads will be closed. Therefore, the additional traffic generation associated with movement of material between the mine and the road sales stockpile area, the mine and Peppertree Quarry, and Peppertree Quarry and the NOE has been thoroughly assessed.

21.2.3 Impacts on the road network

Proposed road changes

As described in **Section 4.4**, the following improvements and changes are proposed to roads near the mine:

- realignment of a section of Marulan South Road near the proposed northern extension of the WOE area;
- the upgrade of sections of Marulan South Road to the minimum DCP and Austroads standards; and
- a new cross junction intersection in Marulan South Road at the road sales stockpile area and associated improvement works.

Boral may install traffic signals if the section of Marulan South Road east of the agricultural lime facility's driveway becomes a Boral owned private road, as it is unlikely that RMS would support traffic lights while this section of the road remained public. Single lane approaches and departures will be sufficient and the signals will have a simple two phase operation, either vehicle activated or timed.

The signals would be appropriate for either of the proposed overburden haul routes, that is, the Peppertree Quarry haul trucks crossing Marulan South Road from the road sales stockpile area to the NOE, or the trucks entering and exiting the emplacement from the east along Marulan South Road.

Impacts on roads

The additional traffic associated with the Project will be from the transport of aggregate and sand from the Peppertree Quarry, and limestone products from the mine. This will account for an extra 34 truckloads (68 vehicle movements) on an average week day, and up to 58 truckloads (116 vehicle movements) on a worst case day. Combined with the existing heavy vehicle movements from the mine of 150 movements (two way trips) per day, the total number of heavy vehicles from the mine with the Project on a worst case day will be 266 movements (two way trips) or 133 truckloads (one way trips).

While Boral seeks approval to continue to transport product from the mine and road sales stockpile area, by road over 24-hours, for the purpose of this assessment and to take into account the worst-case operating scenario, it is assumed that the transport of the additional products will occur over 12-hours generally between 6.00 am and 6.00 pm.

The existing, additional and total hourly heavy vehicle volumes associated with the Project using the local road network during an average and worst case hour are in **Table 21.7**.

Table 21.7: Total hourly heavy vehicles from the mine with the Project

Trips	Existing	Increase	Total
Average hour/average day			
One-way	4-5	2-3	**6-8**
Two-way	8-10	4-6	**12-16**
Worst case hour/worst case day			
One-way	4-5	5	**9-10**
Two-way	8-10	10	**18-20**

Figure 21.1 shows the additional truck movements from the Project during a worst case hour.

The additional traffic will have a relatively small impact on the LoS and AVD along Marulan South Road, and will not change AVD at the minor intersections along the road. Similarly, there will be a very small impact to traffic conditions on the Hume Highway.

Cumulative impacts on Hume Highway interchange

The SIDRA analysis for existing plus Project traffic demonstrated that the Hume Highway westbound ramp/Marulan South Road/Jerrara Road intersection and Hume Highway eastbound ramp/Marulan South Road intersection will have an LoS A (good operation) and low AVDs during the AM and PM peak hours.

A similar LoS A and AVD resulted from modelling additional traffic from Gunlake Quarry in 2025.

Proposed Marulan South Road intersection

Hourly heavy vehicle movements associated with the proposed intersection during a worst case hour on a worst case day are in **Table 21.8** and **Figure 21.2**. This excludes the existing 4-5 one way or 8-10 two way heavy vehicles movements between the mine and the Hume Highway outlined in Table 21.7.

Table 21.8: Heavy vehicle movements through new intersection

Trips	Trucks per hour
Vehicles from road sales stockpile area along Marulan South Road	
One-way	4
Two-way	8
Vehicles from mine to road sales stockpile area	
One-way	2
Two-way	4
Vehicles hauling overburden from Peppertree Quarry to NOE	
One-way	28
Two-way	56
Vehicles from mine along Marulan South Road	
One-way	1
Two-way	2

Auxiliary turning lanes are required for left or right turns at an intersection where the design speed is less than 100 km/h and there are 250 or more vehicle movements per hour in the same or opposing direction. As volumes will be far less than this, auxiliary lanes will not be required.

The SIDRA analysis of the two intersection scenarios (using stop signs) demonstrated a LoS A and relatively low delays of 12 to 13 seconds per vehicle.

The SIDRA analysis of the two intersection scenarios (using signals) demonstrated a LoS A and relatively low delays of up to 13.5 seconds per vehicle.

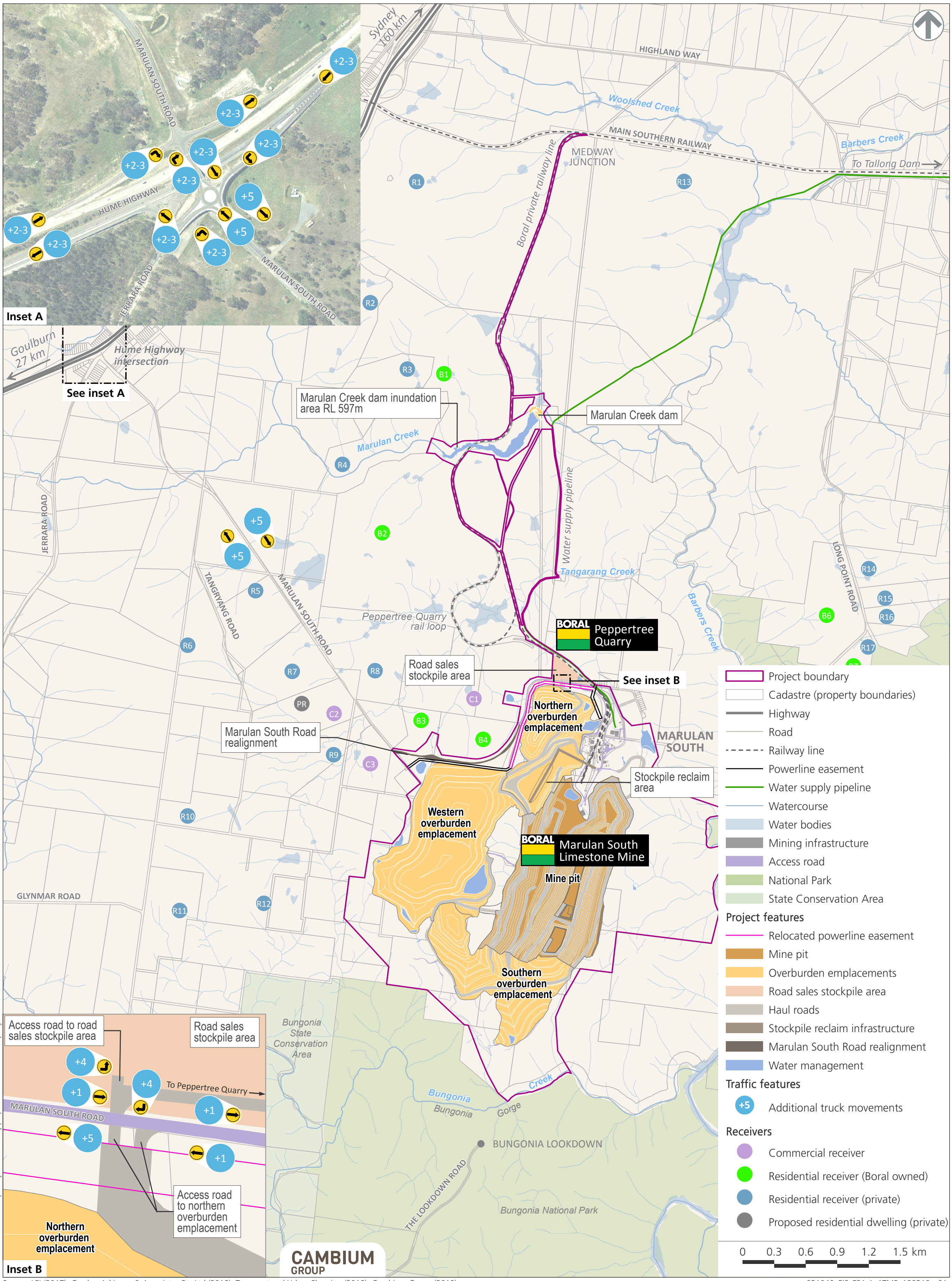
Provided the speed limit is reduced to 60 km/h near the mine, the intersection will have sight distances along Marulan South Road of 200 m to the west and 250 m to the east, which are above the (Austroads, 2015) minimum sight distance requirement of 121 m for a 60 km/h road.

Additional transportation of limestone sand to the Quarry

The proposed increase in production of manufactured sand at the mine will generate an additional four trucks (eight return trips) per hour travelling via the existing internal haul route, currently used to transport manufactured sand to Peppertree Quarry. This will result in a total of eight trucks (16 return trips) per hour transporting manufactured sand. Manufactured sand trucks cross Marulan South Road 175 m east of the rail line level crossing and the mine’s truck entrance. This section of Marulan South Road carries less than 40 vehicles per hour and delays associated with the additional truck movements will be low and will not impact on non-Boral road users. As the site distance in Marulan South Road at the internal haul road intersection is good and traffic volumes that will use the intersection are low, the traffic conditions at this intersection will remain satisfactory and similar to existing conditions at the intersection, with the additional trucks.

Figure 21.1
Additional truck movements from the Project during a worst case hour

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

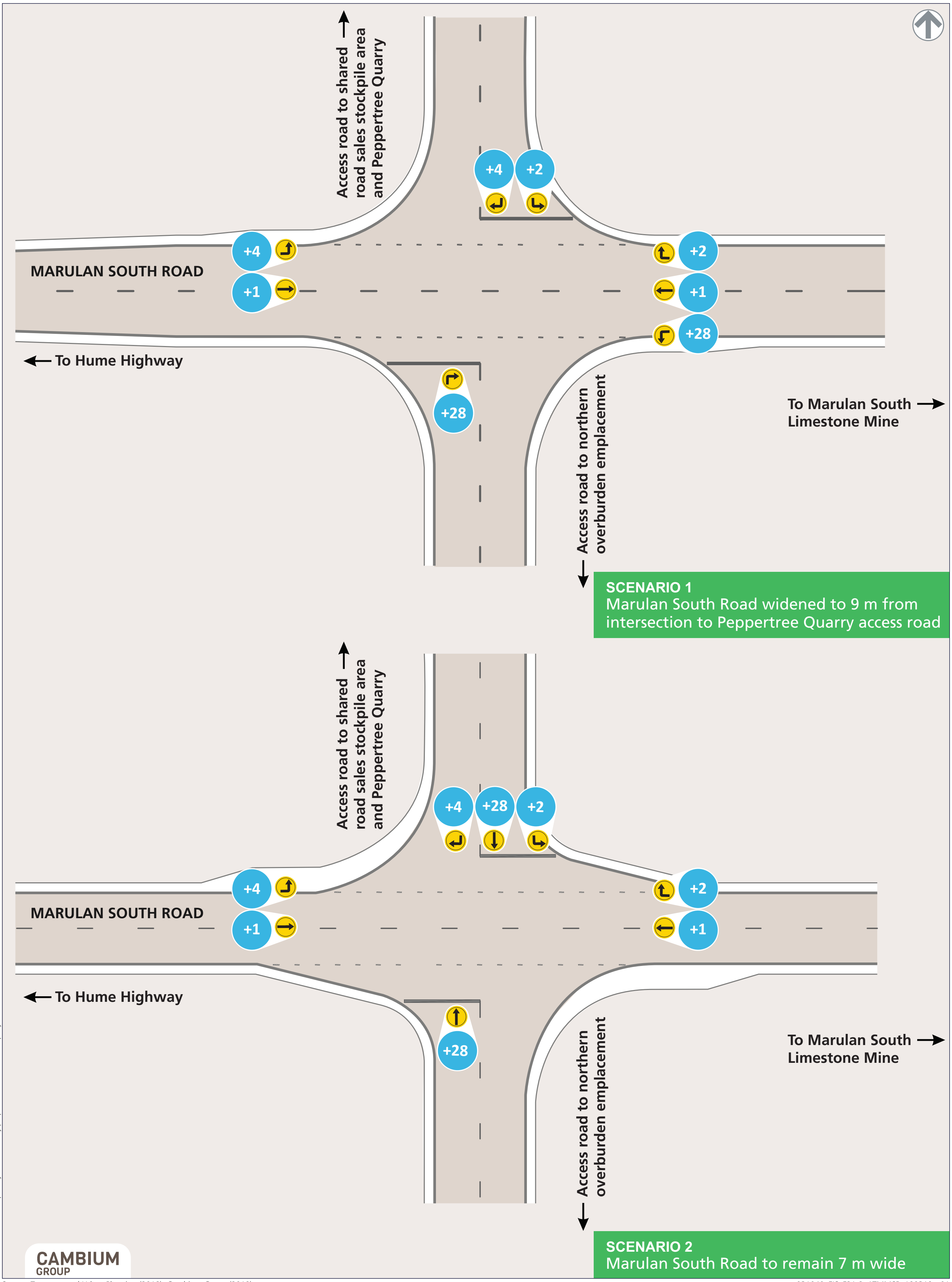


Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Transport and Urban Planning (2018), Cambium Group (2019).

031040_EIS_F21-1_ATMP_190319_v01

Figure 21.2
Additional hourly truck movements - Marulan South Road intersection

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



Source: Transport and Urban Planning (2018), Cambium Group (2019).

031040_EIS_F21-2_ATMMSR_190319_v01

21.2.4 Construction traffic impacts

Establishment of the new mining areas and infrastructure will not have road impacts additional to the operational impacts.

There will be additional traffic impacts during construction of the road improvements comprising the:

- proposed realignment of Marulan South Road, to the north of the proposed WOE;
- widening of the narrower sections of Marulan South Road; and
- construction of the new intersection on Marulan South Road at the road sales stockpile area.

Other construction activities associated with the proposed continuation of operations at the mine include:

- Realignment of a section of the high voltage powerline that currently traverses the NOE;
- Construction of the Marulan Creek dam; and
- Relocation and reconfiguration of the stockpile reclaim area.

Although the majority of these construction activities will involve heavy vehicle movements within the mine site and will use construction materials produced at the mine or Peppertree Quarry, some materials and equipment will need to be brought from off site and would contribute to additional heavy vehicle movements along Marulan South Road for a limited time during each construction project

Construction could result in up to 40 additional inbound and outbound vehicle trips (80 additional two way trips) on some days. These will consist of light vehicle trips associated with additional construction workers, as well as heavy vehicle trips associated with the delivery of materials and equipment.

Construction traffic management will be included in the construction environment management plan.

21.2.5 Impacts on road users and road safety

The Project is not expected to result in any negative impacts to other road users, including school buses, which use Marulan South Road in the morning and afternoon periods on school days.

Upgrades to Marulan South Road will improve road safety and provide school bus stopping and turning facilities. Boral’s driver safety awareness training will include protocols for the interaction with school buses.

The Hume Highway interchange has substantial additional capacity and will enable all vehicles to enter and exit the Highway safely.

The increase in heavy vehicles associated with the Project will be small in real terms and these will have minimal impacts on LoS and AVD on Marulan South Road at the Hume Highway.

21.2.6 Oversize and higher mass limit vehicles

The Project will use the same type of vehicles and equipment currently used by the mine.

Any deliveries of equipment using oversize or higher mass limit vehicles will be in accordance with the National Heavy Vehicle Regulator requirements and permit system.

21.2.7 Assessment of Marulan South Road as a heavy vehicle route

Council requested the reassessment of Marulan South Road as a B Double route and TfNSW requested an assessment for access of higher productivity vehicle movements at a minimum PBS 2B (combinations at higher mass limits).

The RMS restricted vehicle map for NSW shows Marulan South Road as an approved B-double route for use by vehicles up to 26 m long, except between 7.30 am to 9:00 am and 3.30 pm to 5:00 pm on school days.

Currently, a small number of 22 m and 24 m long B-double tankers access the mine. Road conditions along Marulan South Road are suitable for these vehicles, and the most recent road crash statistics indicate that road safety along the route is satisfactory.

The mine's weighbridge can withstand vehicles up to 24 m long, therefore, Boral does not intend to change the existing vehicle fleet.

Proposed road upgrades will be designed and constructed by Boral. Boral will consult Council to ensure the upgraded road will accommodate B-doubles, as well as possible future use by PBS Level 2B vehicles.

21.2.8 Internal roads and parking

Other than the proposed new intersection in Marulan South Road at the road sales stockpile area, there will be no changes to the internal roads or to the parking areas used by employees, contractors and other mine visitors.

The existing arrangements comply with current Australian Standards.

21.2.9 Rail movements

Boral is not proposing any change to its private rail line that connects the mine and Peppertree Quarry to the Great Southern Railway to the north, or to the six trains departing the mine per day.

Boral received written correspondence from the Australian Rail Track Corporation (ARTC) on 3 August 2018 confirming that "Boral can expect their current levels of service capacity to be available on the ARTC network into the future, to support an extended mine life at Marulan Quarry*".*

21.3 Management measures

As concluded by the traffic impact assessment, relative to the existing operations, the Project is unlikely to contribute to any significant impacts to the local and regional road network, or compromise the safety of road users.

The following management measures have been recommended to minimise the potential for adverse traffic and transportation impacts from the Project and ongoing mine operations. The above measures would be implemented in addition to existing management procedures and plans established by Boral, including the Traffic Safety Management Plan.

21.3.1 Construction

The construction impacts associated with the Project would be managed in accordance with a site CEMP, which will be prepared with full consultation with Council. Traffic management during construction will be included in the CEMP.

21.3.2 Marulan South Road upgrade

Boral is proposing upgrades to Marulan South Road. These upgrades will:

- be designed to meet Austroads and Council's relevant standards and specifications;
- will take into consideration the need for, and location of, school bus stopping and turning;
- will consider improving certain significant dips in the vertical alignment of the road to improve visibility and road safety; and
- will minimise clearing of native vegetation adjoining the road.

21.3.3 Driver safety and awareness training

Boral has a Traffic Safety Management Plan for operations at the mine site and holds safety toolbox discussions on a regular basis with employees regarding the safe use of Marulan South Road.

Boral proposes to further develop and continue to implement their driver safety awareness training for heavy vehicle drivers that travel to and from the mine. The training will cover the following matters:

- driver conduct, including operating vehicles in a safe, responsible manner to minimise conflict with other road users and vehicles accessing adjoining land uses;
- compliance with all road transport laws, road rules, including speed limits and occupational health and safety legislation;
- minimisation of traffic noise in Marulan South Road, particularly during night time periods;
- incident management and reporting; and
- protocols for the interaction with school buses along Marulan South Road.

21.3.4 Road Maintenance

Boral currently pays a contribution to Council for road maintenance, and will continue to do so during continued operation of the mine.

It is noted in the SEARs that Council has requested a pavement condition survey be undertaken on Marulan South Road. Boral will undertake this survey and include any required pavement works with the upgrading works of Marulan South Road.

21.4 Residual impacts

The Project will result in a small increase in heavy vehicle trips of two to three heavy vehicle loads per hour (total of four to six two way trips) on an average day using Marulan South Road and the Hume Highway.

Impacts of the additional truck movements on the adjoining road network and intersections will be relatively minor with minimal changes to the LoS and AVDs on the road network, including at all key intersections.

Boral is proposing upgrades to Marulan South Road, which will consider the need for, and location of, school bus stopping and turning. The Project is not expected to have any negative impacts on the other road users and on road safety.

Chapter 22

Waste management

VOLUME 1

Waste management

The Project will not generate significant quantities of general solid, hazardous or liquid waste. Any waste that is generated will be managed in accordance with the waste hierarchy in the NSW *Waste Avoidance and Resource Recovery Act 2001*.

The Project will generate large quantities of overburden, which will all be managed onsite as described in the Project summary and rehabilitation sections.

22 WASTE MANAGEMENT

22.1 Introduction

Waste streams would be generated by the Project and will require responsible management in accordance with the objectives of the NSW *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) POEO Act and other relevant legislative requirements.

Failure to collect, separate and store waste, or transport and dispose of waste appropriately, can result in adverse impacts on the receiving environment.

22.1.1 Assessment guidelines and requirements

The SEARs require consideration of the likely Project waste generation and management (**Table 21.1**).

Table 22.1: Waste SEARs

Requirement	Section and appendix where addressed
▪ A waste (overburden, tailings, etc) management strategy, having regard to the EPA's requirements.	4.5, 4.8, 4.9, 22

The SEARs recommend use of EPA's (2014) *Waste Classification Guidelines*.

22.2 Existing operations

The main waste streams generated by existing mining operations comprise general solid wastes and hazardous and liquid wastes generated from operations and servicing of equipment.

Overburden and lime waste material are currently stockpiled in the WOE, while all other waste generated at the site is separated, collected in designated waste disposal bins, reused where possible, or disposed of at an appropriately licenced waste facility.

22.2.1 Existing waste management practices

Boral has developed a waste management system for the mine that ensures all waste generated on site is classified and managed in accordance with EPA's (2014) *Waste Classification Guidelines* and relevant regulatory requirements of the WARR Act and the POEO Act.

In accordance with the WARR Act, Boral adopts the principles of the waste management hierarchy as follows:

- waste avoidance;
- waste re-use;
- waste recycling/re-processing/treatment; and
- waste removal and disposal.

These principles would continue to be upheld during continued operations of the mine, and be achieved during construction and operation of the Project by:

- purchasing recycled products where appropriate;

- developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site;
- recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and
- where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licenced facility.

22.2.2 General solid waste

The mine generates various sources of general solid waste (non-putrescible), including building and demolition waste, glass, plastic, rubber, garden waste, wood, paper and cardboard. Additionally, general solid waste (putrescible), such as food waste, is generated by mine personnel.

General solid waste streams are currently segregated where possible, and deposited in large waste receptacles such as dumpsters, which are covered and collected weekly by a licensed waste removal contractor. Waste volumes are currently not recorded. However, they are estimated to be between 40–60 m^3 per week.

22.2.3 Hazardous waste

Contaminated materials generated at the workshop, such as oil and grease, pass through an oil and grease separator. Recovered oil and grease material is then collected and stored in tanks for removal by a licensed recycling contractor. Approximately 2.3 t of oil and grease waste is generated per month.

Similarly, used hazardous substance and chemical containers, grease drums, and oil filters, are stored in accordance with relevant standards and regulations, until collected for recycling or disposal by a licensed contractor.

Chemicals used in the laboratory are consumed by analytical operations and do not require disposal off-site.

Any spills which occur in the collection areas would be contained within bunds, and managed in accordance with emergency response procedures.

More information regarding hazardous materials is provided in **Section 3.1**.

22.2.4 Liquid waste

The mine operates the sewage treatment facilities described in **Section 3.1**.

The ‘machine shop’ / primary crusher and ‘Club’ septic tanks are inspected and pumped out regularly by a licenced disposal contractor, while the ‘Fettler’s shed’ unit is serviced by absorption trenches.

22.2.5 On-site resource recovery

Overburden material

Overburden material comprises topsoil and underlying weathered rock profiles, and could be considered as virgin excavated natural material (VENM).

Topsoil

Topsoil is reused on-site as described in **Section 26.2.2**.

__Overburden__

Weathered rock excavated as overburden is stockpiled in designated overburden emplacement areas, which are progressively rehabilitated. Select overburden material is also re-used for a wide range of purposes including earthen bunding, road repairs, upgrading of drainage works, rehabilitation and construction.

The 2017/18 Annual Environmental Management Report (Boral Cement Limited, 2018) states approximately 1,479,865 t of overburden was emplaced in the approved WOE and Barbers Creek Overburden Emplacement during the reporting period. This material was extracted predominately from the western side of the North Pit.

Waste lime management

During the process of limestone mining and lime manufacture, ‘waste lime’ is inadvertently generated due to a combination of process losses and inefficiencies (including spillage and kiln start–up/shut-down), production of lime products which do not meet specifications, and equipment breakdowns. Waste lime can be quicklime, hydrated lime or limestone, or any combination of the three.

The 2018-2023 MOP outlines Boral’s current approach to management of lime waste at the mine.

Past handling practice has involved collection of waste lime predominately from the limestone processing and lime manufacturing plant areas, and haulage to designated landfill sites within overburden emplacement areas.

Waste lime is currently placed in a designated area of the WOE, previously approved by the Resources and Geoscience division of DPE for the purpose.

To date, no significant environmental impacts beyond the immediate waste lime emplacement areas have been identified. Local impacts relating to dust generation, visual and potential safety risks have been managed by various methods of containment, usually by covering, and/or layering the fine, free flowing waste lime material with overburden material.

Despite this, Boral has identified potential environmental risks associated with waste lime, and as such, recent years have seen significant process improvements in an effort to reduce waste lime generation, and manage the handling and emplacement of waste lime, where required, in an environmentally responsible manner. Such improvements include recycling/re-working the waste (63% reduction in waste since 2010) construction of earthen containment bunds, surface water diversion bunds, and installation of groundwater monitoring wells to monitor for indications of leachate down gradient.

Remediation works, recommended within a Phase 1 Land Contamination Report prepared by RCA Australia Pty Ltd in October 2011, have also been carried out at the existing waste lime emplacement areas in order to improve the containment of the existing waste lime emplacements, and improve safety and environmental management of these areas.

__Lime processing improvements__

A number of trials have previously been undertaken within the lime manufacturing process, with the aim of reducing and/or recycling current production waste lime, and improving resource utilisation. These include:

- recycling of kiln dust into lime product;
- modification of kilnstone size to improve limestone yield;
- use of north pit stone for lime manufacturing in the kiln;
- use of hydrated lime sludge into hydrated lime manufacturing;
- use of high magnesium stone into lime manufacturing; and

- recycling quicklime spillage into lime manufacturing through flash calcination.

Recycling of kiln dust

About 7-10% of daily kiln production is fine lime dust, which is collected in bag filters. This averages approximately 7,000–10,000 tpa. Previously, this product has been placed in the designated waste lime emplacement area within the WOE.

During 2009, a dust recycling system was installed which conveys dust from a storage bin to the lime product conveyor at regulated rates. Following installation of the system, approximately 7,000 tonnes of kiln dust was recycled over a 12 month period, rather than being deposited in the waste lime emplacement area. This practice remains in place today and continues to promote recycling initiatives as opposed to long time storage.

Modification of kilnstone size to improve stone yield

The size range of limestone which can be used in the mine's rotary kiln has been successfully increased from previous kiln feedstock size of >15mm<75mm to >12mm<100mm. This has improved the stone yield by an estimated 15%.

Use of north pit limestone for lime manufacturing

Traditionally, the mine's rotary kiln has been operated with 'kilnstone grade' limestone sourced from the south pit. To date, trials involving modified kiln operating parameters have been successful in substituting south pit limestone with 'lower cost' north pit limestone, without any process and quality issues.

22.3 Impact assessment

The primary waste stream to be generated by the continuation of mining operations is overburden material. Approximately 108 million tonnes will be produced over the next 30 years of limestone mining, and will be stockpiled in designated overburden emplacement areas, including south pit (**Figure 4.7**). The potential environmental impacts associated with overburden emplacement have been considered in the various specialist technical assessments, and discussed in previous chapters.

There will be limited volumes of general solid wastes, along with hazardous and liquid wastes generated from operation and servicing of equipment. All waste generated at the site will be managed in accordance with the existing site waste management system. Waste streams generated will be classified according to the Waste Classification Guidelines (NSW Environment Protection Authority, 2014) and disposed of accordingly.

22.3.1 Construction phase impacts

Activities associated with the construction phase of the Project that have the potential to generate waste materials include:

- relocation of the stockpile reclaim area during expansion of the north pit;
- removal of native and exotic vegetation to accommodate new overburden emplacements;
- upgrades to, and realignment of Marulan South Road;
- realignment of a section of high voltage powerline to accommodate the proposed NOE;
- establishment of new infrastructure and services within the Project site;
- development of the road sales stockpile area;
- demolition of farm buildings to make way for the extended WOE, and
- construction of the Marulan Creek dam and associated infrastructure.

The nature and volume of waste generated during construction would be predominantly non-hazardous and relatively minor. However, there is potential for adverse impacts on the local environment if waste is not managed appropriately.

Inappropriately managed waste would have potential adverse impacts upon:

- visual amenity and aesthetic quality of the surrounding area;
- health and safety of local residents, workers and visitors;
- landfill space, through potentially reusable and/or recyclable materials contributing to landfill waste;
- native fauna through ingestion of fugitive waste materials e.g. plastic bags; and
- hazardous waste, in particular fuels or oils, leaching into local drainage lines and watercourses, leading to subsequent water quality degradation.

The following waste sources are likely to be generated by construction activities:

- removed native and exotic vegetation;
- general solid wastes (non-putrescible), including building and demolition waste;
- excavated material (e.g. spoil) unsuitable and/or not required for backfilling and restoration;
- maintenance waste – waste generated from construction plant and machinery maintenance, such as oil and fuel; and
- general solid wastes (putrescible) and liquid waste from construction personnel.

All wastes generated by construction activities associated with the Project would be classified and disposed of in accordance with (NSW Environment Protection Authority, 2014), and in accordance with the resource management hierarchy principles and associated requirements of the WARR Act and Protection of the Environment Operations (Waste) Regulation 2014.

22.3.2 Operational phase impacts

Waste products associated with the operation of the Project would be the same as those currently generated by existing mine operations. Operational waste products that will continue to be generated by the mine are identified in **Table 22.2**, including:

- quantity;
- source;
- whether it is re-used onsite;
- whether it is separated on-site for collection by a contractor for off-site recycling; and
- whether it is disposed of on-site or off-site.

Table 22.2: Operational waste inventory

Waste Description	Waste Classification	Source	Quantity	Re-used on-site?	Recycled?	Disposed of on-site / off-site
Sewerage	Liquid	Main Office Facilities	630 kg / week	No	Yes	On-site
Sewerage	Liquid	Other facilities: Lime plant, maintenance and old club.	420 kg / week	No	No	Off-site
Maintenance / Production waste	Solid	Workshop waste, explosive packaging, waste from mining processes	15 m³ / week	No	No	Off-site

Waste Description	Waste Classification	Source	Quantity	Re-used on-site?	Recycled?	Disposed of on-site / off-site
Office	Solid	General office waste	4.5 m³ / month	No	No	Off-site
Paper	Solid	Office	40 kg / year	No	Yes	Off-site
Rubber	Solid		70 t per year	No	Yes	
Scrap steel	Solid		8 t per month	No	Yes	
Timber	Solid		5 t per year	No	No	On-site
Hydrochloric acid	Liquid / Hazardous	Laboratory	0.9 L per week	No	Diluted, and recycled with liquid from sewerage treatment	On-site

Management of these wastes, including general solid wastes and hazardous and liquid wastes would continue to occur in accordance with current mine waste management systems and practices. Additionally, current on-site resource recovery initiatives for overburden and lime waste materials would continue.

All wastes generated by operational activities associated with the Project would be classified and disposed of in accordance with (NSW Environment Protection Authority, 2014), and in accordance with the resource management hierarchy principles and associated requirements of the WARR Act and Protection of the Environment Operations (Waste) Regulation 2014.

22.3.3 Cumulative impacts

The major source of waste from mining operations relates to overburden material. As opposed to off-site disposal to landfill, the material is placed in overburden emplacement areas and rehabilitated for long term stabilisation. As mining operations progress, some of the overburden would be re-used at the Project site to backfill the south pit, and for haul road maintenance and rehabilitation of disturbed areas. As a result, the major source of waste generated by the mine would be disposed of on-site, thereby avoiding the requirement for significant quantities of waste requiring removal from site and disposal in external landfill sites in the Goulburn Mulwaree region.

General solid wastes, liquid and hazardous wastes would continue to be generated by mining operations, however quantities of such wastes would not be deemed to be significant to the degree that would result in detrimental environmental outcomes, and collection and disposal of these waste streams would be undertaken by licenced waste contractors to ensure recycling or disposal in a legislatively compliant manner.

Other land uses within the vicinity of the mine include the adjacent Peppertree Quarry and other extractive industries in the Marulan district such as Lynwod Quarry and Gunlake Quarry. It is assumed that these operations would also be subject to regulatory requirements as dictated in conditions of consent or other legislative requirements, such as an EPL. As such, waste management practices at these nearby land uses would also be to an environmentally and legislatively responsible manner, thereby minimising the potential for cumulative impacts arising from operation of the mine, coupled with these similar industries.

22.4 Management measures

Waste management practices would be managed as set out in the WARR Act by adopting the resource management hierarchy principles (in order of priority) of avoidance, re-use, recycling / re-processing / treatment and disposal.

An environmental management strategy would be developed and incorporate measures to manage waste and resources, and would take account of the following factors:

- quantity and classification of materials that would be required to be removed from the Project site;
- disposal/reuse strategies for each type of material;
- details of how waste would be stored and treated on site;
- identification of non-recyclable waste;
- identification of strategies to reduce, reuse and recycle; and
- procedures and disposal arrangements for potentially hazardous material.

The environmental management strategy would include the following actions:

- all waste generated as a result of the Project would be managed in accordance with (NSW Environment Protection Authority, 2014) and relevant regulatory requirements. This will include (i) its classification prior to leaving the site and (ii) recording (via an appropriate waste tracking system) its legal off site transportation for re-use, recycling or disposal;
- any waste (excluding toilet waste) generated would be stored in a suitable container, with a lid, and transported from the site to an appropriate facility. A sufficient number of suitable receptacles for general waste, hazardous waste and recyclable materials would be provided for waste disposal at the Project site, including sufficient bins to allow separation of wastes for recycling;
- disposal of wastes will only take place at a licenced waste disposal depot;
- all wastes will be securely stored to ensure that any pollutants are prevented from escaping;
- any fuel, lubricant or hydraulic fluid spillages would be collected using absorbent material and the contaminated material disposed of at a licensed waste facility;
- all hazardous or contaminated wastes on site (if identified) will be removed and disposed in accordance with the state and national regulations and guidelines and best practice for the removal of these materials. Hazardous materials will only be removed by suitably qualified, licensed and experienced contractors;
- personnel will be required to notify the Mine Manager, and follow approved SafeWork NSW procedures for the handling and transport of any asbestos containing material wastes to an EPA approved facility;
- documents and records of the transport and fates of all materials removed from the Project site would be kept as proof of correct disposal and for environmental auditing purposes;
- waste streams will be sorted to maximise the reuse/recycling potential and minimise disposal costs;
- materials would be re-used or recycled wherever possible. Details relating to the recycling of materials at appropriately licensed recycling facilities would be provided;
- waste would be covered stored and removed in a timely manner so as not to attract native animals or vermin; and
- all waste material handling, transport and disposal will be in accordance with the requirements of the POEO Act, WARR Act and relevant OEH, EPA or WorkCover Guidelines, including (NSW Environment Protection Authority, 2014).

22.5 Residual impacts

With implementation of the waste management measures the risk of offsite waste impacts is minimal. As described in this chapter, the majority of waste generated on-site will be overburden, which will be entirely contained and managed on-site.

Chapter 23

Hazards and risks

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Hazards and risks

Hazardous substances to be used at the Project were screened against the thresholds in DPE's (2011) *Applying SEPP 33* to determine if the Project will be hazardous or offensive development under State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33). The quantities of dangerous goods proposed to be stored and handled at the Project will be below the thresholds in *Applying SEPP 33*. Therefore, the Project will not be a hazardous development.

The Project could be an offensive development under SEPP 33 if in the absence of safeguards and controls, the mine could 'emit a polluting discharge that could cause a significant level of offence'. However, if the EPA were to issue a licence for the pollution, then it is demonstrated that the pollution will not be significant and can be controlled via mitigation and management measures. It is expected the existing environmental protection license will continue for the Project (including updates associated with the Project). Therefore, it is unlikely the Project will be offensive development.

Boral will update the existing emergency and bushfire management plans to reflect the Project, which will continue to be implemented at the mine to reduce hazards and risk associated with the continuation of mining operations.

23 HAZARDS AND RISKS

23.1 Introduction

This chapter provides details on the potential hazards and risks associated with the Project, including potential risks to public safety and potential risks associated with bushfire events, along with strategies and management measures which, when implemented, would reduce these hazards and risks to acceptable levels.

Additionally, the chapter provides an assessment on the handling, transport, storage and use of dangerous goods within the Project site, and the implications of these dangerous goods with respect to State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33).

23.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely risks of the Project to public safety (Table 23.1).

Table 23.1: Hazards related SEARs

Requirement	Section and appendix where addressed
▪ Including an assessment of the likely risks to public safety, paying particular attention to the handling, transport and use of dangerous goods and potential bushfire risks, and in accordance with State Environmental Planning Policy No. 33 – Hazardous and Offensive Development.	23.2, 23.3, 23.4

SEPP 33 has been applied to the Project in accordance with (NSW Department of Planning , 2011).

23.2 Application of SEPP 33

(NSW Department of Planning , 2011) states that this EIS needs to determine if the Project will constitute a 'potentially hazardous industry'. If the Project is a potentially hazardous industry, then the SEPP applies and the guideline states that a preliminary hazard analysis (PHA) should be undertaken as part of the EIS.

A 'hazardous industry' under SEPP 33 is one which, when all locational, technical, operational and organisational safeguards are employed, continues to pose a significant risk. A proposal cannot be considered a hazardous industry unless it is first identified as potentially hazardous industry and subjected to the assessment requirements of SEPP 33.

The screening test for potentially hazardous industry relates to the type and quantity of hazardous materials or dangerous goods used and stored on-site, and the distance of the storage facility to the site boundary. As outlined in the following section, the hazardous materials and dangerous goods stored at the mine are below the screening thresholds stipulated in the guideline, and are transported, stored, handled and managed in accordance with relevant regulations and industry standards. As such, the Project does not constitute a potentially hazardous industry, and the assessment requirements of the SEPP, including requirement for a PHA, is not applicable to the EIS.

Despite the above, in accordance with the guideline, the mine may constitute a 'potentially offensive industry'. This is defined where in the absence of safeguards and controls, the mine could 'emit a polluting discharge that could cause a significant level of offence'. Examples of this may include depositional dust, or operational noise impacts on adjacent residents or land uses.

The guideline states that where a project requires pollution licencing from DECCW (now OEH/EPA), that the development could be considered as potentially offensive. The guideline suggests that if the regulatory authority were to issue a licence for the pollution, then this would suggest that the pollution would not be significant and can be controlled via mitigation and management measures. As such, the potentially offensive industry would not be proved to be defined as 'offensive industry'.

As considered in this EIS, the Project may emit pollutants, which in the absence of safeguards would potentially cause offense. However, management measures have been developed as part of this EIS to control and minimise these emissions or pollutants to a non-significant level. Additionally, Boral currently holds an EPL (No. 944), previously issued by the NSW EPA for the operation of the mine. This EPL would potentially require variation following consultation with the EPA following approval of the Project. However, the EPL would continue to be held for the lifespan of the Project. With this in mind, it is likely that the historical provision of an EPL by the NSW EPA is sufficient to suggest that existing levels of emissions and pollutants are acceptable to the regulatory authority, thereby concluding that the mine is not deemed as offensive industry.

Potential additional environmental impacts associated with the continued operations of the mine have been considered in this EIS. Various emissions and potential sources of pollution associated with the Project (including air quality, noise and surface water impacts) have been assessed by technical specialists, and these specialists have concluded that providing the implementation of existing and recommended management and monitoring measures, that these impacts would not be significant to the surrounding environment or community. As such, continued operation of the mine would not be defined as an offensive industry, and the offensive industry assessment requirements of the SEPP are not applicable to the Project.

23.3 Existing hazards and management

Bushfire and public safety risks are managed at the mine as described in **Section 3.1**.

23.3.1 Hazardous substance and dangerous goods management

A variety of hazardous substances and dangerous goods are used for mine operations. These include fuels, oils, greases, compressed gas, chemicals and explosives.

Dangerous goods and other hazardous substances are legislated under the NSW *Work Health and Safety Act 2011* and NSW *Workplace Health and Safety (Mines) Act 2013.*

Boral currently hold all necessary approvals under these Acts and maintain a system for managing dangerous goods and hazardous substances that satisfies the requirements of the legislation and relevant SafeWork NSW codes of practice. Boral also has lodged a NSW WorkCover Acknowledgement of Notification of Dangerous Goods on Premises (Acknowledgement No. 35/008099).

Hazardous substances and dangerous goods storage facilities are inspected annually by an external accredited inspector to check for any defects or upgrades required under relevant regulations.

Given that that Project is largely seeking a continuation of existing mining operations, introduction of additional classes of dangerous goods or hazardous substances is not anticipated.

The hazardous substances and dangerous goods will continue to be stored at the Project site using the current storage systems, as detailed below, with the same controls and management systems.

The main hazardous substances and dangerous goods required for the Project include hydrocarbons, compressed gas, explosives and chemicals. A brief description of these materials is presented in the following pages.

Hydrocarbons

Hydrocarbons used at the mine include fuels (diesel and petrol), oils and greases.

Diesel

Diesel is classified as a combustible liquid by Australian Standard (AS) 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* (AS 1940:2004) (Class C1) for the purpose of storage and handling, but is not classified as a dangerous good by the criteria of the Australian Dangerous Goods (ADG) Code (National Transport Commission, 2017).

The risks associated with the Project include diesel storage and usage. Existing diesel storage facilities at the mine site includes a 95,000 L above ground tank stored adjacent to the limestone processing facilities. A concrete bund surrounds the tank, and any spills which occur in the collection areas are adequately contained within bunds, managed in accordance with emergency response procedures, and classified and disposed in accordance with relevant waste legislation. No spills or leaks have been noted at the storage facility to date.

The mine currently consumes approximately 2.5 ML of diesel per annum, which are typically delivered to site in weekly bulk deliveries of approximately 51,000 L.

The existing diesel storage facility would continue to be operated in accordance with the requirements of AS 1940:2004, as would any upgrades to these facilities over the life of the Project. Additional hydrocarbon storage (e.g. diesel and oils) may also be required by the Project as mining operations progress. Any future construction and/or upgrades of storage facilities would be undertaken in accordance with AS 1940: *The Storage and Handling of Flammable and Combustible Liquids* and the *Work Health and Safety Act 2011*.

Diesel would not be stored within the same bund as other flammable liquids, and as such would not be subject to the Applying SEPP 33 screening thresholds. As a result, the storage of Diesel is not considered potentially hazardous in terms of SEPP 33.

Petrol

Petrol is classified as a flammable liquid (Class 3) by AS 1940:2004, and as such is classified as a dangerous good by the criteria of the ADG code. The risks associated with the Project include petrol storage and usage. Existing petrol storage facilities at the mine includes a 12,000 L underground storage tank located at the 'Store', approximately 800 m from the site boundary.

The mine currently consumes approximately 10,000 L of petrol per annum, which are typically delivered to site in bulk deliveries of up to approximately 4,000 L every 4 months.

The above quantities and setback requirements for the storage of petrol comply with the screening thresholds specified in Applying SEPP 33. Quantities were converted to tonnes and distances measured from the storage area to the closest site boundary. In accordance with Graph 9 of Applying SEPP 33, the quantity and setback distance of petrol stored at the site is located outside of the 'Potentially Hazardous Region', and the storage of petrol is not considered potentially hazardous in terms of SEPP 33.

Oils and greases

Oil is classified as a combustible liquid (Class C2) by AS 1940:2004. Oils are currently stored within bulk storage tanks within a roofed storage facility at the mine, approximately 900 m from the site boundary. A maximum of 10,000 L of hydraulic oil, engine oil and torque fluids respectively are stored within these storage tanks.

Used engine oils (lubricating oils), torque fluids and hydraulic oils are recovered during plant and vehicle servicing in the workshop. Oil and grease generated at the workshop pass through an oil and grease separator. Recovered oil and grease material is then collected and stored in storage tanks for removal by a licensed recycling contractor.

The mine currently consumes approximately 31,000 L of hydraulic oil, 35,000 L of engine oil and 8,500 L of torque fluids respectively per annum. These oils and fluids are typically delivered to site in bi-monthly bulk deliveries of up to approximately 5,000 L.

Small quantities of grease would also be required. Existing procedures at the mine for the handling, storage, containment and disposal of workshop hydrocarbons (i.e. oils and greases) would continue to be implemented for the Project in accordance with AS 1940:2004.

Lubricating and hydraulic oils and greases would not be stored within the same bund as other flammable liquids, and as such would not be subject to the Applying SEPP 33 screening thresholds. As a result, the storage of these materials is not considered potentially hazardous in terms of SEPP 33.

Liquid petroleum gas (LPG) and compressed gas

The ADG code classifies LPG as a Class 2.1 flammable gas. Existing LPG storage facilities at the mine includes an above ground storage area comprising of refill cylinders. LPG is currently, and will continue to be stored in accordance with Australian Standard/New Zealand Standard 1596:2008 The storage and handling of LP Gas (AS/NZS 1596:2008) (Standards Australia 2008).

The mine currently consumes approximately 2,500 L of LPG per annum. As such, the quantities of LPG stored will be less than the SEPP 33 potentially hazardous threshold quantity of 10 t.

Boral also store oxy acetylene cylinders at the mine’s cylinder store for use in welding activities. The ADG code classifies the cylinders as a Class 2.3 flammable gas.

The mine consumes the compressed gas cylinders sporadically, with a range of approximately 5 kg to 40 kg stored on-site. As such, the quantities of compressed gas stored will be less than the SEPP 33 potentially hazardous screening threshold quantity of 100 kg.

In accordance with the above, the storage of these materials is not considered potentially hazardous in terms of SEPP 33.

Explosives

Explosives are classified as Class 1.1D by AS 1940:2004, and as such is classified as a dangerous good by the criteria of the ADG code.

Explosives required for the Project would include initiating products, detonators and emulsion explosives. In accordance with the ADG Code, explosives are currently supplied and transported to the mine by an independent, licenced contractor.

The mine currently consumes approximately 5,000 kg of initiating products, detonators and connecting cord classes of explosives per annum, which are typically delivered to site by a licenced contractor in bulk deliveries of up to approximately 400 kg per delivery. Approximately 1400 tpa of emulsion explosives are used at the mine for blasting which are delivered by an external contractor in a bulk gel form of up to 10 t per delivery

As bulk explosives are not stored at the site (other than detonators/initiators and accessories) but rather imported to site by a qualified and licensed contractor, the screening thresholds specified in Applying SEPP do not apply, and the use of explosives is not considered potentially hazardous in terms of SEPP 33.

Chemicals

Boral utilises a variety of chemicals within the laboratory located on-site. The quantity of these materials stored and consumed at the mine is generally low. All chemicals stored in the laboratory are managed in accordance with the relevant Australian Standards, code or other regulation, and in accordance with the requirements of the safety data sheet (SDS) for the particular substance. The chemicals are generally stored in 5–20 L plastic storage containers and stored in a secure, enclosed room.

The primary chemicals used in the laboratory include Ammonia solution (approximately 2.5 L per month), Derket (descaler) (approximately 2 L per month), Home Kerosene (approximately 4 L per month), Hydrochloric Acid (approximately 2 L per month), Iso-propanol (approximately 8 L per month) and Potassium Hydroxide (approximately 0.5 L per month).

Chemicals utilised at the mine generally constitute classification of a flammable liquid (Class 3) or corrosive substances (Class 8) by AS 1940:2004, and as such are classified as dangerous goods by the criteria of the ADG code.

The quantities of chemicals stored at the mine is less than the SEPP 33 potentially hazardous threshold quantity for Class 8 materials. Additionally, the quantities and setback requirements for the storage of Class 3 chemicals comply with the screening thresholds specified in Applying SEPP 33. Quantities were converted to tonnes and distances measured from the storage area to the closest site boundary. In accordance with Graph 8 and 9 of Applying SEPP 33, the quantity and setback distance of chemicals stored at the site is located outside of the ‘Potentially Hazardous Region’, and the storage of these chemicals is not considered potentially hazardous in terms of SEPP 33.

The management and storage of chemicals at the mine would continue to be conducted in accordance with Boral’s prescribed management procedures and Australian Standards, codes and relevant regulations.

All chemicals transported on-site for future use at the mine would be recorded in the existing inventory registers at the laboratory. No chemicals or hazardous substances would be permitted on-site unless a copy of the appropriate SDS is available on-site or, in the case of a new product, it is accompanied by a SDS.

The Project is not anticipated to require introduction of any new hazardous substances or dangerous goods to the mine. The Project would involve an increase in the amount of process consumables used at the mine, due to the increased production of the mine over its lifespan. However, no changes to the existing on-site handling, storage or management of these materials would be required for the Project, and all materials would continue to be stored and used in accordance with the relevant SDS’, Australian Standards, codes or other regulations.

23.3.2 Emergency management

Boral maintains emergency preparedness as a commitment to its workforce (including subcontractors), customers, neighbouring community and shareholders in providing a safe, healthy and environmentally responsible working environment. Whilst prevention is the first defence against any incident or emergency, Boral is also prepared to respond to potential incidents, regardless of how large or complex.

Emergency response is a component of Boral's current safety management system, and is outlined in the Site Emergency Response Plan, and Pollution Incident Response Management Plan, which sits as a supplementary plan to the Emergency Response Plan.

23.4 Impact assessment

The major hazards identified for the Project have been grouped into broad categories and are outlined in the following sections. These hazards and risks were identified in numerous risk workshops conducted during the EIS studies, which included relevant experts and experienced personnel. For each risk, the potential hazard, the possible causes, and the foreseeable consequences are outlined, whilst key mitigation and management measures are presented in **Section 23.5**.

Hazards were also identified through a review of Boral's existing risk registers, including the *'Broad Brush Risk Assessment relating to Environmental Aspects for the Blue Circle, Marulan Limestone Mine, Marulan'* (GSS Environmental Pty Ltd, 2008).

23.4.1 Bushfire

The majority of vegetation within the Project site consists of fragmented remnant and recovering stands of open Eucalypt woodland, interspersed with low diversity grassland and exotic pastures. This pattern reflects the extensive historical agricultural land use of the wider region, predominantly as grazing land for livestock.

The eastern and southern boundaries of the Project site are situated directly adjacent to dense bushland areas associated with the Morton NP, Bungonia NP and Bungonia SCA.

A bushfire risk management plan was developed in 2009 for the Southern Tablelands region by the Southern Tablelands Zone Bushfire Management Committee. The plan identifies land areas and associated community assets within the Goulburn Mulwaree LGA at risk of bushfire, and recommends measures to reduce these risks. The mine itself, and surrounding areas were not listed within the Plan.

The bushfire season in the Southern Tablelands region predominantly occurs during the hotter months of the year, between October and April. The prevailing weather conditions associated with the bushfire season are north and north-westerly winds, with short periods of southerly and easterly winds in the late afternoon.

The Southern Tablelands region has an average of 265 bush fires per year, with five of these fires considered to be large fire events. Historically, major bush fires occur sporadically within a three to five year period, however this varies among the different LGAs which comprise the region. The Goulburn Mulwaree LGA has a history of major fire events occurring within a cycle of five to seven years.

The main sources of bushfire ignition within the region include:

- lightning;
- fugitive embers from legal burn off events;
- fugitive embers from illegal burning;
- human error (e.g. fire ignition via use of farm machinery or motor vehicles, and incorrect disposal of cigarette butts along roadways); and
- arson.

The land within the Project site is considered to pose a low to moderate risk of bushfire due to limited available fuel source; existing vegetation composition interspersed with disturbed areas, large open mine pit and mine infrastructure; future vegetation composition associated with proposed rehabilitation of overburden areas; and current agricultural land uses within and adjacent to the Project site.

During construction and operation of the Project, various activities may result in inadvertent bushfire ignition. Such activities may include grass fires sparked by the hot exhaust of vehicles driving or parking in long, dry grassland; fires sparked during hot work activities such as welding; clearing of vegetation for overburden emplacement activities; or stockpiling of removed vegetation and timber (prior to reuse in revegetation or rehabilitation) contributing to a fuel source for ignition. However, strategic mitigation and management measures, as outlined in Boral's Marulan South Operations Bushfire Management Plan 2015, summarised in **Section 23.5.1**, would be implemented in order to ensure that the potential for bushfire events or risks as a direct result of construction and operation of the Project remains low. Further, employees are trained for hot work and carry it out in accordance with safe work methods.

The 'Marulan Rural Bushfire Brigade' monitors bushfire risks within the vicinity of the Project site, and conducts an annual inspection to determine levels of natural fuel sources in and around the mine. Subsequent bushfire risks are minimised by carrying out 'burn offs' as required, in accordance with the necessary permits and regulations.

In addition, fire risks associated with natural fodder or grassed paddocks in and surrounding the mine are currently controlled by sheep grazing, or by leasing rights for grazing.

Adjoining environmental conservation reserves including Morton NP, Bungonia NP and Bungonia SCA, would experience build-up of high fire fuel sources over time, associated with dense vegetation canopy contributing to leaf litter and tinder on the ground surface. A combination of relatively low rainfall, dry nature of the landscape, topography, and dense vegetation and high fuel source in these reserves could pose a significant bushfire risk to the mine and adjacent residential and commercial land uses. Bushfire risks within the reserves would be managed by NSW Rural Fire Service along with the relevant land authority including National Parks & Wildlife Service and NSW Department of Primary Industries (Crown Lands). Boral will continue to work with the Marulan Rural Bushfire Brigade, NSW Rural Fire Service and respective land authorities to co-ordinate any scheduled burn off events, and monitor and report any fires, suspicious behaviour or hazardous fuel loads within proximity to the mine's boundary.

The prevailing weather conditions associated with the bushfire season are north and north-westerly winds, with short periods of southerly and easterly winds in the late afternoon. As such, firebreak design will therefore take into consideration that a bushfire is likely to enter the Project site from the north-west, and exit the Project site to the south-east. Firebreaks should also be designed to protect the western and southern boundary of the Project site, by stopping or slowing the path of the bushfire within the Project site, thereby minimising the threat to the environmental conservation areas to the east and south.

23.4.2 Soil and water contamination

In the event of a spill of the hazardous substances or dangerous goods stored and used on-site, via human error, or failure or rupture of the storage vessel, potential impacts may include localised contamination of soil and water, as well as impacts on health and safety. Spill response is included in the eSite emergency response plan.

If released to the environment uncontrolled, hydrocarbons and chemicals may be damaging to soils and aquatic ecosystems, and fires can occur if these materials are ignited.

Potentially hazardous products such as fuels, oils, lubricants, grease and other chemicals required for construction and operation of the mine would be contained within appropriately bunded areas in accordance with relevant Australian Standards, codes and regulations, as outlined previously.

Refuelling and maintenance activities would be restricted to hardstand bunded areas within the workshop. As such, the risk of soil, surface water and groundwater contamination during the Project arising from spills is anticipated to be low.

Plant and equipment would also be maintained to minimise the potential for leakages, while appropriately sized and stocked spill response kits would be provided within strategic areas of the mine, and within mobile vehicles.

Any accidentally contaminated soil would be excavated, stockpiled, chemically classified for disposal and transported to an appropriately licensed waste facility.

23.4.3 Explosion

Fire or explosion may arise during construction and operation of the Project due to ignition of flammable or combustible material, or unintentional detonation of explosives resulting in injury or destruction of property.

Fire or explosion within a confined space may have catastrophic consequences, whilst fire may spread to other areas of the Project site in strong wind conditions, thereby triggering a potential bushfire event on and off the Project site.

The risk of explosion would be minimised via avoiding the bulk storage of explosive material. Currently, all explosives are transported to the mine by a licenced contractor as required. This therefore avoids the requirement for bulk storage on-site which has inherent risk.

The potential for fire events would be minimised as all storage areas are designed, installed and maintained as required by relevant Australian Standards, codes or regulations. Providing these storage areas are frequently inspected and audited for effectiveness and defects, these materials would be adequately contained and the potential for fire or explosion via a spillage or tank rupture would be minimised.

23.4.4 Risk to workers

As with any operational mine site, daily mining operations have inherent risk to workers and contractors. Such activities have the potential to result in injury or fatality in the event that workers are ill informed of the hazards involved, or plant and machinery are not mitigated via various controls. Examples of activities which could result in injury or fatality include crush injuries by moving plant and equipment, motor accidents or crush by heavy vehicles, exposure to hazardous materials, heat exhaustion, working from heights or confined spaces, blasting events and exposure to airborne dust and industrial noise.

Boral has a rigorous workplace health and safety regime, as required by the NSW *Work Health and Safety Act 2011* (WHS Act). All workers, contractors and visitors are inducted on the mine's safety protocols and procedures before entering active parts of the site. All personnel working on the mine site are required to wear personal protective equipment (PPE) such as hard hats, high visibility clothing and enclosed footwear. Communication of safety requirements and initiatives is also undertaken on a daily basis.

Provided the continued implementation of workplace health and safety protocols during construction and operation of the Project, as required by the *WHS Act 2011* and other relevant regulations or standards, the potential for injuries or fatalities to workers, contractors or visitors to the mine would be minimised.

Designated first aid and emergency rescue facilities and equipment would be available during construction and operation phases of the Project. Appropriately trained personnel will be on site throughout the life of the Project to provide first aid and respond to site emergencies.

Any injuries or fatalities incurred at the mine would be reported and investigated in consultation with DRG and other relevant authorities.

23.4.5 Public safety

Risks to public safety may potentially arise where members of the public may potentially gain unauthorised access to the site via Bungonia NP to the south, or Morton NP to the east of the mine. This is particularly hazardous as it could result in potential fatality for members of the public associated with non-evacuation of potentially impacted areas during blasting events, along with other risks involved with other mining operations, including movement of heavy vehicles and moving plant.

To address the risks to public safety, Boral has previously undertaken a review of the security network and implemented various extensions and improvements to the existing security network including new fencing, gates and signage.

With these security initiatives in place, coupled with a regular review and inspection of the integrity and effectiveness of these measures, the potential for members of the public to gain unauthorised access to the Project site will be minimised.

As mining operations progress into previously undisturbed areas, Boral would investigate requirements to extend the existing security network to cover these additional areas. This may require extension of perimeter fencing and additional signage as visual deterrents.

23.4.6 Road safety

Heavy vehicles associated with transport of materials and products from the mine, along with deliveries of consumables, frequently travel along the Hume Highway and Marulan South Road on route to and from the mine. Potential implications to the general public who also utilise these public roadways may occur in the event of a motor vehicle accident, or tip over resulting in the spill of materials across the roadway. Such events could result in injury, fatality, or general inconvenience to the community associated with road closures.

As outlined in **Chapter 21**, the Project is not expected to result in any negative impacts to other road users, including school buses which utilise Marulan South Road in the vicinity of the mine.

Boral is proposing various upgrades to Marulan South Road, including widening of the narrower sections to Austroads and Council standards, and the realignment of a section of Marulan South Road to the north of the proposed WOE. These works will improve the standard of the existing road.

On the wider road network, traffic generated by the mine join and depart the Hume Highway via the existing grade separated interchange intersection, and travel north and south via the Highway. This interchange has substantial additional capacity and permits all vehicles to enter and exit the Hume Highway safely.

Therefore, the Project is expected to have negligible adverse impacts on other road users, and the safety of the public road network.

23.4.7 Cumulative impacts

Despite the Project site being located within proximity to Peppertree Quarry and other extractive and industrial applications in the Marulan district, there will be no significant cumulative risks as a result of the proximity of the mine to these operations.

It is assumed that these operations would also experience similar hazards and risks at these individual sites, and would also be subject to regulatory requirements in regards to storage and use of hazardous materials and dangerous goods. As such, storage facilities and management practices at these nearby operations would also be to an environmentally and legislatively responsible manner, thereby minimising the potential for cumulative hazards or risks arising from operation of the mine, coupled with these similar industries.

As the mine operations are situated entirely on privately owned Boral land, and at a sufficient setback distance from neighbouring commercial and residential receivers, it is considered that the potential for hazards and risks associated with the Project site itself to impact upon surrounding sensitive receptors and land uses is minimal. The exception to this would be a fire event, which may be ignited by an incident associated with the Project site, which could spread to surrounding vegetation and become a bushfire. Bushfires threaten people, property and the environment. Controls for the prevention and management of bushfire are outlined above.

The Project involves continued operation of the mine, which to date has been operated and managed in a manner designed to try and achieve zero harm. It is considered that with no additional hazardous substances or dangerous goods being required to be used in mining operations, and the continued storage and management of these materials to industry standards, would ensure that the Project would not contribute additional hazards or risks, or deteriorate existing conditions at the mine. As such, the potential for future incidents to occur will be minimised.

23.5 Management measures

23.5.1 Bushfire

Boral would continue to review and implement the Marulan South Operations Bushfire Management Plan for the Project. The Plan has previously been prepared in accordance with NSW *Rural Fires Act 1997* and in consultation with the RFS. Any future additions or amendments to the Plan would also be conducted in accordance with relevant legislation and in consultation with the RFS.

The Plan includes the following objectives:

- establish procedures to maintain and monitor areas and equipment where bushfire risks are present, to prevent or minimise the outbreak of fire;
- minimise the risk of bushfires spreading from the Project site to adjacent land uses: and
- establish measures to respond to and control the outbreak of fires.

The Plan will be updated to reflect new Project elements and areas.

Risk assessment

An annual bushfire risk assessment will be undertaken on the Project site before the commencement of the bushfire season (October to March). However, factors such as fuel load, rainfall history and climatic conditions may bring forward or extend the bushfire season.

The bushfire risk assessment will consider:

- fuel loads on the Project site;
- advice from the Marulan brigade captain of the RFS;
- the climatic conditions (particularly rainfall) of the preceding year; and
- methodologies of bushfire risk assessment

Total fire bans

Activities that create sparks or hot particles, such as metal grinding and welding, would be limited to workshops and hardstand areas, or areas clear of vegetation by a minimum of 20m. Designated hot work areas will have completed a “Designated Hot Work Area Risk Assessment HSEQ-6-06-F01”.

All fire bans, as determined by the RFS, will be adhered to by employees, contractors and service providers and enforced by Boral.

On days of total fire ban, Boral would undertake an inspection of all fire fighting equipment and conduct a toolbox talk or briefing with mine personnel on the restrictions associated with total fire bans.

On days of total fire ban, the following activities would not be permitted across the entire Project site:

- hot works in the open air;
- driving of vehicles on or over vegetation;
- mowing/slashing activities; or
- earthworks in vegetation.

On days of ‘Catastrophic Fire Danger’ as advised by the NSW Rural Fire Service, the following activities would be undertaken in addition to those undertaken on total fire ban days:

- A risk assessment of all mining operations;
- A risk assessment on closing the plant and sending personnel home;
- An inspection and test of all fire fighting equipment; and
- Establishment of communications with the Marulan Brigade Captain.

On days of catastrophic fire danger, the following activities would not be permitted across the entire Project site in addition to those required on total fire ban days:

- All hot works;
- Driving in or on vegetation in any vehicle;
- Explosions, other than pre-charged holes; and
- Train despatch wherever possible.

Fire preparation and response

Information on the bushfire danger period is broadcast by the official emergency warning radio, which locally is 666 ABC Radio Canberra. A radio shall be set up within the administration building to receive these warnings. The radio shall have an emergency backup power supply, so it will continue in the event of a power failure. Dedicated personnel shall be directed to listen to the radio broadcast on days of very high fire danger and above.

23.5.2 Hazardous substance and dangerous goods

When storing and handling hazardous substances, the management objectives are to avoid contamination of soil and water, and to minimise risks to health and safety, which can be achieved by implementing the following management and mitigation measures:

- all personnel are to complete awareness training that includes hazardous substance management, emergency response and the use of spill kits;
- hazardous materials shall be transported to and from the Project site by a licenced contractor, and stored and handled in accordance with relevant regulatory requirements, Australian Standards and the ADG Code;

- storage facilities for hydrocarbons, LPG and other hazardous materials will be designed in accordance with applicable Australian Standards and legislation;
- storage facilities, vehicles and transport vessels used on-site are to be regularly inspected for leaks, spills or other damage;
- storage facilities are to be inspected annually by an independent and suitably accredited inspector;
- storage and handling of chemicals shall comply with Australian Standards, including but not limited to, AS1940 Storage and Handling of Flammable and Combustible Liquids, 2004;
- appropriately sized and stocked spill response kits would be provided within strategic areas of the mine, and within mobile vehicles used to transport hazardous materials at the site;
- spill response kits would be maintained, clearly identified and readily accessible on site for use in case of accidental spill. Key staff would be skilled in their location as well as usage, application and disposal of contaminated material;
- ensure all dangerous goods are securely stored, with fencing, signage and restricted access for authorised personnel only;
- during construction activities, all potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) would be stored in appropriate containers in bunded areas within mobile vehicles, or designated storage areas to minimise the risk of spillages and mobilisation of any pollutants into the soil or aquatic environments;
- conduct refuelling, fuel decanting and vehicle maintenance work within work compounds where possible. If refuelling in the field is necessary, do so in a designated area away from waterways and drainage lines with spill response kits immediately available;
- equipment will not be used if there are any signs of fuel, oil or hydraulic leaks. Leaks will be repaired immediately or the equipment will be removed from site and replaced with a leak-free item;
- all chemicals and fuels will be stored, labelled, transported and used in accordance with Australian Standards and in line with best practices. All hazardous substances or chemicals imported to site shall be accompanied by a SDS;
- a database would be maintained to assist in the recording and management of chemicals and hazardous substances stored at the Project site;
- any fuels spillage will be collected and the contaminated material disposed of at a licensed waste management facility; and
- develop emergency procedures for dealing with spillage of chemicals or fuels.

23.6 Residual impacts

The Project will not involve transport, storage and use of hazardous materials at sufficient quantities and/or distances to public areas to qualify as hazardous industry under SEPP 33. The Project will not qualify as offensive industry under SEPP 33 as it will operate under an EPL and all licence requirements will be complied with.

The Project has been designed to minimise the occurrence of bushfire, contamination, explosion, public safety and road safety risks and/or their consequences. These risks will be further examined as part of detailed project design and re-assessed in an ongoing hazard assessment process to ensure that risks are kept as low as reasonably and practically possible.

With the continued implementation of the management measures contained in Boral’s Marulan South Operations Bushfire Management Plan, the risk of a fire starting on Boral owned land and moving onto adjacent properties is low.

Chapter 24

Economics

VOLUME 1

Economics

Cost benefit analysis (CBA) and two forms of local effects analysis were used to assess the potential economic impacts of the Project in refence to the Project not being approved and the mine closing.

CBA is concerned with whether the incremental benefits of the Project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the Project compared to 'without' it. The CBA compared the production and environmental costs with the production benefits, such as the value of the limestone and residual land values at the end of the Project.

The CBA determined the Project will have net social benefits to Australia of $643 million (M) and to NSW of $321 M including employment benefits and a 7% discount rate. Any unquantified residual impacts of the Project after mitigation, offset and compensation would need to be valued at greater than these amounts for the Project to be questionable from a national and NSW economic efficiency perspective.

The local effects analysis determined the Project is likely to have the following net local (LGA) benefits:

- 42 full time equivalent jobs;
- $3.1 M disposable wages per year; and
- $7.1 M of other non-labour expenditure.

The supplementary local effects analysis used an input-output (IO) table to identify the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of indicators of economic activity – output, income, value-added and employment. The IO analysis determined the Project will make the following contributions to the region:

- $82 M in annual direct and indirect regional output or business turnover;
- $48 M in annual direct and indirect regional value added;
- $14 M in annual direct and indirect household income; and
- 198 direct and indirect jobs.

The IO analysis determined the Project will make the following contributions to NSW:

- $137 M in annual direct and indirect regional output or business turnover;
- $74 M in annual direct and indirect regional value added;
- $27 M in annual direct and indirect household income; and
- 364 direct and indirect jobs.

24 ECONOMICS

24.1 Introduction

This chapter summarises the economic assessment report, which is in **Appendix U**. It describes the cost benefit analysis (CBA), local effects analysis (LEA) and supplementary local effects analysis of the Project.

24.1.1 Assessment requirements

The SEARs require an assessment of the likely economic impacts of the Project (**Table 24.1**).

Table 24.1: Economics related SEARs

Requirement	Section and appendix where addressed
▪ An assessment of the likely economic impacts of the development, paying particular attention to:	Chapter 24, Appendix U
- the significance of the resource;	24.5.1, Appendix U
- the economic benefits of the project for the State and region; and	24.5.2, Appendix U
- the demand for the provision of local infrastructure and services.	24.5.3, Appendix U
▪ The reasons why the development should be approved having regard to physical, economic and social considerations, including the principles of ecologically sustainable development.	6.3.5

The following guidelines were used for the assessment:

- *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Department of Planning and Environment, 2015); and
- *Draft guideline for economic effects and evaluation in environmental impact assessment* (Planning NSW, 2002).

24.1.2 Overview of assessment methods

Cost benefit analysis

CBA is the standard technique applied to identify changes in aggregate wealth, from a national perspective, associated with alternative resource use patterns.

CBA compares the present value of aggregate benefits to society as a result of a project with the present value of the aggregate costs. It is the financial and non-financial values held by individuals in society that are relevant. Provided the present value of aggregate benefits to society exceed the present value of aggregate costs (i.e. a net present value of greater than zero), the project is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

The key steps in CBA are:

1. **Establish the base case** against which to assess the potential economic, social and environmental impacts of changes due to the project.
2. **Define the project** including all significant inputs required to achieve the project's objectives.

3. **Quantify the changes** from the base case resulting from the project. This will focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the project.
4. **Estimate the monetary value of these changes** and aggregate these values in a consistent manner to assess the outcomes. Where market prices exist, they are a starting point for valuations of both outputs and of inputs used for production. For non-market goods, as for many environmental impacts and some social impacts, the aim is to value them as they would be valued in money terms by the individuals who experience them.
5. **Estimate the net present value (NPV)** of the project's future net benefits, using an appropriate discount rate.
6. **Undertake sensitivity analysis** on the key range of variables, particularly given the uncertainties related to specific benefits and costs.
7. **Assess the distribution of costs and benefits** across different groups.
8. **Report CBA results, including all major unquantified impacts** so the appraisal addresses and incorporates all material relevant to the decision maker.

Local effects analysis

LEA complements CBA by translating effects at the NSW level to impacts on the communities near the Project site (using Statistical Area Level 3 – the LGA). It also provides additional information to describe changes that are anticipated in a locality, such as employment changes. LEA informs the scale of change rather than being representative of costs and benefits to the local community.

The local effects analysed in a LEA are:

- local employment and income effects;
- other local industry effects, for example on suppliers; and
- environmental and social change in the local community.

24.2 Cost benefit analysis

24.2.1 Cost and benefit estimates

In summary, CBA is concerned with whether the incremental benefits of the Project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the Project compared to 'without' it.

The base case (without the Project proceeding) for the CBA was continued mining at 3.38 Mtpa until 2021[3] with rehabilitation and decommissioning. Relative to the base case, the Project may have the incremental economic benefits and costs in the description columns of **Table 24.2**.

The main potential economic benefit is the producer surplus (net production benefits) generated from mining, producer surplus generated from ex-mine transportation to customers, any wage benefits to employment, nonmarket benefits to employment, economic benefits to existing landholders or benefits to suppliers. The main potential economic costs relate to any environmental, social and cultural costs of mining and product transportation, including any net public infrastructure costs and loss of surpluses to other industries.

[3] The economic impact assessment is undertaken on a financial year basis, discounting costs and benefits to the beginning of the 2018 financial year i.e. 1 July 2018. It was assumed that without Project approval the existing mine would cease in the 2021 financial year, essentially June 2022, with the current mining lease expiring on 26 February 2023 (7 months later). Using end of June 2022 as the date at which mining is assumed to cease rather than 7 months later in February 2023 results in a slight reduction in net benefits of the Project but would be well within the bounds of the sensitivity analysis.

The environmental, social and cultural costs are only economic costs to the extent that they affect individual and community well-being through direct use or non-use of the environmental factors. Unless community well being is significantly affected by these, only mitigation, compensation or offsetting costs are included in the CBA.

The analysis period was 32 years (Project life plus two pre-Project years) and was in real values with 7% discounting. Where available, competitive market prices were used as indicators of economic values.

Production costs

Production costs were applied as follows:

- Opportunity cost of land – most of the land is owned by Boral and some is leased or Crown land. This land could be used for rural production rather than mining and has an estimated value of $14 M in 2021.
- Capital equipment and infrastructure – there is an opportunity cost of using this equipment for the Project instead of its next best use of $44 M in 2021.
- Development cost – capital costs for construction, mobile plant and replacement and upgrades of major fixed plant will be $111 M.
- Additional one-off costs – $4 M was attributed to acquisition of biodiversity offsets and surface and ground water WALs; and preparation of management plans.
- Annual operating costs – operating costs of $31 M/year include those associated with mining (including implementation of management plans and management of stewardship sites), limestone production, overheads and administration (including labour). Operating costs do not include royalties or depreciation.
- Rehabilitation and decommissioning costs – the cost to decommission and rehabilitate the mine will be approximately $19 M.

Production benefits

Production benefits were applied as follows:

- Avoided rehabilitation and decommissioning costs – avoiding the $19 M cost to decommission and rehabilitate the mine in 2021 is a benefit of the Project.
- Value of lime and limestone – The main economic benefit of the Project will be the market value of the annual lime and limestone produced for external and internal sale. The internal price was estimated at $18/t.
- Residual value at end of evaluation period – the capital equipment was estimated to be worth $44 M and land (not including stewardship sites) in the Project site was estimated to be worth $14 M at the end of the Project life.

As product transport externalities are a consideration of the EIS, economic benefits associated with transportation of mine product to customers were considered. These production benefits relate to the net revenue that accrues to transport provided and was estimated to be $45 M during the Project life.

Environmental, social and cultural impacts

Other than GHG and historic heritage, costs or benefits were not attributed to environmental, social or cultural impacts as:

- The opportunity costs of any foregone agricultural production was incorporated in the CBA by inclusion of the full value of land required for the Project (including land already owned by Boral).
- There will be no material noise, blasting, air quality or visual impacts.
- The opportunity cost of extracting 183 ML/year from Marulan Creek dam was included in the operating costs by applying an assumed market value of water of $1,800/ML.

- No private registered bores will be impacted by the Project and hence no material impacts from an aggregate economic efficiency perspective were identified for inclusion in the CBA.
- The capital and operating costs of providing biodiversity offsets were included in the capital and operating costs of the Project.
- The cost of road upgrades were included in the capital costs of the Project. The continuing contribution to Council for road maintenance was included in the operating costs of the Project.
- Any impacts on Aboriginal heritage sites may impact the well-being of the Aboriginal community. However, monetisation of these impacts is problematic and so these impacts were left to consideration in the Aboriginal Cultural Heritage Assessment Report.

To place an economic value on CO_2-e emissions, a shadow price of CO_2-e is required that reflects its global social costs. The global social cost of CO_2-e is the present value of additional economic damages now and in the future caused by an additional tonne of CO_2-e emissions. A shadow price of AUD$23/t CO_2-e was applied to the 13,979 t CO_2-e Scope 1 and 2 emissions during construction and the 110,440 t CO_2-e Scope 1 and 2 emissions per year during mine operation.

The values of the directly impacted historic heritage items were estimated at $4.3 M for the Australian population, $1.4 M for the NSW population and $0.006 M for the Goulburn Mulwaree LGA population.

Employment

Market benefits to workers were determined by assuming 50% of the direct workforce (96 employees) would be unemployed for three years if the mine closed and would have a reservation wage of $39,350, compared to $97,000 if they continued working. The market employment benefit would be $13 M, which would mostly accrue to the region since 92% of employees reside in the region.

Adjoining land values

During consultation, a mine neighbour expressed concern that expansion of the mine towards adjoining properties may decrease their land values. The value of land is a function of the attributes of the property including structural, access and environmental attributes. For remote rural properties there is a simple relationship between the agricultural income earning potential of the land and the capital value of the property.

Conceptually, if surrounding properties are likely to be impacted by noise, odour, vibration or visually, then there would be some impact on property values, with the greatest impact on property values being felt by properties experiencing the greatest impacts from the mine. Logically, where impacts exist or are expected to exist they are likely to be greatest with closer proximity to the mine and therefore there is likely to be some gradient of property value impact that decreases with distance from the mine.

However, the existence of property value impacts and the distance gradient of these impacts are expected to be related to actual or expected physical impacts from the site rather than a simple distance relationship. Where noise, dust, vibration, odour and visual impacts are contained, no impacts would be expected to occur.

24.2.2 Consolidated value estimate

The present value of costs and benefits, using a 7% discount rate, are summarised in **Table 24.2**. The Project is estimated to have total net production benefits (mining and product transportation) of $581 M. Assuming 25% foreign ownership of Boral, $492 M of these net production benefits would accrue to Australia.

For the Project to be questionable from an economic efficiency perspective, all incremental residual environmental impacts from the Project would need to be valued by the community at greater than $492 M. This is equivalent to each household in Australia valuing the residual environmental, social and cultural impacts at $55. If only households in NSW hold values for the residual environmental, social and cultural impacts of the Project then the threshold willingness to pay per household would be $170. The equivalent figure for the region is $40,000.

However, most of the potential impacts are internalised into the capital and operating costs of the proponent via mitigation, offset or compensation, and hence are incorporated into the estimate of net production benefits. Other impacts to Australia are approximately $4 M, considerably less than the estimated $492 M net production benefits of the Project to Australia.

Table 24.2: Global and national cost benefit analysis results

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M) (present values at 7% discount rate)**
Net production benefits from mining	Opportunity cost of land.	11	Avoided decommissioning and rehabilitation costs	14
	Opportunity cost of capital.	33	Financial value of limestone products – internal and external sales	595
	Development costs.	48	Additional economic value from internal sales	304
	Operating costs ex royalties.	291	Residual value of capital	2
	Decommissioning and rehabilitation costs.	2	Residual value of land	5
	Sub-total	***386***	***Sub-total***	***920***
	Net production benefits			**535 (447)**
Net production benefits from ex mine transport	Transport costs.	275	Transport revenue	321
	Net production benefits			**47 (45)**
	Total net production benefits			**581 (492)**
Environmental, social and cultural impacts	GHG	28 (0.3)	Market values of employment	13
	Agricultural	Included in opportunity cost of land	Non-market values of employment	142
	Noise	No material impacts	Economic benefits to existing landholders	Not quantified
	Blasting	No material impacts	Economic benefits to suppliers	Unquantified
	Air quality	No properties impacted by exceedances		
	Surface water	Cost of WALs included in capital costs		
	Groundwater	Cost of WALs included in capital costs		
	Ecology	Some loss of values but offset. Cost of offset included in capital and operating costs		

	Costs		Benefits	
	Description	Value ($M)	Description	Value ($M) (present values at 7% discount rate)
	Road transport	No capacity issues. Cost of upgrades included in capital and operating costs		
	Aboriginal heritage	Unquantified		
	Historic heritage	3		
	Visual	No material impacts		
	Net public infrastructure costs	No material impacts		
	Loss of surplus to other industries	No material impacts		
	Non-market impacts sub-total	**31 (4)**		**155**
Net social benefits – including employment benefits				**705 (643)**
Net social benefits – including employment benefits				**550 (488)**

24.2.3 NSW costs and benefits

The costs and benefits of the Project to NSW are summarised in Table 24.3. The potential impacts were apportioned to NSW as follows:

- 100% of mining royalties go to NSW.
- 32% of the company tax (mining and product transport) goes to NSW.
- 32% of the residual net producer surplus (mining and product transport) goes to NSW.
- 100% of potential wages benefits go to NSW residents.
- 100% of the potential non-market values of employment go to NSW based on benefit transfer from a study that surveyed the NSW population.
- GHG impacts to Australia are attributed to NSW based on NSW's share of the Australian population.
- All other potential environmental, social and cultural impacts accrue to NSW households. However, these impacts are largely mitigated, compensated or offset by the proponent.

The estimated net social benefits of the Project to NSW range from $166 M to $321 M, present value at 7% discount rate (the latter including employment benefits). Consequently, as well as resulting in net benefits to Australia, the Project would also result in net benefits to NSW.

Any unquantified residual impacts of the Project after mitigation, offset and compensation would need to be valued at greater than $166 M to $321 M, present value for the Project to be questionable from an NSW economic efficiency perspective.

Table 24.3: NSW cost benefit analysis results

Costs		Benefits	
Description	**Value ($M)**	**Description**	**Value ($M) (present values at 7% discount rate)**
Environmental, social and cultural impacts		**Net production benefits of mining**	
GHG	0	Royalties	15
Agricultural	No material impacts. Included in opportunity cost of land	Direct company taxes	25
Noise	No material impacts	Residual net production benefits	33
Blasting	No material impacts	Economic surplus passed on internally	
Air quality	No properties impacted by exceedances	Company tax	29
Surface water	Cost of WALs included in capital costs	Residual net production benefits	51
Groundwater	Cost of WALs included in capital costs	Contributions not linked to demand	0
Ecology	Some loss of values but offset. Cost of offset included in capital and operating costs	***Sub-total***	***153***
Road transport	No capacity or safety issues. Cost of upgrades included in capital and operating costs	**Net production benefits of product transport**	
Aboriginal heritage	Unquantified	Boral company tax	1
Historic heritage	1	Boral residual net production benefits	2
Visual	No material impacts	Other transport providers company tax	3
Net public infrastructure costs	No material impacts	Other transport providers residual net production benefits	8
Loss of surplus to other industries	No material impacts	***Sub-total***	***14***
		Additional benefits	
		Wage benefits to employment	13
		Non-market benefits of employment	142
		Economic benefits to existing landholders	0
		Economic benefits to existing suppliers	0
Total	**1**	***Sub-total***	***155***
Net social benefits (including employment benefits)			**321**
Net social benefits (excluding employment benefits)			**166**

Incidence of NSW costs and benefits

The costs and benefits of the Project to NSW will potentially be distributed among the stakeholders summarized in **Table 24.4**.

Table 24.4: Incidence of NSW costs and benefits

Benefits and costs	Incidence of costs and benefits	Magnitude of impact ($M)
Net production benefits of mining		
Royalties	NSW Government and households	15
Direct company tax	NSW Government and households	25
Residual net production benefits	Boral and its Australian shareholders	33
Economic surplus passed on internally		
Company tax	NSW Government and households	29
Residual net production benefits	Boral and its Australian shareholders	51
Contributions without a nexus	Council and residents of LGA	0
Net production benefits of product transport		
Boral company tax	NSW Government and households	1
Boral residual net production benefits	Boral and its Australian shareholders	2
Other transport providers company tax	NSW Government and households	3
Other transport providers residual net production benefits	Other transport providers and their owners/shareholders	8
Additional benefits		
Wage benefits to employment	Employees of the Project who reside in NSW	8
Non-market benefits of employment	NSW households	88
Economic benefits to existing land holders	Local landholders who sell land required for Project including buffer land	0
Economic benefits to suppliers	Regional and State suppliers of inputs to production	0
Environmental, social and cultural costs		
GHG	Local and NSW households.	0.1
Agricultural	Boral.	No material impacts. Included in opportunity cost of land
Noise	Adjoining landholders.	No material impacts
Blasting	Adjoining landholders.	No material impacts
Air quality	Adjoining landholders	No properties impacted by exceedances
Surface water	Local surface water users	Cost of WALs included in capital costs
Groundwater	Local groundwater users	Cost of WALs included in capital costs

Benefits and costs	Incidence of costs and benefits	Magnitude of impact ($M)
Ecology	Local and NSW households	Some loss of values but offset. Cost of offsets included in capital and operating costs
Road transport	Local residents	No capacity or safety issues. Cost of upgrades and maintenance include in capital and operating costs
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	Unquantified
Historic heritage	Local and NSW households who value heritage	1
Visual	Adjoining landholders and visitors to Bungonia and Morton NPs	No material impacts
Net public infrastructure costs	NSW Government and NSW households	No material impacts
Loss of surplus to other industries	Local industries adversely impacted by the Project	No material impacts

24.3 Local effects analysis

Two different methods were used to assess local effects, with the local effects analysis summarised in this section. The LGA was used as the local area.

The Project will have a direct effect by continuing to employ 118 people on-site, 92% of which live in the LGA. Assuming the Project did not proceed, these people would be employed in other sectors with an average wage of $44,577, which is $28,661 lower than the average mining sector wage. Therefore, continued employment in the mining sector (assuming 42 full time equivalent jobs at the mine) will result in approximately $3.1 M of disposable wages per annum.

Non-labour expenditure will be $19 M/year, with $7.1 M of this to accrue to the local area.

The incremental expenditure by employees and non-labour expenditure that is captured by the local area provides flow-on economic activity to the local economy, which can be estimated in terms of economic activity indicators of output, value-added, income and employment. This will result in $5.1 M per annum in total local income and generate 28 local flow on jobs.

- The Project could result in a reduction in agricultural activity from land directly impacted by the mine, the stewardship sites and the purchase of groundwater WALs. However:
  - the land affected by the extension area has low agricultural potential (land and soil capability class VI to VIII) and has not seen significant agriculture use for many years;
  - land purchased for biodiversity offsets is also likely to have low agricultural capability or be difficult to clear and develop for agriculture; and
  - there is up to 53,074 ML/year available for extraction from the Goulburn Fractured Rock Groundwater Source with only 12% of this currently being allocated.

In summary, the Project is likely to have the following net local benefits:

- 42 full time equivalent jobs;
- $3.1 M disposable wages per year; and
- $7.1 M of other non-labour expenditure.

24.4 Supplementary local effects analysis

The supplementary local effects analysis uses input-output analysis to identify the gross economic activity associated with the Project on the local economy. It involves the development of an input-output (IO) table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.

IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of indicators of economic activity – output, income, value-added and employment. Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

The Project is estimated to make up to the following annual contribution to the regional economy for 30 years:

- $82 M in annual direct and indirect regional output or business turnover;
- $48 M in annual direct and indirect regional value added;
- $14 M in annual direct and indirect household income; and
- 198 direct and indirect jobs.

The Project is estimated to make up to the following total contribution to the NSW economy for 30 years:

- $137 M in annual direct and indirect regional output or business turnover;
- $74 M in annual direct and indirect regional value added;
- $27 M in annual direct and indirect household income; and
- 364 direct and indirect jobs.

24.5 SEARs economic heads of consideration

As summarised in Table 24.1, the SEARs require assessment of the likely economic impacts of the Project, with reference to the following.

24.5.1 Significance of resource

Size, quality and availability of the resource

Refer to **Section 2.2.4** of this EIS.

Proximity and access of the land to which the application relates to existing or proposed infrastructure

The Project is a continuation and extension of an existing mine and as such will use the existing infrastructure at the mine. The use of existing infrastructure enables the resource to be mined at a considerable discount compared to if a new mine had to be established to mine the resource.

The relationship of the resource to any existing mine

The Project is a continuation and extension of the existing mine. It will enable the continuation of employment for approximately 118 employees on-site (excluding contractor personnel) and another 73 that are employed at other locations e.g. Berrima and Maldon Cement Works and North Ryde that would otherwise not be employed if it weren't for the mine.

Whether other industries or projects are dependent on the development of the resource

92% of the existing workforce live in the LGA and hence a material component of their expenditure would flow-on to local businesses. Boral has identified that it spends considerable operational expenditure with 28 local firms.

The agricultural lime facility is entirely dependent on the mine for the supply of raw materials for fertiliser manufacturing.

24.5.2 Economic benefits

Employment generation

Refer to **Section 1.2** of this EIS for direct employment.

The IO analysis resulted in 198 and 364 direct and flow-on jobs for the region and NSW, respectively.

Expenditure including capital investment

The incremental capital costs over the life of the mine are estimated at $111 M. Capital costs of the Project primarily relate to annual sustaining capital but also includes an allowance for construction of the components described in **Section 4.4**. There will also be the one-off costs described in **Section 24.2.1**. There will be ongoing expenditure of $31 M/year.

The payment of royalties to the State

The Project will generate royalties of $44 M in total and at 7% discount rate the present value of royalties will be $15 M.

24.5.3 Demand for the provision of local infrastructure and services

Given that the Project is a continuation of an existing mine with no additional workforce there is not expected to be any additional demand for local community infrastructure.

There is not expected to be any change in demand for local infrastructure and services as sewage and water requirements will be met with on-site infrastructure.

There will continue to be demand for use of local and State roads. Where the Project requires upgrades, relocation or maintenance of roads these will be funded by Boral.

24.6 Residual impacts

A CBA of the Project indicated that it would have net social benefits to Australia of between $488M and $643M, and net social benefits to NSW of between $166M and $321M. Hence the Project is desirable and justified from an economic efficiency perspective. Environmental, social and cultural impacts of the Project have been minimised through Project design and mitigation, offset and compensation measures. The economic value of residual impacts are considered to be immaterial from an aggregated economic efficiency perspective.

Chapter 25

Social impacts

VOLUME 1

Social impacts

Social impacts were assessed in the context of the Project's potential changes to people's way of life; community; access to and use of infrastructure, services and facilities; culture; health and wellbeing; surroundings; personal and property rights; decision making systems; and fears and aspirations.

The community was extensively consulted in 2015, 2016 and 2018 via correspondence, meetings, the media and social media to understand attitudes towards the mine and Project and issues of most importance to the community. Issues of concern to the community were noise, visual and dust impacts; access to property; road safety and traffic impacts; and livelihood concerns such as property values, employment opportunities and raw material supplied to business.

A social impact scoping exercise determined that some of these potential impacts required detailed assessment of impacts without management measures in the form of consultation with residents (noise, visual and dust impacts), visual impacts assessment, ethnographic content analysis (ECA – dust and traffic impacts), health impact assessment (HIA – road safety and livelihood impacts) and interviews with stakeholders (access to property and traffic impacts).

The following positive impacts were predicted:

- Way of life – local and regional employment and business opportunities.
- Personal and property rights – driveway access improvements along Marulan South Road.
- Access to and use of infrastructure, services and facilities – widening and upgrade of Marulan South Road.

The following negative impacts were predicted:

- Access to and use of infrastructure, services and facilities – cumulative and perceived risk of increased traffic volumes and impact to pavement condition along Marulan South Road.
- Health and wellbeing – perceived low frequency (cumulative noise) and disturbance from airbrakes.
- Surrounds – headlight spill into properties from re-aligned Marulan South Road.
- Personal and property rights – dust fallout causing damage to property asset (shed).

Impacts to property values and business revenue were discounted after detailed economic assessment and further engagement respectively. Other than environmental management controls to avoid other identified negative impacts, no mitigation is required to minimise impacts on property values. However, Boral will meet with the neighbour that raised this concern and will talk them through the results of the economics assessment, other technical studies and proposed mitigation measures. Boral met with the business owner concerned about the supply of raw materials was assured that their supply would not diminish.

Physical impacts to roads and road safety will be mitigated as described in the project description and transport sections of the EIS, and perceived traffic and safety impacts will be addressed by further consultation with stakeholders, including provision of the EIS.

Noise impacts will be managed as described in the noise section of the EIS, including provision of monitoring results to concerned stakeholders. The resident concerned about low frequency noise will continue to be consulted and sources investigated if necessary, which changes to mining operations implemented where reasonable and feasible.

Light spill onto private property will be addressed at the detailed design phase of the road re-alignment, with options including adjustments to the vertical alignment of the road and/or construction of earth bunds and planting of screening vegetation.

Dust impacts will be addressed as described in the air quality section of the EIS and ongoing consultation with concerned stakeholders, including provision of monitoring results.

25 SOCIAL IMPACTS

25.1 Introduction

This chapter summarises the social impact assessment report (SIA), which is in **Appendix V**. It describes the air quality assessment criteria which apply to the Project, potential air emission sources, modelling method and results, potential impacts and mitigation measures where impacts are unavoidable.

25.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely social impacts of the Project (Table 25.1).

Table 25.1 Social impact related SEARs

Requirement	Section and appendix where addressed
▪ An assessment of the likely social impacts of the development.	25.3, Appendix V

The SEARs recommended the use of the *Social impact assessment guideline – For State significant mining, petroleum production and extractive industry development* (NSW Department of Planning and Environment, 2017).

25.1.2 Overview of assessment methods

Section 1.1 of (NSW Department of Planning and Environment, 2017) states that social impacts can involve changes to people's:

- way of life – how they get around, work, have recreation and interact with each other;
- community – composition, cohesion, character, functioning and sense of place;
- access to and use of infrastructure, services and facilities;
- culture – shared beliefs, customs, values and stories, connections to land, places and buildings;
- health and wellbeing;
- surroundings – access to and use of ecosystem services, public safety and security, access to and use of the built environment, and its aesthetic value and/or amenity;
- personal and property rights;
- decision making systems – the extent to which they can have a say in decisions; and
- fears and aspirations – related to one or a combination of the above, or the future of their community.

The SIA involved the following steps:

- scoping the SIA – including consultation to understand issues potentially affecting stakeholders and determining the Project's area of social influence;
- establishing the social baseline – which is described in **Section 2.3.3** of this EIS;
- predicting and analysing social impacts;
- evaluating social impacts;
- developing responses to social impacts; and
- developing a monitoring and management framework.

Scoping

The ‘scoping tool’ defined in (NSW Department of Planning and Environment, 2017) was used for the SIA scoping exercise. The tool is designed to ensure a consistent approach to identifying which of the social impacts associated with a project need to be investigated in the SIA and provides a methodological guide and ready-made SIA template.

(NSW Department of Planning and Environment, 2017) was released after the EIS commenced so the early stakeholder engagement results were used retrospectively in the scoping tool. Use of the tool comprised:

1. Considering each ‘matter’ (i.e. amenity, access, built environment, heritage, community and economic) and its subcategories, and determining how likely it is that Project activities will impact the matter.
2. For each matter, considering and assessing the material characteristics of any likely impact.
3. For each matter, considering stakeholder/community opinions and sentiment towards the Project activities.
4. For each matter, determining whether a social impact will arise from the Project activities, and then developing a rationale for the decision.
5. For each matter, determining the level of assessment (and engagement) which is required in the EIS preparation phase, and selecting from the following list the most appropriate SIA type:

    a. desktop;
    b. standard; or
    c. comprehensive.

6. Each matter and its associated level of assessment (determined by the scoping tool) was considered in the context of the social impact categories specified in Section 1.1 of the Guideline.

Engagement

The strategic approach to consultation developed by the Centre for Social Responsibility in Mining was used and involved deciding who to consult and how to consult them, carry-out consultation, summarise outcomes and follow-up with stakeholders.

Stakeholders

A stakeholder is a group, individual or organisation that is interested in, affected by, or has the capacity to influence a project. The locally-specific stakeholders are known to Boral courtesy of their long-term presence in the Marulan South area. The stakeholders are generally:

- residents – neighbours and in the community;
- people in host communities – people in communities where construction workers and other people may in-migrate;
- other communities – more distant communities that may be affected or which may be near associated works such as pipelines;
- project employees;
- indigenous people – including non-residents who may have connections to the land;
- non-government organisations – local, national or international groups who may have an interest in environmental values of a site; and
- other stakeholders – such as governments, developers, agencies, funding agencies.

Engagement methods

The community was comprehensively engaged during 2015-16 (scoping engagement) and 2018 (further engagement) for the Project. A range of methods were used to engage stakeholders and provide an opportunity to interface with Boral about its operations in Marulan South. Engagement methods used and when they were deployed are described in detail in Table 2 of **Appendix V**. The engagement methods and stakeholders are summarised in **Table 25.2**.

Table 25.2: Stakeholders and engagement methods

	Basic	Letter (formal)	Email (formal/informal)	Phone briefing (informal)	In-Person Interactive	One-on-one meeting (formal) / Informal briefing / 'Door knock'	Site visit/inspection (individual/small group)	Formal presentation (key stakeholder/s)	Community meeting (general)	Community Liaison / Reference Group meeting	Panel discussion / workshop	Site Open Day / experience	Community drop-in sessions	Written	Information/fact sheet	Q&A	Community newsletter	Media	Editorial (media release / statement)	Editorial (media opportunity / photo)	Advertorial / advertising	Social media / online	Website / microsite
Fenceline Neighbours / Host Communities / Supported Community Organisations																							
Immediate boundary neighbours		X	X	X		X							X		X	X	X		X		X		X
Non-boundary Marulan Sth Road residents		X	X	X		X							X		X	X	X		X		X		X
Peppertree Quarry Community Consultative Committee		X	X	X						X			X		X	X	X		X		X		X
Marulan township and area residents / Tallong township and area residents													X		X	X	X		X		X		X
Residents in wider region - Goulburn / Mulwaree villages													X		X	X	X		X		X		X
HASP Project participants / individual community group members		X	X	X				X					X		X	X	X		X		X		X
Tallong Community Focus Group		X	X	X				X		X			X		X	X	X		X		X		X
Local Government																							
Goulburn Mulwaree Council - Mayor		X	X	X		X	X	X		X			X		X	X	X		X		X		X
Goulburn Mulwaree Council - GM		X	X	X		X	X	X					X		X	X	X		X		X		X
Goulburn Mulwaree Council - Elected Councillors							X	X					X		X	X	X		X		X		X

	Basic	Letter (formal)	Email (formal/informal)	Phone briefing (informal)	In-Person Interactive	One-on-one meeting (formal) / Informal briefing / 'Door knock'	Site visit/inspection (individual/small group)	Formal presentation (key stakeholder/s)	Community meeting (general)	Community Liaison / Reference Group meeting	Panel discussion / workshop	Site Open Day / experience	Community drop-in sessions	Written	Information/fact sheet	Q&A	Community newsletter	Media	Editorial (media release / statement)	Editorial (media opportunity / photo)	Advertorial / advertising	Social media / online	Website / microsite
Goulburn Mulwaree Council - Dir Planning / Planning & Environment teams			X	X		X	X	X					X		X	X	X		X		X		X
Goulburn Mulwaree Council - Economic Development			X	X			X	X					X		X	X	X		X		X		X
State and Federal Government																							
NSW Member for Goulburn		X	X	X		X							X		X	X	X		X		X		X
Fed Member for Hume		X	X	X		X							X		X	X	X		X		X		X
Govt Authorities																							
NSW Dept of Planning & Environment		X	X	X		X	X	X							X	X	X		X		X		X
Environment Protection Authority (NSW)		X	X	X		X	X	X							X	X	X		X		X		X
National Parks & Wildlife Service (NSW)		X	X	X		X							X		X	X	X		X		X		X
Transport for NSW (RMS / Centre for Transport Planning)		X	X	X		X													X				X
NSW Dept of Primary Industries		X	X	X		X													X				X
Local Land Services NSW		X	X	X		X													X				X
NSW Dept of Planning & Environment - Division of Resources & Geoscience		X	X	X		X													X				X
WaterNSW		X	X	X		X													X				X
ARTC		X	X	X		X													X				X

	Basic	Letter (formal)	Email (formal/informal)	Phone briefing (informal)	In-Person Interactive	One-on-one meeting (formal) / informal briefing / 'Door knock'	Site visit/inspection (individual/small group)	Formal presentation (key stakeholder/s)	Community meeting (general)	Community Liaison / Reference Group meeting	Panel discussion / workshop	Site Open Day / experience	Community drop-in sessions	Written	Information/fact sheet	Q&A	Community newsletter	Media	Editorial (media release / statement)	Editorial (media opportunity / photo)	Advertorial / advertising	Social media / online	Website / microsite
NSW Dept of Industry		X	X	X		X													X				X
Media																							
Goulburn Post			X	X											X	X			X	X	X		X
Discover Marulan e-newsletter			X	X											X	X	X		X	X			X
2GN/Eagle FM			X	X											X	X			X				X
Interest / Activist Groups																							
Nil																							
Environment / Heritage Groups																							
Nil																							
Nil																							
Business Groups																							
Marulan Chamber of Commerce		X	X	X				X					X		X	X	X		X		X		X
Cement Industry Federation		X													X	X			X				X
Concrete Cement Aggregates Australia (NSW)		X													X	X			X				X
Indigenous Groups																							
Pejar Local Aboriginal Land Council		X																	X	X	X		X
Customers/Contractors/Lessees																							
Aglime		X	X	X		X							X		X	X	X		X		X		X
Omya			X	X											X	X			X				X

	Basic	Letter (formal)	Email (formal/informal)	Phone briefing (informal)	In-Person Interactive	One-on-one meeting (formal) / informal briefing / 'Door knock'	Site visit/inspection (individual/small group)	Formal presentation (key stakeholder/s)	Community meeting (general)	Community Liaison / Reference Group meeting	Panel discussion / workshop	Site Open Day / experience	Community drop-in sessions	Written	Information/fact sheet	Q&A	Community newsletter	Media	Editorial (media release / statement)	Editorial (media opportunity / photo)	Advertorial / advertising	Social media / online	Website / microsite
BlueScope Steel			X	X											X	X			X				X
Boral Berrima Cement			X	X											X	X			X				X
Key non-competitor customers (via Sales/Marketing)			X	X											X	X			X				X
Essential Community Services																							
School bus service accessing Marulan Sth Road		X	X	X		X							X		X	X	X		X		X		X

Area of social influence

The term 'locality', or area of social influence (ASI), does not have a prescribed meaning or refer to a fixed, pre-defined geographic boundary. People may not perceive social impacts created by a project to be those felt exclusively within or immediately adjacent to the project boundary, or at a time when operations are conducted on site.

These time and space relationships between the Project site and communities, economies, infrastructure, and resources (both human and natural), were explored using a mixed-methods approach. The specific methods adopted were:

- semi-structured interviews with key Boral Project personnel familiar with the existing operations on site and the local communities near the Project;
- feedback from residents obtained during the early community engagement methods, in particular the in-person interactive methods; and
- analysis of historical correspondence records.

The development of the ASI considered factors including but not limited to:

- supply chains;
- haulage of resources;
- transport of goods;
- materials and equipment;
- movement of workers (drive-in-drive-out/fly-in-fly-out working arrangements);
- natural features and recreational values (e.g. Bungonia NP, gorges and caves);
- ancillary infrastructure; and
- reputation of other extractive industries in the area.

Social impact assessment

At the completion of the further engagement activities, the Project team possessed a thorough collection of feedback and questions raised by stakeholders. This collection was obtained from both the scoping engagement and further engagement activities. At this point in time the full collection of results was considered, and a decision was made about the SIA methods to be implemented for the study. It was evident that the feedback and questions raised during the early engagement activities, closely aligned with those raised in the equivalent 2018 activities. Table 25.3 summarises the collection of stakeholder feedback and reflects the decisions made in regard to the SIA methods.

Table 25.3: The collection of stakeholder feedback and the SIA method selected for the study

Engagement topic and stakeholder feedback	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of Assessment for the social impact (scoping tool output)	SIA method(s) to be implemented for the assessment
Acoustic Low frequency, night time, and cumulative noise impacts Methodology and efficacy of monitoring Use of truck air brakes outside of normal business hours	Health and wellbeing	Yes	Desktop SIA	Consultation with residents
Visual	Surroundings	Yes	Standard SIA	VIA Consultation with residents

Engagement topic and stakeholder feedback	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of Assessment for the social impact (scoping tool output)	SIA method(s) to be implemented for the assessment
Bungonia Lookdown provides a visual perspective of the mine Lightspill from continued operations and cumulative impacts associated with Peppertree Quarry Appearance of the rehabilitated south pit overburden emplacements Headlight spill from vehicles using Marulan South Road Retention of vegetation for screening on Marulan South Road during re-alignment and upgrade				
Dust Dust fallout and impacts to private assets	Personal and property rights	Yes	Desktop SIA	ECA Consultation with residents
Access to property Improve private driveway accesses as part of the Marulan South Road upgrade	Personal and property rights	No	No SIA required	Interview
Road and rail network / Public Infrastructure Traffic impacts between the Project and Hume Highway along Marulan South Road Traffic changes and increased traffic volumes on Marulan South Road Need to 'level out' road undulations on Marulan South Road during road upgrade Use Marulan Creek Road for haulage instead of the proposed route along an upgraded Marulan South Road	Access to and use of infrastructure, services and facilities	Yes	Standard SIA	ECA Interview
Safety Will an increase in traffic volumes impact the safety of road users? Reduce truck speed to 60 km/h on Marulan South Road	Fears and aspirations	Yes	Standard SIA	Interview HIA
Livelihood Impacts of the continued operations of the mine on nearby property values was queried	Way of life	Yes	Standard SIA Standard SIA	HIA

Engagement topic and stakeholder feedback	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of Assessment for the social impact (scoping tool output)	SIA method(s) to be implemented for the assessment
The provision of employment opportunities to the regional population The proposed additional road transportation volumes suggest that Boral intends to cease supply to one of the neighbouring businesses			Comprehensive SIA	

Visual impact assessment

Visual impacts are relevant to the 'surroundings' social impact category. The technical VIA in **Appendix S** was supplemented by a VIA concentrating on impacts to residences as a resident expressed concerns with this aspect during consultation. The supplementary VIA involved consulting the resident about their sensitivity to the viewscape and potential changes.

The significance of visual impacts was assessed by considering:

- Magnitude – the magnitude of visual change in the landscape and its proximity to the viewer. This is influenced by the visibility of the Project/components and comprises the combination of scale, extent, distance and duration of views.
- Sensitivity – depends on the nature of the existing environment and on the likely response from people viewing the scene. Someone who is enjoying a recreational experience or someone who is viewing the scene from their living room is more sensitive to a view than someone passing by in a car.

Magnitude and sensitivity are ranked as:

- Negligible – very minor loss or alteration to one or more key elements of the baseline visual character and/or introduction of elements that are consistent with the existing visual character.
- Low – minor loss/alteration of one or more key elements of the baseline visual character and/or introduction of elements that are consistent with the existing landscape character.
- Moderate – partial loss or alteration of one or more key elements of the baseline visual character and/or introduction of elements that may be prominent but not considered to be substantially uncharacteristic of the existing landscape character.
- High – substantial to total loss of key elements of the baseline visual character and/or introduction of elements considered to be totally uncharacteristic of the existing landscape character.

The rankings can be determined by a combination of the factors in **Table 25.4**.

Table 25.4 Visual impact criteria

Criteria	Definition	Rating
Duration of view		
Long term	>1 hour	High
Moderate term	30 minute to 1 hour	Moderate
Short term	<30 minute	Low
Number of viewers		
High	>1,000	High
Moderate	100-999	Moderate

Criteria	Definition	Rating
Low	<100	Low
Viewer sensitivity (type)		
Resident	N/A	High
Pedestrian/cyclist		Moderate
Motorist		Low
View sensitivity		
Pristine landscape	N/A	High
Moderately modified landscape		Moderate
Significantly modified landscape		Low
View distance/proximity		
Short	< 100m	High
Medium	100m-500m	Moderate
Long	>500m	Low

Semi-structured interview

Interviewing was used to explore and assess a number of matters identified in the scoping tool. An interview was conducted under a semi-structured format using a list of predetermined questions. The process involved:

- developing the pre-determined interview questions, designed to explore the social matters identified in the scoping tool;
- sending an interview invitation letter to the participant. The letter explained the purpose of the interview, the intention to record it, and provided some frequently asked questions. It explained that consent was required, and sought to obtain it in a 'free, prior and informed' fashion;
- obtaining participant consent;
- arranging a date and forwarding the participant an advanced copy of the predetermined questions;
- conducting and recording the interview;
- drafting and conducting a qualitative analysis of the interview transcript; and
- extracting transcript content for use in the SIA assessment.

Health impact assessment

The HIA addresses the 'way of life' social category and used an interview transcript, complaints records associated with the existing operations at the mine, media articles collected for the ECA, and doorknock records. The HIA involved:

- Referring to the scoping tool results and identifying the social matters to be assessed using the HIA.
- For each matter, qualitatively analysing the interview transcript, complaints records, media articles and doorknock records to identify statements regarding health impacts of the SSD, or other similar operations which may cause cumulative impacts.
- For each matter, considering the statements against the below health impact rating descriptions.
- Applying a health impact rating.

The health impact ratings are:

- Positive – results in improvements to well-being or the likelihood of injuries/illness, or preserves livelihood status quo.
- High positive – results in moderate improvements to well-being, the likelihood of injuries/illness, or livelihood.

- Very high positive – results in a well-being revolution, a significant reduction in the likelihood of injuries/illness, or dramatic livelihood improvement.
- Neutral – not perceptible/influential on livelihood.
- Negative – results in annoyance, minor injuries, illnesses, or livelihood impacts that do not require intervention.
- High negative – results in moderate injury, illness, or livelihood impact that may require some intervention.
- Very high negative – results in loss of life, sever injuries, chronic illness, or livelihood impact that requires intervention.

Ethnographic content analysis

ECA is a qualitative media analysis method used to obtain, categorise and analyse different media documents (such as newspapers and magazines) in addition to other forms of media delivered online and via television. It blends the traditional notion of objective content analysis with participant observation to form ethnographic content analysis.

ECA encourages the investigator to be reflexive and interactive, and it enables an element of ongoing discovery as progress is made towards the SIA research goal. It is in this vein that ECA enables documents to be studied to understand culture – or the process and the array of objects, symbols, and meanings that make up social reality shared by members of a society.

The most important element of ECA is the protocol, or a data collection sheet. It is a way to ask questions of a document; a protocol is a list of questions, items, categories or variables that guide data collection from documents.

The following ten steps were applied to articles from the *Goulburn Post*:

1. Pursue a specific problem to be investigated – the scoping tool provided the social matters to be investigated.
2. Become familiar with the process and context of the information source. Explore possible sources of information – the *Goulburn Post* was used as it is the most dominant and popular text media publication.
3. Become familiar with several examples of relevant documents and select a unit of analysis – the string ‘Marulan + mine’ was searched online and the five highest ranked articles (‘unit of analysis’) were read to recognise article layouts and other sections of the page.
4. List several categories (variables) to guide data collection and draft a protocol (data collection sheet) – categories that emerged from the articles discovered in Step 3 were entered into the protocol. The articles contained the following discourses:

    a. Mine is essential for development.
    b. Consumption at the mine.
    c. Request for mining approval.
    d. Community support for the mine.

5. Test the protocol by collecting data from several documents – additional articles were collected using the string ‘Marulan + mine news’, which provided new discourses and the protocol was expanded accordingly.
6. Revise the protocol and select several additional cases to refine the protocol – the protocol was revised when all articles had been analysed by renaming, splitting, re-defining and merging categories as appropriate.
7. Arrive at a sampling rationale and strategy (e.g. theoretical, purposive, opportunistic, cluster or stratified) – theoretical sampling was used, which involves the selection of material based on emerging understanding of the topic under investigation and was used to identify and refine knowledge of narratives about the mine over time. A five-year range of articles was selected to capture cumulative social impacts emerging in the media narratives.

8. Complete data collection for the target social matters – the relevant search strings were applied and the collection of relevant *Goulburn Post* articles continued in a sustained and rigorous fashion until all articles returned via the online searches had been covered. At the completion of Step 8 the sample had been obtained, each article in the sample had been subject to a manifest content analysis, and the results from these analyses had been recorded in the protocol. The results provided a means to understand the implications of the SSD for the target social impact matters, via the discourses being circulated amongst the population.
9. Consider the content analysis results shown in the 'discourse' section of the protocol. Write summaries or overviews of the key findings – the individual results were considered, each discourse was summarised, and they were the key findings of the ECA.
10. Integrate the findings including the discourse interpretations and key concepts into the SIA report – refer to impact section.

25.2 Results

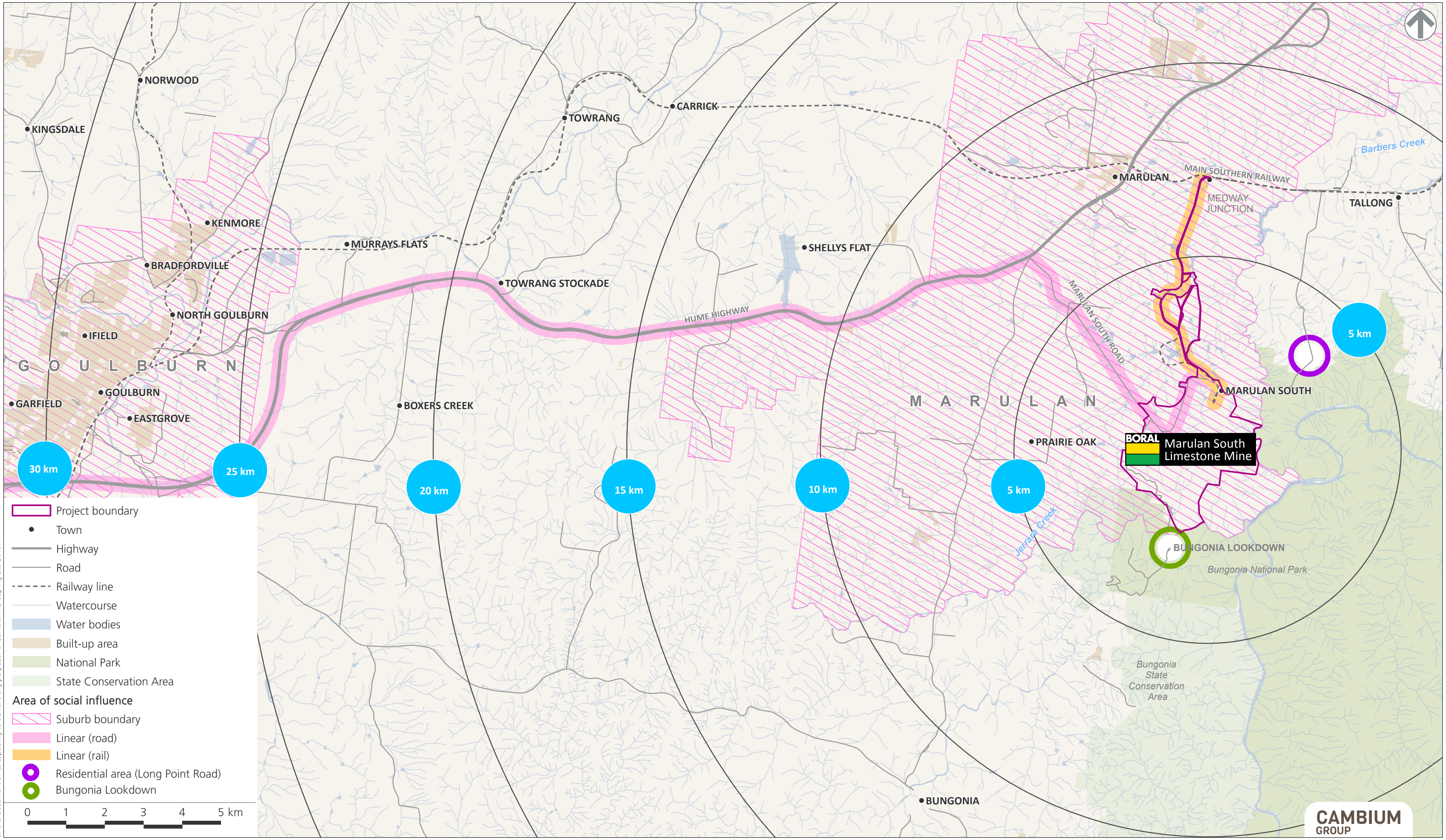
25.2.1 Area of social influence

The ASI comprises a polygon containing the Project site, the nearest communities including Goulburn, residential and business properties along Glymar Road, Tangryang Road, and Long Point Road in the cleared area across the Gorge, and Bungonia Lookdown from where a large extent of the Project is visible (Figure 25.1).

Haulage routes are also included in the ASI as linear areas, as transport corridors have obvious links to social issues. The haulage routes are via road (i.e. from the site to the Hume Highway along Marulan South Road), and rail (from the site to the interchange at Medway Junction where the rail spur line meets the main railway). There are no remote locations considered to be indirectly impacted.

Figure 25.1
Area of social influence

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



Source: LPI (2017), Gordon Atkinson & Associates Pty Ltd (2018), Element Environment (2019), Cambium Group (2019).

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25.2.2 Early engagement

Engagement feedback was relevant to the SIA scoping phase and was used to consider what social impacts might warrant investigation.

Community workshop

Eleven people attended a workshop on 22 July 2015 and raised the matters in Table 25.5.

Table 25.5 Issues raised by workshop attendees

Issue number	Feedback/question raised in the first community workshop
Verbal feedback	
5)	Will the continued operations of the mine result in increased traffic volumes on Marulan South Road?
6)	Has the Gunlake Quarry and Lynwood Quarry traffic been taken into consideration in the traffic assessment of the Marulan South Road – Hume Highway intersection?
7)	Marulan South Road requires upgrading and any future upgrades should include the driveways of residents.
8)	Will an increase in traffic volumes impact the safety of road users?
9)	The speed limit on Marulan South Road should be reduced to 60-70 km/h.
10)	What is the potential impact that continued mining operations could have on property values in the vicinity? Are there any examples from other projects on how much property values may be affected in proximity to a mine?
11)	When easterly winds blow (mainly during the summer months) there are occasional dust fallouts on a neighbouring farm that affect the condition of a zinc shed on the property.
12)	Resident (living on Long Point Road in a north-east direction from the Project) observed low frequency noise associated with the mine operations, also night time noise impacts, and cumulative noise impacts associated with Peppertree Quarry.
13)	Peppertree Quarry is the main source of visible night light (glow). Is the limestone mine going to increase their lighting over time, making the mine more visible at night.
Written feedback	
14)	Expression of gratitude to the Project team for conducting the workshop, and statement that excessive demands were being placed on the Project team by some workshop attendees. Resident was pleased with the plans and considerations that Boral had developed for the mine.

Email and phone briefings

Two conversations were held, which concerned the impact the Project may have on a nearby neighbour's property value and potential noise impacts on an adjacent neighbour.

One-on-one meetings

Members of the Project team met the above residents. No action was deemed necessary or plausible regarding the property value issue and historic noise data was discussed with the resident concerned about noise. Noise was also monitored at the property.

Marulan Region Chamber of Commerce meeting

Members of the Project team presented to the chamber during its 2015 meeting. Feedback concerned the extra traffic on Marulan South Road and the volume of material transported from Peppertree Quarry, and the visual appearance of rehabilitation of the south pit overburden emplacements.

Council meeting

Members of the Project team met the mayor and general manager in January 2015 and presented the key aspects of the Project. The following feedback was provided:

- Council sought ongoing financial contributions for maintenance of Marulan South Road and upgrading of the road.
- Council would prefer community contributions separate of operations related levies.
- Council would support the northward extension of the WOE across the current Marulan South Road, and the realignment of the road to the north.

Government agencies

Agencies were consulted after receipt of the SEARs and nothing was raised that required feedback specific to the SIA.

25.2.3 Further engagement

Stakeholders were engaged further during 2018 regarding the revised mine plan via the methods summarised in **Table 25.6**. The full results of consultation were considered, which resulted in the selected SIA methods summarised in Table 25.3.

Table 25.6 Results of further engagement

Engagement activity	Feedback/question received by Project team
Door knock (briefing) – private premises within footprint of Marulan South Operations. Five interviews conducted, contact cards left at non-attended premises	1. There is a dust fallout from the mine. It settles on vehicles and buildings, and is corrosive; 2. Supportive of the Project; 3. Proposed alignment of section of Marulan South Road will put headlights of vehicles in line with anticipated location of new dwelling (yet to be built). Requested visual bunding/barrier to address this; 4. Concerned about the prospect of heavy vehicles using air brakes outside of normal business hours. Indicated previous incidences of this nature appear to have involved contractor vehicles (i.e. not Boral branded); and 5. Need to 'level out' road undulations on Marulan South Road and improve private accesses as part of the road upgrade. Discussed headlight spill screening options for proposed residential property.
Staff briefing (toolbox talk)	Interest shown by employees about longer term future of the mine and longevity of employment.
Website update	Nil feedback about the mine was received via the website company email address.
Email (formal) to all stakeholders on the Project mailing list	Nil email responses received.
Community drop-in sessions	Seven people attended each of the community drop-in sessions (i.e. 14 people in total). There was genuine interest in the Project shown by all attendees. The following feedback was provided by attendees: 1. Resident raised the potential for headlight spill from vehicles travelling on the re-aligned section of Marulan South Road to the proposed residence; 2. Resident request for undulations in the road to be rectified when the upgrades are carried out; 3. Marulan South Road business owner queried the capacity of the road to absorb the extra road volumes proposed in the SSD; 4. Marulan south road business owner raised concern that the SSD application for additional road tonnage could threaten the revenue potential of the business; 5. Request raised by Marulan South Road resident to reduce the truck speed limit on the road to 60 km/h; and

Engagement activity	Feedback/question received by Project team
	6. Request for vegetation to be retained during Marulan South Road re-alignment, to act as visual screening (i.e. vehicle headlight spill mitigation).
Peppertree Community Consultative Committee meeting	No specific feedback provided.
Marulan Region Chamber of Commerce meeting	Member raised question about Marulan South Road traffic changes proposed in the SSD, and how the community drop-in sessions were received.
Facebook campaign	At 31 October 2018, the Facebook post had attracted 95 'likes' and one 'reaction'. It had been shared six times and attracted five comments (one positive, three neutral, and one 'tag'). Predictive post reach at 24 September 2018 was 2700 users at an engagement rate of 13 percent.
Meeting with GMC	1. 11 September 2018: Council expressed interest in Boral carrying out the road upgrades, instead of Council per their initial preference. No other specific feedback provided. 2. 20 November 2018: Seven councillors in attendance. Councillors raised questions about design elements of the dam, and the expected timing of the start of road upgrade work on Marulan South Road.
Community newsletter sheet - emailed to neighbours, Project mailing list, and the Peppertree Quarry Community Consultative Committee.	Nil specific feedback received.
Letters (formal) – sent to NSW MP for Goulburn; Federal MP for Hume; Pejar LALC	Nil specific feedback received.
Site visit (GMC planning representatives)	Nil specific feedback received.
Consultation with fenceline and nearby neighbours	1. Resident raised concern about the potential for future development north of Peppertree Quarry, and associated visual impacts. 2. Resident suggested the Project team consider using Marulan Creek Road for haulage instead of the proposed route along an upgraded Marulan South Road. 3. Long Point Road resident reviewed results of noise monitoring conducted at the residence. Raised questions about the methodology and efficacy of monitoring during periods of equipment inactivity on site. 4. Following the community drop-in session, a Marulan South Road business owner was concerned that the proposed additional road transportation volumes meant Boral was intending to cease the supply of raw materials to their business. The business is 100% reliant on the mine for that supply. Although the business owner has a commercial agreement with Boral to supply raw materials, the consultation revealed the business owner's perception that an increased road tonnage would threaten that agreement. Boral committed to meeting both Principals of the company to address that concern and dispel the perception.

25.3 Impact assessment

The potential negative social impacts of the Project are summarised in this section assuming there is no mitigation. Predicted positive impacts are also assessed.

25.3.1 Way of life

The livelihoods of individuals and families in Marulan were assessed, which drew on the economic assessment in **Appendix U**. The HIA results are also discussed in this section.

Impacts of continued mining on property values

Refer to **Section 24.2** for a summary of the economic analysis of property values.

Consultation indicates concern about the impact of the Project on property values is not widespread. One communication was submitted to the project team during the community workshop in 2015 and a follow-up conversation was held with the Marulan South Road resident. The topic is not evident in historic complaint records at the mine and was not raised during the doorknocks by the project team. Furthermore, concerns about the Project impacts on property values was not evident in the media articles collected and analysed during the ECA.

Based on the above, the impact for the local resident at all stages of the project life-cycle is predicted to have a **low social risk rating**. It is immaterial and not requiring the implementation of a mitigation measure.

Employment opportunities to regional population

Regional employment opportunities presented by the Project are a positive social outcome. The Project will result in continued direct employment of 191 full time personnel in association with the mine, lime manufacturing, administration and logistics. This includes 118 site personnel and 73 employed at Berrima Cement Works, Maldon Cement Works and Boral's office at North Ryde.

It will also provide indirect employment in the regional economy from employee and Project expenditure. 92% of the existing on-site workforce lives in the LGA, and hence a material component of their expenditure would flow-on to local businesses.

Toolbox talk participants at the mine affirmed how the Project would support livelihoods in the community and maintain the way of life for existing employees.

The level of interest, scale of benefit, equity in the distribution of the benefit, and likelihood of the benefit is forecast to be **high**.

Perceived decrease in supply of raw materials to a local business reliant on the mine

A local business raised concern that the proposed increase in road transportation from the mine meant that Boral was increasing their supply of limestone products to other clients, and was potentially not going to be able to supply their business that relies 100% on the mine for their raw materials. This concern that the business's financial viability would be compromised by the Project was determined to be a misconception, dispelled at a meeting between the business owners and Boral. Therefore, this matter was dismissed from the SIA and does not require further analysis.

Production induced and consumption induced flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the:

- other repairs and maintenance sector;
- retail trade sector;
- specialised and other machinery and equipment manufacturing;
- road transport sector;
- food and beverage services sector; and
- wholesale trade sector.

Businesses that can provide the inputs to the production process required by the Project and/or the products and services required by employees would directly benefit from the Project by way of economic activity. However, because of the interactions between sectors, many indirect businesses may also benefit.

The loss of revenue impact for local businesses at all stages of the Project life-cycle, is predicted to have a **low social risk rating**. Again, it is immaterial and not require the implementation of a mitigation measure. Conversely, a positive Project impact is predicted on the basis that the level of interest, scale of benefit (region and NSW wide), equity in the distribution of the benefit, and likelihood of the benefit is forecast to be **high**.

Health impact ratings

Health ratings for each of the matters considered above are in Table 25.7.

Table 25.7 Health impact ratings for livelihood matters

Livelihood ('Way of Life') matter	Health impact rating	Description
Impact on property values	Neutral	Effect is not perceptible/influential on livelihood.
Impact on employment opportunities	High positive	Effect results in moderate improvements to well-being, the likelihood of injuries/illness, or livelihood.
Impact on business viability	High positive	Effect results in moderate improvements to well-being, the likelihood of injuries/illness, or livelihood.

25.3.2 Community

Community, comprising its composition, cohesion, character, how it functions, and sense of place, was considered in the scoping exercise and determined to be a social impact not affected by the SSD (Table 25.3).

25.3.3 Access to and use of infrastructure, services and facilities

This social impact category was identified as being relevant to the SSD and comprises the road and rail network, and public infrastructure. These were assessed in the traffic impact assessment (**Appendix T**), which was supplemented by the ECA and interview methods for the purpose of the SIA.

Road and rail network

The following traffic issues were identified during consultation in relation to heavy vehicles:

- traffic impacts between the Project and Hume Highway along the Marulan South Road;
- traffic changes and increased traffic volumes on Marulan South Road; and
- the use Marulan Creek Road for haulage, instead of the proposed route along an upgraded Marulan South Road.

As described in **Section 21.2**, the Project will only result in minor impacts to traffic.

The ECA revealed a social impact appears to be present in the community, and one that is exclusively cumulative in nature. The discourses manifest in the ECA results were:

- unjustified increase to the number of trucks using the road network;

- trucks cause delays for motorists;
- truck volumes are excessive for the capacity of the local road network;
- truck haulage compromises safety of network; and
- trucks are part of social life in Marulan.

The presence of these discourses in the community, and the associated community sentiment, was confirmed in an interview with Council's director of operations.

This social impact was assessed to have a **moderate social risk** rating during the operational phase as additional heavy vehicle traffic would likely contribute to the cumulative social impact reported by stakeholders, even if the impact is exclusively perceptual. The small increase in heavy vehicles would have only a minor consequence on the level of service of Marulan South Road. However, there is still a need to upgrade sections of Marulan South Road to improve safety.

Public infrastructure

Public infrastructure was identified as a social matter relevant to the SIA from feedback during scoping and further engagement about dips and narrow sections along Marulan South Road. The traffic assessment summarises Boral's commitment to the proposed upgrade of Marulan South Road, comprising widening sections of the road, repairing unsafe dips and remedying pavement condition where required.

The following two discourses emerged from the collection of articles for the ECA, which indicate that social unease exists in relation to the cumulative impact of heavy vehicles using local roads (not specifically Marulan South Road):

- road maintenance funding and duty dispute; and
- trucks are responsible for pavement damage.

The interview with Council's director of operations aligned with the ECA of social impacts.

Taken together, the ECA and interview results suggest that a social impact exists in relation to public infrastructure. There is a **moderate social risk** from a social impact perspective during the operational phase due to those reasons for the public infrastructure social risk rating above.

25.3.4 Culture

Culture, comprising shared beliefs, customs, values and stories, and connections to land, places, and buildings (including Aboriginal culture and connection to country), was considered during the scoping phase and determined to be a social impact not affected by the SSD (Table 25.3).

25.3.5 Health and wellbeing

Acoustic impacts are relevant to this social impact category. These were assessed in the noise impact assessment (**Appendix R**), which was supplemented by engagement with residents to address the following issues raised during consultation:

- low frequency, night time, and cumulative noise impacts;
- Methodology and efficacy of monitoring; and
- Use of truck air brakes outside of normal business hours.

Predicted noise levels were less than the Project noise trigger levels at all sensitive receivers for all stages of the proposed 30-year mine operations. As such, it is considered that the mine would have no significant noise impacts on neighbouring communities.

Consultation with three residents following receipt of their feedback had the following outcomes:

- Resident 1: the resident was shown the assessment method and results and agreed that noise levels would be compliant. The Project team committed to discuss noise impacts with the resident on a quarterly basis. It was confirmed that plant operations on site would be scheduled to accommodate prevailing wind conditions (where feasible), and be investigated in the event of acoustic disturbance.
- Resident 2: concerns about the use of air brakes and the associated acoustic impacts were received by the Project team in person. The Project team stated that vehicles involved were likely to be owned and operated by contractors, rather than the Boral fleet. The Project team committed to sharing concerns of the resident with all staff and contracted personnel, and emphasising the need to observe it through appropriate driving behaviour.
- resident 3: consultation determined that the noise source was not Project related.

A **moderate** social risk rating applies for the construction and operational phases.

25.3.6 Surroundings

Visual impacts are relevant to this social impact category. Stakeholder feedback is summarised in Table 25.8.

Table 25.8: Stakeholder feedback on visual impacts

Viewpoint Location Plan item	Stakeholder feedback about visual impacts (SIA matters)
VP20	What will the rehabilitated south pit overburden emplacements look like form the Bungonia Lookdown, and are there any cumulative visual impacts from the Lookdown associated with Peppertree Quarry.
PR	Headlight spill from vehicles using Marulan South Road towards existing businesses, residences and proposed residences to the south of Marulan South Road. Construction of a bund and/or retention of vegetation on the southern side of Marulan South road for visual screening of headlights.

The property owner associated with the proposed residential dwelling (PR) was consulted and the issue raised was the provision of screening on Marulan South Road to mitigate vehicle headlight spill, which has the potential to arise from the re-alignment of the road. It should be noted that the receiver of the headlight spill will be a proposed dwelling (i.e. yet to be built).

Concerns of the property owner were discussed and Boral committed to developing a solution in collaboration with the property owner. Boral indicated the placement of an overburden bund/berm to mitigate headlight spill will be feasible.

After the visual impact results described above were considered in relation to the receiver PR, the visual assessment method was applied, which determined that visual impacts at PR, disregarding the above-mentioned overburden bund, will be **low** as the duration of the view and viewer sensitivity type is high, and all other criteria (i.e. number of viewers, view sensitivity and view distance/proximity) is low.

25.3.7 Personal and property rights

Dust impacts and access to property were identified under this social impact category.

Dust impacts

Dust impacts were assessed in the air quality impact assessment (**Appendix P**), which was supplemented by ECA and engagement with residents. The air quality assessment determined there will be a low potential for dust impacts at privately owned sensitive receivers as a result of the Project.

The ECA found that dust impact discourses regarding other mines in the region were present in the media. The ECA revealed that the following discourses about the dust impacts of mining are present in the community:

- Dust control and compliance in articles concerned with mining development applications, or the status of project approvals.
- Lack of faith in dust controls/studies from residents or businesses in the region who had experienced dust impacts from a neighbouring mine.
- Business revenue reduction due to dust emerged in one article which described the dust impacts felt by a business owner, with business operations occurring nearby to a mine.

A fenceline neighbour was consulted, which extended a pre-existing dialogue with the resident about the shed reported (by the resident) to be sustaining damage as a result of mine related dust.

A **moderate** social risk rating was predicted for the Project during the construction and operational phases.

Access to property

A statement was made that any future upgrade of Marulan South Road should include an upgrade of the driveways connected to it. The interview method was selected to explore the matter, which had the potential to be a thoroughly positive impact of the Project. A statement was made that any future upgrade of Marulan South Road should include an upgrade of the driveways connected to it.

Council’s director of operations confirmed the view of the community that the road upgrade as part of the re-alignment is essential and valuable in terms of social outcomes. On the question of driveway access upgrades being included as part of the work, the sentiment was similarly positive.

There will be a positive social impact for the community if the Marulan South Road upgrade includes driveway access improvements. The benefit is forecast to be **high** based on the level of interest, scale of benefit, equity in the distribution of the benefit, and likelihood of the benefit**.**

25.3.8 Decision making systems

Decision-making systems comprise the extent to which people can have a say in decisions that affect their lives, and have access to complaint, remedy and grievance mechanisms and was considered in the scoping phase. It was determined to be a social impact not affected by the SSD (Table 25.3).

25.3.9 Fears and aspirations

The safety sub-set was determined to require assessment from a traffic perspective as the increased traffic volumes proposed for the Project was a cause of a traffic safety concern in the community

A request to reduce the speed limit from 80 to 60 km/h on Marulan South Road was made to the Project team. The traffic assessment determined the minor increase in truck movements associated with the Project will not result in traffic safety impacts, and recommends the 60 km/h speed limit in the old Marulan South village be extended 200 m to the west, so that the new intersection is in the 60 km/h speed limit area.

The social risk ratings applicable to this social matter are:

- Traffic volumes: a **low** social risk rating is applicable during the operational phase as the traffic volume increase from the Project will be immaterial. The community perception of a safety risk will likely remain, despite there being a minimal safety consequence.
- Speed limit: disregarding the potential speed limit reduction described above, a **low** social risk rating is applicable during the operational phase. This is due to the community view about decreasing the speed limit would likely be maintained, regardless of the approval status of the Project. It is immaterial and not requiring the implementation of a mitigation measure.

25.3.10 Summary

Positive and negative social impacts are summarised in Table 25.9.

Table 25.9 Predicted positive and negative social impacts

Social impact type	Social impact category	Predicted social impact
Positive	Way of life	Local and regional employment opportunity
		Local and regional business opportunity
	Personal and property rights	Driveway access improvements (Marulan South Road), benefitting both residents and road users
	Access to and use of infrastructure, services and facilities	Marulan South Road widening and upgrade (i.e. removal of dips, and bus-stop provision) for all road users
Negative	Access to and use of infrastructure, services and facilities	Cumulative and perceptual risk of increased traffic volume
		Impact to condition of pavement on Marulan South Road
	Health and wellbeing	Perceived low frequency (cumulative) noise
		Disturbance from air brake noise
	Surroundings	At property headlight spill from re-aligned Marulan South Road
	Personal and property rights	Dust fallout causing damage to property asset (shed)

25.4 Management measures and residual impacts

The negative social impacts predicted for the Project and management measures are summarised in Table 25.10. Implementation of the management measures will result in low social risk ratings. Some low residual risks will remain but most would be immaterial whilst a smaller number will need to be addressed by compliance monitoring.

Table 25.10 Summary of negative impacts and management measures

Social impact category	Impact description			Impact without mitigation		Impact with mitigation		
	Impact	Timing	Affected parties	Impact characteristic	Social risk rating	Mitigation	Social risk rating	Residual risk description
Way of life	Impact to property values	All stages	Nearby residents	Reduced property values	Low	N/A	N/A	N/A
	Impact to business revenue	All stages	Nearby businesses	Reduced business revenue	Low	N/A	N/A	N/A
Access to and use of infrastructure, services and facilities	Impact to road network	Operational	Fenceline neighbours Road users (Marulan South Road)	Cumulative and perceptual risk of increased traffic volume	Moderate	1) written notification about the availability of the EIS on exhibition, and offer of meeting to fenceline neighbours; and 2) Facebook and local print media campaign to counter perception of increased heavy vehicle traffic	Low	Low and immaterial
	Impact to public infrastructure	Operational	Road users (Marulan South Road)	Impact to condition of pavement on Marulan South Road	Moderate	Marulan South Road upgrade	Low	Low and immaterial
Health and wellbeing	Acoustic impacts	Construction and operation	Fenceline and nearby residents	Perceived Low frequency (cumulative) noise	Moderate	1) undertake noise monitoring; 2) continue to consult with	Low	Low and immaterial

Social impact category	Impact description			Impact without mitigation		Impact with mitigation		
	Impact	Timing	Affected parties	Impact characteristic	Social risk rating	Mitigation	Social risk rating	Residual risk description
						the resident about any low frequency noise disturbance to determine times, dates and weather conditions; and 3) investigate ways to reduce and ultimately prevent low frequency noise concerns of the resident		
				Disturbance from air brake noise	Moderate	1) Honour commitment to address air braking in driver training.	Low	Low, however residual impacts will remain if compliance with training is not observed.
Surroundings	Visual impacts	Operational	Fenceline neighbour (identified as PR)	At property headlight spill from re-aligned Marulan South Road	Moderate	Investigate during detailed design, adjustments to the vertical alignment of the realigned section of Marulan South Road, or the construction of vegetated earth bunds.	Low	Low and immaterial

Social impact category	Impact description			Impact without mitigation		Impact with mitigation		
	Impact	Timing	Affected parties	Impact characteristic	Social risk rating	Mitigation	Social risk rating	Residual risk description
Personal and property rights	Dust impacts	Construction and operation	Fenceline neighbour	Dust fallout causing damage to property asset (shed)	Moderate	1) Continuation of dust monitoring; 2) Relocation of the deposited dust gauges to the boundary's of the Project site; 3) Consultation with the affected neighbour about further dust monitoring at the asset; 4) provide deposited dust monitoring results to the neighbour; 5) Maintain an open communication channel with the neighbour so they can report any dust fallout on their property; 6) investigate ways to reduce and ultimately prevent dust fallout; and	Low	Low, however residual risk will remain given the reported damage that has occurred. A specialist assessment would need to confirm the damage is related to dust fallout, and suggest a property treatment option, if feasible and warranted. Any treatment would reduce the residual risk to an immaterial level.

Social impact category	Impact description			Impact without mitigation		Impact with mitigation		
	Impact	Timing	Affected parties	Impact characteristic	Social risk rating	Mitigation	Social risk rating	Residual risk description
						7) Conduct specialist assessment of asset damage and engage with neighbour on rectifying the damage.		
Fears and aspirations	Impact to personal safety	Operational	Road users	Cumulative and perceptual safety risk from increased heavy vehicle volume	Low	1) written notification about the availability of the EIS on exhibition, and offer of meeting to fenceline neighbours; and 2) Facebook and local print media campaign to counter perception of increased heavy vehicle traffic.	Low	Low and immaterial
				Excessive speed limit on Marulan South Road	Low	N/A	N/A	N/A

Chapter 26

Rehabilitation strategy

VOLUME 1

Rehabilitation strategy

The mine will be progressively rehabilitated to achieve a final landform based on the following objectives:

- Rehabilitated land will be geotechnically stable and will not present a greater safety hazard than surrounding land to land-users, public, livestock and native fauna accessing or transiting the post-mining area.
- Land capability will, as far as possible, be returned to a class similar to that existing prior to Project commencement (class V, VII or VIII).
- Except for the mine void, mined land will be visually compatible with the surrounding natural landscape.
- Rehabilitated landforms will be designed to shed water without causing excessive erosion or increasing downstream pollution.
- Rehabilitated landforms will not negatively impact visual amenity for nearby residents and users of conservation reserves.

To achieve these objectives the site was divided into primary and secondary domains. The primary domains were operationally based e.g. overburden emplacements/infrastructure area, and the secondary domains were based on post-mining land use objective e.g. woodland.

The domains will be rehabilitated by reshaping and stabilising post-mining landforms, topdressing reshaped landforms and establishing and maintaining native woodland communities over the following phases.

- decommissioning;
- landform establishment;
- growth medium development;
- ecosystem and land use establishment;
- ecosystem and land use sustainability; and
- relinquishment.

The domains will be rehabilitated in the above phases to achieve the domain specific objectives described in the 2018–2023 MOP. Rehabilitation will be complete once the completion criteria for each rehabilitation element (landform stability, topsoil, vegetation, fauna, water quality and safety) are satisfied.

There will be 215,510 m^3 of stripped topsoil available for rehabilitation, which will not be sufficient to cover all rehabilitation areas. Therefore, topsoil will be prioritised for rehabilitation of the high and moderate erosion risk areas on overburden emplacement slopes and alternative growth media will be used on lower slopes and flats.

Decomposed granite from the Peppertree Quarry and weathered shale from the mine has been used as a growth medium in previous rehabilitation at the mine. The weathered shales have resulted in good tree germination rates, and the decomposed granite was useful in establishing ground cover vegetation.

26 REHABILITATION STRATEGY

Additional to **sections 4.5**, **4.8**, **4.9** and **4.10**, This chapter summarises the rehabilitation information in **Appendix I**. It describes the rehabilitation domains, phases, domain objectives and method.

26.1.1 Assessment guidelines and requirements

The SEARs require a rehabilitation strategy for the Project (**Table 26.1**).

Table 26.1: Rehabilitation strategy SEARs

Requirement	Section and appendix where addressed
A rehabilitation strategy, having regard to DRE's requirements.	26.1.2, 26.5, Appendix I

The SEARs recommend use of the following guidelines, which were used during the assessment:

- Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Department of Industry, Tourism and Resources, 2006);
- Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry (Department of Industry, Tourism and Resources, 2006) and
- *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000).

26.1.2 Overview of rehabilitation methods

The mine will be progressively rehabilitated as described in **Section 4.5** to achieve the final landform described in **Section 4.9.** The general rehabilitation objectives will be:

- Rehabilitated land will be geotechnically stable and will not present a greater safety hazard than surrounding land to land-users, public, livestock and native fauna accessing or transiting the post-mining area.
- Land capability will, as far as possible, be returned to a class similar to that existing prior to Project commencement (class V, VII or VIII).
- Except for mine void, mined land will be visually compatible with the surrounding natural landscape.
- Rehabilitated landforms will be designed to shed water without causing excessive erosion or increasing downstream pollution.
- Rehabilitated landforms will not negatively impact visual amenity for nearby residents and users of conservation reserves.

To achieve these objectives, the Project site was divided into land management units (domains) that share operational or functional purposes and, therefore, similar geophysical characteristics. The domains can be:

- primary – operationally based domains for example overburden emplacements; and
- secondary – characterised by post mining land use objective for example native woodland.

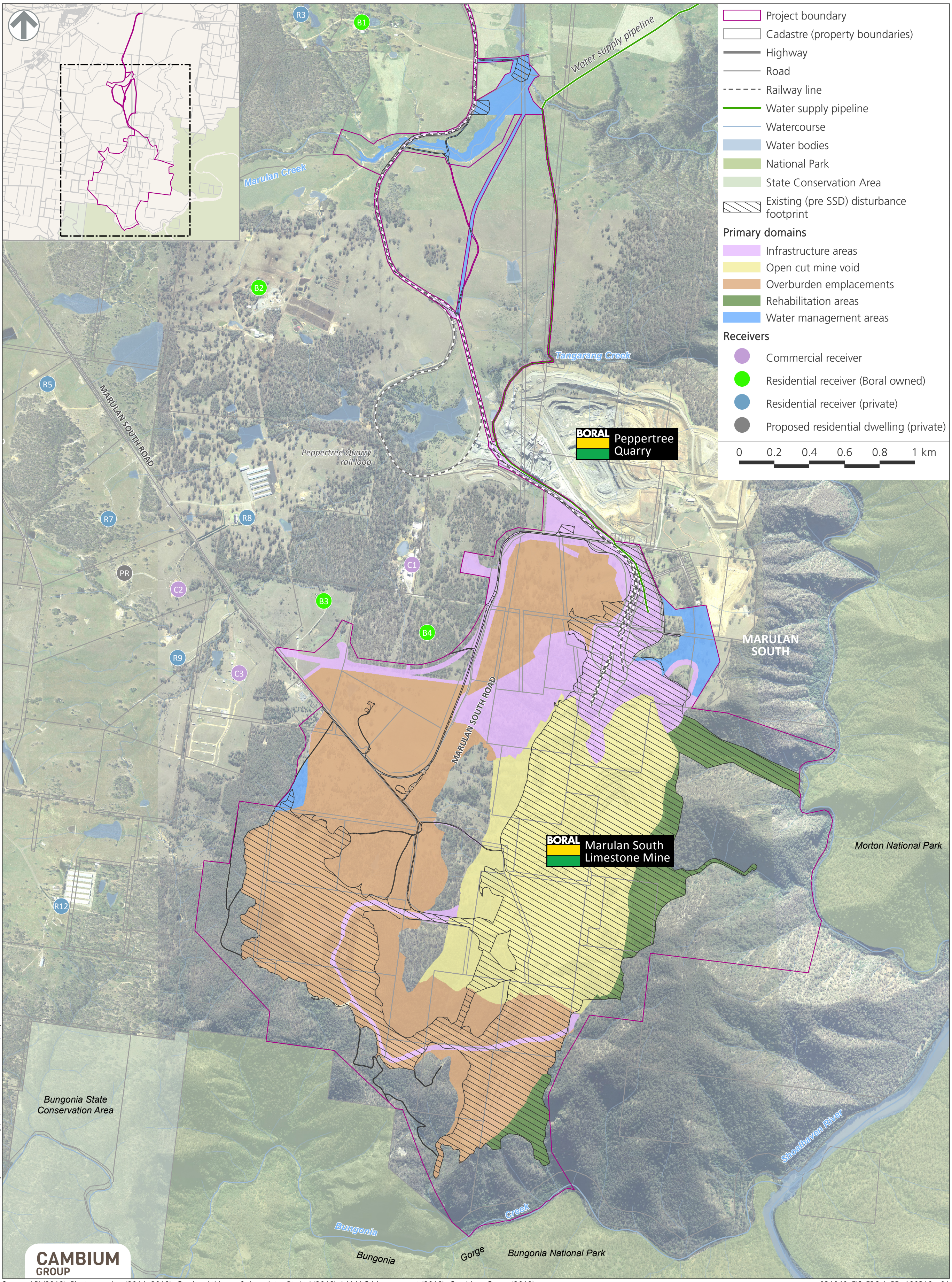
The primary domains are summarised in **Table 26.2** and presented in **Figure 26.1** and the secondary domains are summarised in **Table 26.3** and presented in Figure 4.21**.** Rehabilitation of these domains over the mining stages is described in **Section 4.5**.

Table 26.2: Primary rehabilitation domains

No.	Rehabilitation domain	Description	Area (ha)
1	Infrastructure area	Mining related infrastructure on lower gradients in the central northern section of the main Project site including processing facilities, workshops, administrative buildings, roads, rail facilities, dams, pipelines, and hard stand. Some additional disturbance associated with site haul and access roads together with existing access tracks of about 1 ha. Infrastructure will generally remain operational (and unrehabilitated) until end of Project life. Infrastructure not required post mining will be decommissioned and demolished. It is expected that the Marulan Creek dam (and vehicle access road) will remain operational post-mining, and will be in parts rehabilitated at the end of the mine life.	106.2
2	Waste lime storage / emplacement area	Discrete area in WOE designated for placement and capping of waste lime materials.	2.0
3	Water management areas	Sediment basins and water supply dams across the Project site including Marulan Creek dam infrastructure.	30.0
4	Overburden emplacement areas	Existing overburden emplacement to the west and south of the open cut pit.	246.3
5	Stockpiled material area	Designated areas within infrastructure and mine void areas for management of raw, processed and product materials. This area has been incorporated into domain 1 (infrastructure).	0
6	Open cut mine void	Open cut mine void. Will expand towards the west as the pit develops.	155.5
7	Rehabilitation areas	Rehabilitated overburden emplacement areas, currently consisting of rehabilitation areas of WOE and Bryces Gully Emplacement; Barbers Emplacement and Eastern Batters (south).	58
Total			**598**

Figure 26.1
Primary domains

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



Source: LPI (2018), Photomapping (2014, 2018), Gordon Atkinson & Associates Pty Ltd (2018), LAMAC Management (2018), Cambium Group (2019).

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Table 26.3: Secondary rehabilitation domains

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

The domains will be rehabilitated by reshaping and stabilising post-mining landforms, topdressing reshaped landforms and establishing and maintaining native woodland communities over the following phases, which are described in **Section 26.2**:

- decommissioning;
- landform establishment;
- growth medium development;
- ecosystem and land use establishment;
- ecosystem and land use sustainability; and
- relinquishment.

The domains will be rehabilitated in the above phases to achieve the domain specific objectives summarised in **Table 26.4** and described in the 2018–2023 MOP. Rehabilitation will be complete once the completion criteria for each rehabilitation element (landform stability, topsoil, vegetation, fauna, water quality and safety) in **Table 26.5** are satisfied.

Table 26.4: Domain rehabilitation objectives

No.	Functional objective	Rehabilitation phase					
		Decommissioning	Landform establishment	Growth medium development	Ecosystem and land use establishment	Ecosystem and land use sustainability	Relinquishment
Primary domains							
1	Safe, stable, free-draining and non-polluting landform. Suitable for rehabilitation to native woodland. Select infrastructure retained to facilitate continued site access and support post-mining land use.	Infrastructure not required for post-mining use decommissioned and demolished. Contamination assessment completed, with contamination and contaminant sources removed or managed.	Landform slopes <10º or assessed as geotechnically stable. Accessible for rehabilitation, and suitable for rehabilitation to native woodland or post-mining land use. Surface free-drains to sediment control structure, with no ponding or significant erosion.	See secondary domains: A – Native woodland area, for the majority of the rehabilitated Infrastructure area; or F – Infrastructure, for residual access roads and residual post-mining structures.			
2	Safe, stable and non-polluting encapsulation of waste lime materials.	No (wind or water) migration of waste material from emplacement area. Area capped with 1.5 m of inert overburden to prevent risk of future exposure.	Capped emplacement surface merges seamlessly with adjacent landform, sheds water and drains to sediment control structure. Landform suitable for rehabilitation to native woodland.	See secondary domain A – native woodland area.			
3	Receive and store water for operational use, or	Water management structures not	Water management structures to	See secondary domain E – water management.			

No.	Functional objective	Rehabilitation phase					
		Decommissioning	**Landform establishment**	**Growth medium development**	**Ecosystem and land use establishment**	**Ecosystem and land use sustainability**	**Relinquishment**
	temporarily hold surface catchment run-off for sediment control purposes.	required for post-mining use decommissioned and backfilled or removed.	remain post mining assessed as geotechnically stable, meeting water quality requirements, and meeting selected land use function.				
4	Stable, safe, free draining and non-polluting landform capable of sustaining a native woodland vegetation community	Emplaced landform generally matches maximum elevation and contours shown in relevant MOP plans.	Slopes reshaped to designed contours and gradients < 1:3 to 1:6. Benches and drainage structures incorporated and functioning as designed. Landforms shed water, and drain to sediment control structures. Landform surfaces accessible and able to be rehabilitated.	See secondary domain A – native woodland area.			
5	Temporary storage of stockpiled materials within infrastructure areas (raw materials, processed materials and waste materials).	Infrastructure demolished and potentially contaminating materials removed / scalped. Compacted surface layers ripped or capped to	Landforms shed water, and drain to sediment control structures. Landform surface merges seamlessly with adjacent landform, is	See secondary domain A – native woodland area.			

No.	Functional objective	Rehabilitation phase					
		Decommissioning	Landform establishment	Growth medium development	Ecosystem and land use establishment	Ecosystem and land use sustainability	Relinquishment
		ensure near-surface material compatible with rehabilitation.	accessible and able to be rehabilitated.				
6	Void landforms safe, stable and non-polluting. Void preferentially available for overburden emplacement or short-term water detention.	Slopes and benches shaped to match stability criteria. All sources of potential contamination removed. Safe access to void maintained, while unauthorised access controlled.	Ramps, slopes and benches determined as stable from geotechnical assessment. Void provides water capture, temporary holding (and potentially filtration treatment) capacity. Void perimeter and upper benches accessible and suitable for vegetation establishment.	See secondary domains: C – Final void, general safety and stability treatment for the residual void: or D - Visual screening, for the void perimeter and in-void vegetation screens.			
7	Native woodland community of variable density and function enhancing slope stability and visual amenity.	Ongoing monitoring and maintenance.	Variable, but generally safe, stable, non-polluting, and conforming to adjacent landscape.	See secondary domain B – trees over grass.			
Secondary domains							
A	Resilient and self-sustaining native woodland community	See relevant primary domains: infrastructure area; waste lime storage / emplacement area; overburden emplacement areas; or		Where used, topdressing material (meeting EC, pH and ESP	Vegetation established, with species mix reflecting species	Vegetation community composition (including key	Sufficient monitoring evidence to indicate woodland community exhibiting essential

No.	Functional objective	Rehabilitation phase					
		Decommissioning	Landform establishment	Growth medium development	Ecosystem and land use establishment	Ecosystem and land use sustainability	Relinquishment
	providing slope stability, biodiversity enhancement and visual amenity.	stockpiled material areas.		criteria) placed as per erosion risk: Low risk: 10cm depth topdressing material. Mod risk: 10cm depth good quality topsoil. High risk: Rock / soil mulch. Or suitable ameliorant (i.e. organic growth medium (OGM)) used as per industry leading practice.	composition of open native woodland. Controls implemented to prevent interference with rehabilitated areas. Monitoring program expanded to ensure representative coverage.	species) and structure developing towards reference site as per landscape function analysis (LFA) monitoring. Evidence of reproduction (setting viable seed, flowering or Filial 1 (F1) plants establishing).	ecosystem processes, landform stabilisation, habitat enhancement and visual screening.
B	Resilient and self-sustaining vegetation community, promoting visual screening, landform stability and erosion control.	See primary domain 7 – rehabilitation areas.		Where used, topdressing material (meeting EC, pH and ESP criteria) placed as per erosion risk: Low risk: 10cm depth topdressing material. Mod risk: 10 cm depth good quality topsoil. High risk: Rock / soil mulch. Or suitable ameliorant (i.e. OGM) used as per industry leading practice.	Vegetation established, with species mix reflecting species composition of open native woodland. Controls implemented to prevent interference with rehabilitated areas. Monitoring program expanded to ensure representative coverage.	Vegetation community composition (including key species) and structure developing towards reference site as per LFA monitoring. Evidence of reproduction (setting viable seed, flowering or plants establishing).	Sufficient monitoring evidence to indicate woodland community exhibiting essential ecosystem processes, landform stabilisation, habitat enhancement and visual screening.
C	Resilient and self-sustaining native	See primary domain 6 – open cut void.		Inert weathered material used to	Native grass, shrub and tree species	Diverse native woodland tree and	Sufficient monitoring evidence to indicate

No.	Functional objective	Rehabilitation phase					
		Decommissioning	Landform establishment	Growth medium development	Ecosystem and land use establishment	Ecosystem and land use sustainability	Relinquishment
	dominated tree / shrub community (where vegetation establishment achievable) providing landform stability and habitat value.			establish growth medium on non-flooded flat surfaces. Or suitable ameliorant used as per industry leading practice.	established on non-flooded level surfaces.	shrub community developing, with no evidence of vegetation failure or widespread premature senescence. Evidence of reproduction observed.	diverse native woodland community essential exhibiting ecosystem processes and landform stabilisation and habitat enhancement.
D	Resilient and self-sustaining dense to moderately dense native woodland vegetation community, with mid-storey and canopy providing visual screening.	See primary domain 6 – open cut void.		As for C – final void.	Native grass, shrub and tree species (with key canopy and mid-storey species) established on void perimeter and upper benches and ramps.	Visual screening vegetation moderately dense to dense, with no evidence of vegetation failure or widespread premature senescence. Evidence of reproduction observed.	Sufficient monitoring evidence to indicate diverse native woodland community exhibiting essential ecosystem processes, landform stabilisation and visual screening.
E	Receive and store water for selected post-mining land use, or temporarily hold surface catchment run-off for sediment control purposes.	See primary domain 3 – water management area.		Placement of 10 cm of topdressing material (meeting EC, pH and ESP criteria) on outer batters of sediment basins, dams, drains or other infrastructure slopes with high erosion risk.	Erosion control groundcover vegetation established on water management infrastructure slopes. No trees to be established where roots may penetrate and compromise water holding / carrying capability of structures.	Mix of tree and shrub species establishing and groundcover > 70% for erosion control. No evidence of vegetation failure. Water management structure inspected periodically and assessed as functional. Significant water holding structures assessed periodically as safe	Sufficient monitoring evidence to indicate groundcover vegetation resilient and self-sustaining and providing landform stabilisation function. Water management structures assessed as necessary, functional, safe and stable. Arrangements made to meet ongoing management requirements.

No.	Functional objective	Rehabilitation phase					
		Decommissioning	Landform establishment	Growth medium development	Ecosystem and land use establishment	Ecosystem and land use sustainability	Relinquishment
						and geotechnically stable.	

Table 26.5: Completion criteria development from 2018–2023 MOP

Rehabilitation element	Indicator	Criteria
Landform Stability	Slope gradient	▪ Where the slopes are steeper than 10°, additional water management structures will be utilised (as required). ▪ Where hostile material is present and exposed, the landform is capped with a minimum of 1.5m of inert material and is free draining.
	Erosion control	▪ Erosion control structures are installed at intervals commensurate with the slope of the landform. ▪ Dimensions and frequency of occurrence of erosion rills and gullies are generally no greater than that in reference sites that exhibit similar landform characteristics.
	Surface water drainage	▪ Use of contour banks and diversion drains to direct water into stable areas or sediment control basins. ▪ All landforms will be free draining except where specific structures (i.e. dams) have been constructed for the storage of water as required for sediment and erosion control or some post mining land-use.
Topsoil	Salinity (EC)	▪ Soil salinity content is <0.6 dS/m.
	pH	▪ Soil pH is between 5.5 and 8.5.
	Sodium content	▪ Soil exchange sodium percentage (ESP) is <15%.
	Nutrient cycling	▪ Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and / or other microsymbionts. Adequate macro and micro-nutrients are present.
Vegetation	Land use	▪ Area accomplishes and remains as healthy native woodland.
	Surface cover	▪ Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present).
	Species composition	▪ Subject to proposed land use, comprise a mixture of native trees, shrubs and grasses representative of regionally occurring woodland where possible.
	Resilience to disturbance	▪ Established species survive and / or regenerate after disturbance. ▪ Weeds do not dominate native species after disturbance or after rain. ▪ Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Sustainability	▪ Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of shrub and understorey species. ▪ Vegetation develops and maintains a litter layer evidenced by a consistent mass and depth of litter over subsequent seasons. ▪ No evidence of premature die back or senescence.
Fauna	Vertebrate species	▪ Representation of a range of species characteristics from each faunal assemblage group (e.g. reptiles, birds, mammals), present in the ecosystem type, based on pre-mine fauna lists and sighted within the three-year period preceding mine closure. ▪ The number of vertebrate species does not show a decrease over a number of successive seasons prior to mine closure.
	Invertebrate species	▪ Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.
	Habitat structure	▪ Typical food, shelter and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present, including: a variety of food plants; evidence of active use of habitat provided during rehabilitation such as nest boxes, and logs and signs of natural generation of shelter sources including leaf litter.

Rehabilitation element	Indicator	Criteria
Water quality		▪ As per water quality trigger values presented in **Section 8.3.2** and regulatory limits.
Safety		▪ Risk assessment has been undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with relevant stakeholders.

26.1.3 Key rehabilitation learnings

Experience from previous rehabilitation at the mine has been used to inform the proposed rehabilitation method. The performance of rehabilitation at the mine has been mixed. Woodland has been successfully established in the WOE area, however, sections of rehabilitation on the Eastern Batters require further attention. The performance of existing rehabilitation indicates the following key limitations to success:

- Hostile soil conditions – the overall limited availability of material suitable for use in rehabilitation is exacerbated by the elevated pH levels in the natural soils. This has impeded the successful development of a growth medium layer that can support rehabilitation.
- Steep slopes – although overburden emplacements have been designed to mimic adjacent natural steep slopes, landform steepness has contributed to an inherent lack of geotechnical stability in some emplacements, resulting in erosion and downslope water quality impacts.
- Climate – highly variable and irregular climatic conditions hinder rehabilitation. These include hot summers, cold winters and periodic droughts. It is important to plan towards rehabilitation in the traditional seasonal windows of Spring and Autumn, but allow flexibility in long term rehabilitation planning to allow for drought periods.
- Environment – local environmental factors resulting from the mine’s location have impeded rehabilitation. Such factors include predation by herbivorous pests such as goats and rabbits, and native macropod species, as well as invasion of weed species.
- Water supply – rehabilitation success has been impeded by water shortages following good initial germination. There have been irrigation trials, with mixed success.

26.2 Rehabilitation management measures

This summarises the components of each phase of the rehabilitation process. The decommissioning phase is not described here as it is unique to the mine closure phase of the Project as described in **Section 4.9**.

26.2.1 Landform establishment

Completed mine landforms will be shaped as described in **Section 4.9** to provide a stable landform which incorporates slopes, benches and drainage features that blend with the surrounding natural topography. The following activities will occur at the overburden emplacements, however, the final void will be treated separately.

Bulk shaping

Overburden will be emplaced during mining to conform with the general final emplacement shape, with hostile material (acid, alkaline, saline or sodic material) buried deep to isolate it from future root zones. The outer slopes of the WOE and NOE will have gradients up to 20% and will have a moderate erosion risk. The upper surfaces will have lower gradients and erosion risk and will be slightly domed to provide visual relief and prevent water ponding.

The SOE will have gradients up to 33% and high erosion risk, which will be mitigated by benches of up to 20 m high to reduce slope length.

Drainage

Lengths of the outer slopes will be reduced by provision of graded banks to intercept and divert water and prevent erosion. The banks will lead to lined drop structures that will direct water to sediment detention and water storage structures. Erosion risks will reduce as vegetation is established on the slopes.

Final trim

The final trim will occur after bulk shaping and drainage construction is complete and will comprise ripping and rock raking to smooth the surface and prepare it for vegetation planting. Relatively level surfaces, such as the Infrastructure area, where minimal bulk reshaping will be required, should incorporate local relief to avoid uniform, straight surfaces and integrate with surrounding natural areas and prevent water pooling.

Final void

The rehabilitation method will not be applied to the final mine void as its sides will consist of consolidated limestone rock and it will be internally draining, and subsequently does not present a sedimentation risk to nearby streams. The stability of in-pit slopes during and after mining has been considered in the design of ramps, benches and inter-ramp slopes.

26.2.2 Growth medium establishment

Establishment of vegetation on rehabilitated surfaces will reduce erosion risks and provision of a good quality growth medium layer will enable successful vegetation establishment. The growth medium layer will be the inert and fertile material that will be provided over the emplaced and disturbed material and will comprise the A1 horizon of stripped topsoil and/or subsoils, organic mulches, weathered geological strata or rock mulch.

Topsoil availability

As described in **Section 10.3.1**, there will be 215,510 m^3 of stripped topsoil available for rehabilitation. The topsoil will be reserved for the following uses:

- approximately 70,000 m^3 for the top 10 cm of 70 ha of the high erosion risk SOE slopes;
- approximately 117,000 m^3 of the top 10 cm of 117 ha of the moderate erosion risk NOE and WOE outside slopes; and
- approximately 28,510 m^3 for the lower gradient slopes.

Using topsoil for the above priority areas will result in a deficit of topsoil for lower and level gradients in other rehabilitation domains.

Alternative growth media

Topsoil may not be required as a growth medium for the lower and level gradients as decomposed granite from the Peppertree Quarry and weathered shale from the mine has been used as a growth medium in previous rehabilitation at the mine. The weathered shales has resulted in good tree germination rates, and the decomposed granite was useful in establishing ground cover vegetation (with sparse tree stem density).

This indicates the weathered granite maybe useful for establishing ground cover to reduce erosion on lower slopes and the weathered shale may be useful for establishing native woodland on flat areas such as the Infrastructure area and void benches.

The materials described in this section are unlikely to contain the nutrients and biological processes necessary for plant growth and they will need to be mixed with composted organic material. Any material other than the topsoil assessed in **Appendix I** will need to be characterised for its suitability as growth medium and potential ameliorant requirements.

Growth media management

At a minimum, gypsum will be applied as an ameliorant to treat clay material. The growth media layer will not be heavily trafficked but micro relief will be provided to enable water infiltration. Growth media will be placed at the top of steep and inaccessible slopes and pushed over the edge with dozers and spread across the slope with long reach excavators. Planting will occur as soon as possible to reduce erosion.

Topsoil will be directly placed on rehabilitation surfaces where possible. Stockpiled topsoil will be selected based on proximity of stockpiles to the rehabilitation area, age and quality of the soil and vegetation community at the topsoil resource compared to the outcomes for the rehabilitation area.

The quality of topsoil greater than five years old will be assessed prior to use including the need for supplements or ameliorants. Topsoil will be inventoried to track stripping, stockpiling and usage, which will be updated at least annually via a topsoil survey and balance and reported in the annual environmental management report.

Management measures for topsoil stripping and stockpiling are in Appendix 5 of **Appendix I**.

26.2.3 Ecosystem and land use establishment

A number of revegetation techniques will be used, reflecting the topographic and climatic variation over the Project site.

Weed management

The existing site wide weed control program will be extended into newly established rehabilitation to assess and, where required, treat weeds before vegetation establishment.

Direct seeding

Direct seeding is the most effective and cost efficient method of vegetation establishment and can be via manual seeding (by hand) or mechanical (tractor). Aerial seeding by aircraft or hydroseeding/hydromulching can be used in remote areas or difficult terrain.

Seed species selection will be informed by previous biodiversity studies of the area and results of previous rehabilitation. A 40% shrub and 60% tree seed mix will be prepared and mixed with fertiliser and/or bulking material and applied at a rate of 5–7 Kg/ha. A light cover crop of sterile annual groundcover species will be sown with the native mix to assist early soil stabilisation. Contour benches and grass lined drains will be sown with pasture species for rapid groundcover establishment.

Hydroseeding and hydromulching

Hydromulch will be applied to high erosion risk slopes where rapid vegetation establishment will be required to stabilise landforms. Hydroseeding is effective but possibly less cost effective.

These techniques must be used immediately after site preparation when the surface is still freshly scarified.

Tube stock

Planting tubestock is useful where specific species are required in a specific location, such as visual screens. Tubestock can also be used to supplement existing rehabilitation where species compositions have not been achieved. However, use of tubestock for general rehabilitation is not efficient as it requires manual planting, watering or irrigation, weed control and protection from browsing animals.

Cleared vegetation and seedbank

Up to the top 5 cm of topsoil stripped from vegetated areas will contain seeds which can be a useful resource when direct placement of topsoil on rehabilitation surfaces is possible. vegetation can also re-establish from roots and saplings in the stripped topsoil.

The existing program of seed collection from onsite stands of remnant native vegetation will also be continued, to provide a source of seed for use in rehabilitation. Native vegetation will be assessed for habitat, such as logs, prior to clearing, which may be transported to rehabilitation areas to provide fauna habitat.

26.2.4 Ecosystem and land use sustainability

Established rehabilitation will be maintained and monitored as described in **Section 26.2.6** to determine if rehabilitated landscapes are developing towards the relevant success criteria and to develop remedial actions in case rehabilitation is failing.

New rehabilitation areas will be protected with signs and fences and the mine planning process will ensure rehabilitation is not disturbed. Livestock grazing is not a proposed use of post-mining landscapes and livestock have been excluded from rehabilitated land. However, there should be controlled grazing trials on rehabilitated land if grazing is ever proposed as a future use of the land.

Eastern Batters

The Project's preliminary risk assessment identified that the rehabilitated steep slopes east of the mine void have a high risk of failure due to steepness and erosion. Subsequent geotechnical assessments determined mass movement or failure of the eastern batters is unlikely. However, gullies on the lower slopes are susceptible to erosion, undercutting and slumping.

Boral is consulting the EPA and DPE's Division of Resources and Geosciences (DPE-DRG) regarding a remediation strategy for managing erosion on these overburden emplacements.

26.2.5 Relinquishment

Notwithstanding potential future development at the mine, individual sections of rehabilitation may have reached the relinquishment phase towards the latter stages of the Project life.

An application will be submitted to DPE-DRG for relinquishment of rehabilitated areas when monitoring indicates rehabilitated areas are well into the ecosystem and land use sustainability phase and are tracking towards meeting all general and domain specific success criteria.

26.2.6 Rehabilitation monitoring

The ecosystem function analysis monitoring method is used at the mine, and will continue to be used for the Project. This is a transect based method that comprises analysing:

- landscape function;
- vegetation dynamics;
- habitat complexity; and
- disturbance.

Landscape and vegetation parameters are periodically measured along established transects in rehabilitated areas. The data are converted to indices which are compared against measurements at reference transects in undisturbed target vegetation, with repeated measurements showing if progress towards the criteria is occurring.

26.3 Residual impacts

After implementation of the rehabilitation method there is a risk that threats to rehabilitation could occur, for example:

- Soils, geology and erosion – poor quality and/or insufficient topsoil; erosion; geotechnical failure such as slumping or subsidence; failure of water management structures; rehabilitation not meeting targeted land capability classes.
- Biological and environmental – poor vegetation establishment; inadequate weed control; animal predation of juvenile vegetation; disease infestation; poor vegetation development; severe or prolonged drought; bushfire; and major storm damaging vegetation and resulting in erosion.

A trigger action response plan is included in the 2017–2023 MOP and will be included in future MOPs, which identifies trigger events or indicators related to the above threats, and provides appropriate response strategies.

Chapter 27

Revised environmental risk analysis

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27 REVISED ENVIRONMENTAL RISK ANALYSIS

As discussed, the preliminary environmental risk analysis undertaken as part of the PEA did not consider the potential outcomes of specialist technical assessments and the application of avoidance, management, mitigation or offset measures for each of the environmental factors considered in the assessment of the Project. Therefore, a revised environmental risk analysis has been undertaken as part of the EIS, which considers the outcomes of specialist technical assessments and the implementation of all recommended avoidance, management, mitigation and offset strategies for the Project.

In some cases, a residual risk remains after the implementation of management and mitigation measures. This residual risk has been assessed within the EIS, as outlined in **chapters 8** to **26** and is summarised for each respective environmental issue in Table 27.1. A discussion on why each environmental issue was attributed their associated preliminary risk rating is included in Table 7.4 as it was presented in the PEA and then further discussion is provided on why the risk rating has been changed or remains the same.

The objective of the revised environmental risk analysis was to determine whether the implementation of avoidance, management and mitigation measures proposed for the Project would result in a reduction of environmental risks or whether unavoidable significant environmental impact remains at the end of the Project planning process for some environmental issues, which require offsetting.

Eleven of the environmental issues achieved a **low** revised risk rating after the incorporation of environmental controls into the Project design and commitments to further avoidance, minimisation, and mitigation measures. Two environmental issues achieved a **medium** risk rating due to unavoidable impacts with substantial mitigation. One environmental issue retained a **high** risk rating due to unavoidable impacts with limited mitigation and therefore required offsetting.

Table 27.1: Revised risk rating for environmental issues

Environmental issue	Preliminary risk rating	Revised risk rating	Comments	Residual risks
Surface Water and Hydrology	High	Low	The water management system will be designed to retain almost all runoff onsite with only occasional overflows from sediment basins into natural receiving waters. There will be a reduction in flows in Marulan Creek downstream from the Marulan Creek dam. However, the dam will be designed to allow water seepage into the creek and maintain a riparian flow.	Implementation of the water management system will restrict overflows from the sediment basins to twice a year, which is within the NorBE criteria. Marulan Creek dam will be designed to maintain daily riparian flow along Marulan Creek.
Groundwater	High	Low	At equilibrium, there will be an approximately 1 m drawdown of the water table, which will not impact any water users. The Project will result in an increase in outflows from the pit to underlying geology, which will increase flows into springs.	An approximately 1 m drawdown of the water table to approximately 1.2 km north-east of the northern extent of the mine, and approximately 600 m east and west of the final void at equilibrium. This will not impact water users and 'make good' arrangements will not be required.
Air Quality	High	Low	Cumulative TSP, PM_{10}, $PM_{2.5}$ and dust deposition results do not exceed criteria at privately-owned residential or commercial receivers. Annual average PM_{10} criteria will be exceeded at B4 (Boral owned) in Stage 1. Stack emissions will be below criteria at Boral owned, private residential and commercial receivers. The Project will not have dust impacts on more than 25% of any privately owned properties.	Annual average PM_{10} criteria will be exceeded at Boral owned receiver B4 in Stage 1.
Noise and Blasting	High	Low	Noise will not exceed Project operational noise trigger levels or sleep disturbance screening level at any residences during any mining stage or time period. Noise generated by construction of Marulan Creek dam will comply with criteria at all receivers. Traffic noise will comply with the criterion at all receivers. Noise from Project related trains will be below the RING criterion at all receivers. Highest predicted blast vibration and overpressure will be below the human comfort and structural damage criteria.	No residual or noise impacts were predicted.
Soils and rehabilitation	High	Low	Topsoil stripping will generate topsoil resources for use during rehabilitation. However, it will not generate a sufficient quantity and will need to be supplemented with alternative growth media.	After implementation of the rehabilitation method there are risks that rehabilitation will only be partially successful. A trigger action response

Environmental issue	Preliminary risk rating	Revised risk rating	Comments	Residual risks
			The Project will have an overall minimal impact on agricultural land. Disturbed areas will be rehabilitated to be stable, returned to the pre-mining land capability, be visually compatible with surrounding areas and not increase surface water impacts.	plan will be prepared and implemented to address issues with rehabilitation should any arise.
Aboriginal Heritage	High	Medium	Ten Aboriginal sites will be totally disturbed by the Project and 39 will be totally lost without management measures. One of the sites to be totally disturbed is of medium significance, five of the sites to be totally lost are of medium significance and one is of high significance. Thirty two sites will be collected prior to disturbance and there will be salvage excavations in the areas of moderate and high archaeological sensitivity. Impact to a cultural site on Marulan Creek will be avoided through the redesign of the Marulan Creek dam.	Eight sites in the main Project site and two along the Marulan Creek dam access road will have unmitigated impacts. These sites are of low scientific value.
Biodiversity	High	High	The Project will result in the clearing of a TEC and habitat for the Koala and Large-eared Pied Bat, and the loss of one individual plant of a threatened flora species. A biodiversity offset strategy will be prepared and implemented to offset the impacts to the TEC and threatened species habitat. Stygofauna has not been identified in the Project site and is unlikely to be impacted by the Project.	Even though there will be loss of a portion of a TEC and threatened species habitat in the Project site, the offset strategy will ensure compensatory land is protected into perpetuity.
Visual	High	Low	The Project has low overall visual exposure to its visual catchment. Of the 24 assessed viewpoints, only two will have medium impacts and the remainder will have low impacts. The viewpoints with medium impacts are Bungonia Lookdown Lookout and near Long Point Lookout.	Views from the affected viewpoints will improve over time as overburden emplacements are rehabilitated. Bungonia Lookdown Lookout has the most significant views to the mine, which will substantially reduce by Year 30 when the SOE complete and being rehabilitated.
Traffic and Transport	Medium	Low	The Project will result in two to four additional one-way trips in an average hour on an average day, which will have a minor impact on LoS and AVD along Marulan South Road. The extra traffic will not change the LoS at the Hume Highway interchange from A. The proposed intersection on Marulan South Road will have LoS A and the Project is unlikely to impact safety along Marulan South Road, for example on school buses.	The small increase in vehicle movements associated with the Project will have minor residual impacts on intersections and road service levels and safety. The proposed upgrade of Marulan South Road will improve safety.
Contamination	Medium	Low	TPH was found in a sampling bore, however it only represents negligible risk to human health. Elevated levels of MBAS in two	After identification and removal of asbestos in Marulan South township

Environmental issue	Preliminary risk rating	Revised risk rating	Comments	Residual risks
			sample bores have negligible migration pathways or human health risks. There is a potential human health exposure pathway for asbestos at the former Marulan South township.	there will not be any residual contamination risks.
Historic Heritage	**Medium**	**Medium**	Thirteen items of historic heritage significance were discovered in the Project site. Seven of these will be removed as it is not possible to significantly alter the disturbance footprint given the alignment of the limestone.	The Project will have moderate residual impacts on items of historic heritage as there is little opportunity to alter the mine plan due to the alignment of the limestone.
Economics	**Medium**	Low	The CBA determined the Project will have net social benefits to Australia of $643 million (M) and to NSW of $321 M. Any unquantified residual impacts of the Project after mitigation, offset and compensation would need to be valued at greater than these amounts for the Project to be questionable from a national and NSW economic efficiency perspective.	There are no residual economic risks associated with the Project.
Greenhouse Gases	**Medium**	Low	GHGs generated by the Project will equate to 0.83% of the national ‘Metal ore and non-metallic mineral mining and quarrying’ sector’s annual GHG emissions.	The Project will continue to generate minor quantities of GHGs after implementation of management measures.
Waste Management and Minimisation	Low	Low	The Project will not generate significant quantities of general solid, hazardous or liquid waste. The Project will generate large quantities of overburden, which will all be managed onsite.	The Project will generate minor quantities of waste requiring offsite disposal.

Chapter 28

Project alternatives

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28 PROJECT ALTERNATIVES

Identifying project alternatives, evaluating them and selecting one is possibly the most difficult and most important process in planning a new project or a 30-year continuation of mining at the oldest and largest limestone mine in Australia. The process of considering alternatives is difficult to explain and document fully as it is an iterative process that evolves as a project's planning progresses, as new information arises from detailed technical studies and constraints and cost benefit analysis, as well as stakeholder engagement. Evaluating alternatives and arriving at the preferred Project is not a perfect science with a clear set of criteria that can be applied to arrive at the ideal outcome that achieves a harmonious balance between the three pillars of true environmentally sustainable development. Evaluating alternatives is granular, subjective, two steps forward – one step back, influenced by conflicting priorities and objectives of different legislation, stakeholders and even cultures. Evaluating alternatives requires a polycentric decision making approach where the environmental, social and economic impacts of each alternative are considered to lesser or greater degrees based on the potential level of impact and then a value judgement is made on which alternative should be adopted and why certain environmental, social or economic values should receive greater consideration than others.

Chapter 28 explains and documents the process of considering Project alternatives which has been informed by Boral and their mine planners expertise and experience in open cut mining, detailed technical studies, cost benefit analysis, and stakeholder engagement. A simple 'tool' or matrix has been developed as described in **Section 28.1** to inform and visually present the evaluation of certain Project alternatives such as the 'do-nothing' versus preferred Project alternatives.

This chapter should be read in conjunction with the 'polycentric approach' detailed in **Section 7.1** to develop a full picture of the thought, planning, evaluation and decision making process adopted during the four year SSD planning and assessment process for the Project.

28.1 Project alternatives evaluation tool

The simple Project alternatives evaluation tool involves consideration of the level of impact, either positive or negative against the key environmental, social and economic values considered throughout the SSD and EIS preparation process after the application of mitigation measures (**Table 28.1**).

Table 28.1: Likely impact categories for evaluating Project alternatives

Impact categories
Significant positive impact
Moderate positive impact
Negligible impact (negligible positive/negative)
Moderate negative impact
Significant negative impact

28.2 Do nothing

The 'do nothing' option of ceasing limestone mining needs to be considered as a real alternative to the continuation of mining.

Without securing SSD approval for the 30-year mine plan and the continuation of mining, the mine will cease to operate after 26 February 2023, when CML 16 expires, resulting in the following negative impacts:

- the loss of approximately 191 direct full time employment jobs across Boral Cement operations in the Southern Highlands;
- loss of an estimated 229 other related jobs throughout NSW;
- loss of approximately 364 direct and indirect jobs within NSW;
- loss of net social benefits to Australia of between $488M and $643M, and net social benefits to NSW of between $166M and $321M;
- a potential 60% shortage in cement sold in NSW and a potential 30% shortage in concrete sold in Sydney;
- sterilisation of a valuable resource (remaining limestone resource estimated at 640 Mt with approximately 438 Mt available for mining); and
- significant implications to Boral's business, the NSW economy and construction industry in general, as well as local employees and service providers.

Without the Project it is also unlikely that:

- Marulan South Road would be upgraded including widening, vertical alignment and pavement improvements and improvements to resident's driveways and bus pick up and turning areas;
- there would be the same level of knowledge gained about Aboriginal occupation in the area;
- the significant Cultural heritage site along Marulan Creek would have been identified;
- additional knowledge of historic mining practices at the site and life at Marulan South would be obtained; and
- the south pit would be backfilled to the extent proposed leaving the mine pit visible to views from Bungonia NP and the Bungonia Lookdown in perpetuity.

Potential key local positive impacts of ceasing mining operations, rehabilitating disturbed areas and using the site for conservation purposes include:

- avoiding clearing approximately 182.4 ha of native vegetation and associated habitat, including 88.6 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, 132.4 ha of Koala habitat and 140.3 ha of Large-eared Pied Bat habitat;
- reduced dust and noise emissions from the site;
- reduced traffic on Marulan South Road, especially heavy vehicles;
- reduced erosion risk and therefore suspended solids in surface water runoff resulting in improved water quality in receiving water;
- avoiding disturbance or loss of Aboriginal heritage sites; and
- avoidance of various historic heritage items associated with previous mining operations.

Although these may be positive impacts for the site and local area, unless the deficit in limestone based products left by the cessation of mining at Marulan South is met entirely by foreign imports, it is likely that this national limestone deficit would need to be met by starting new greenfield limestone mines elsewhere in NSW and Australia. It is unlikely that establishing a new greenfield limestone mine elsewhere with the same production capacity as the Marulan South Limestone Mine, would be economically viable due to the significant establishment costs in today's terms compared to importing clinker from overseas and would have any less environmental, social and economic impact. For example, starting a new greenfield limestone mine would require disturbing a substantial area to establish the pit, processing plants and associated infrastructure. Whereas these significant disturbances are already established at the mine. Also, the mine was started in 1830 and people moved to the area to work at the mine and established the previous Marulan South village just to service the mine. Therefore, it could be said that the mine is part of the fabric and culture of the Marulan South area.

Also, importing all limestone or limestone based products from overseas may reduce environmental and social impacts at a local and possibly regional level but are likely to result in far greater environmental and social impacts at a global level as limestone and limestone products would most likely be imported from third world countries where planning, environmental and social regulations are far less onerous than in Australia.

28.2.1 Evaluating the stop mining vs continue mining alternatives

Table 28.2 provides a visual evaluation of the 'do noting' or stop mining option against the preferred Project – MP 2 option using the developed Project alternatives evaluation categories. The evaluation demonstrates that across the 19 values considered, the stop mining option would result in:

- five significant positive impacts;
- six moderate positive impacts;
- three negligible impacts; and
- five significant negative impacts.

The evaluation demonstrates that across the 19 values considered, the continued mining preferred Project option would result in:

- five significant positive impacts;
- six negligible impacts;
- six moderate negative impacts; and
- two significant negative impacts.

The evaluation provides justification for the continuation of mining at the site.

Table 28.2: Evaluation of continued operations with preferred Project versus 'do nothing'

Value	Do nothing – Stop mining	MP 2 – Preferred Project
Limestone resource		
Surface water		
Groundwater		
Soil erosion		
Contamination		
Terrestrial biodiversity		
Aquatic biodiversity		
Stygofauna and GDE		
Aboriginal heritage		
Historic heritage		
Air quality and GHG		
Noise and blasting		
Visual		
Traffic		
Transport infrastructure		
Waste management		
Hazards and risks		
Employment		
Economic		

28.3 Alternative mine plans

The development of a 30-year mine plan for continued operations at the mine commenced around 2013 with the SSD process commencing in August 2014. The overarching goal of most open cut mine plans is to:

- target the most easily accessible and highest grade resource;
- achieve the best overburden to limestone ratio i.e. minimise overburden extraction and maximise limestone extraction;
- minimise out-of-pit overburden emplacements;
- minimise haul distances of limestone to processing infrastructure and overburden to emplacements;
- minimise environmental and social impacts; and
- minimise capital and operating costs.

As outlined in **Section 3.1.2** an exploration drilling program was carried out in 2005 to meet the needs of the mining operation at the time as well as to better define the limestone resource. This work proved to be the basis for further exploration carried out between 2014 and 2017.

28.3.1 Mine Plan 1

The original mine plan (known as MP 1) was developed to target the eastern limestone and some of the Mt Frome limestone. MP 1 was developed on the understanding of the limestone geology extent (vertical and horizontal), configuration (angle of vertical dipping) and quality in 2014/2015 and achieved a limestone to overburden ratio of 1:>1. Earlier stakeholder consultation, technical studies and EIS preparation was based on MP 1 and the EIS prepared for MP 1 was due for lodgement with DPE in mid 2016.

28.3.2 Mine Plan 2 – Preferred Project

Drilling undertaken in 2016 started to show that the extent and configuration of the various limestone bodies were different to the mines previous understanding. The results of the drilling were significant enough for Boral to cease the SSD process, commission further drilling and revisit the mine plan. Further drilling was completed in early 2017 which filled knowledge gaps, especially on the northern extent of the limestone bodies and a revised mine plan (known as MP 2) was developed. MP 2 achieved a limestone to overburden ratio of around 1:0.9 which results in a reduction from MP 1 in the amount of overburden that needs to be removed and emplaced to extract the same amount of limestone. MP 2 was therefore adopted as the preferred mine plan and is the Project described in this EIS.

28.3.3 Mine Plan 3

With the far greater understanding of the extent and configuration of the limestone bodies from the extensive drilling program, during development of MP 2, Boral also investigated possibilities of focusing mining in the northern half of the pit and mining the limestone beneath much of the southern processing infrastructure (known as MP 3). This option required the relocation of significant existing infrastructure including the primary, secondary and tertiary crushers, conveyors, transfers, rail spur and various utilities and buildings. This would also result in the northern edge of the pit being very close to the heart of the processing area and offices which may result in unacceptable blasting and vibration impacts. Preliminary calculations for this northern mine plan option achieved a limestone to overburden ratio of 1:>1. Due to the significant capital costs of relocating and rebuilding infrastructure of at least $158 M, disruption to customers during the relocation/reconstruction of this infrastructure, increased product costs to customers, and the less than ideal overburden to limestone ratio, this option was not pursued further. It was initially thought that MP 3 would significantly reduce out-of-pit overburden emplacements as much of the southern part of the pit could be used for in-pit overburden emplacement, however not only would this sterilise significant resource but development of the southern part of the north pit restricted backfilling of the south pit until later in the mine staging, resulting in substantial out-of-pit overburden emplacement, not dissimilar in size to those required under MP 1 and MP 2.

28.4 Alternative Project component considerations

Various other options for pit development, overburden emplacement, mine water supply and reducing the disturbance footprint were considered during the mine planning process. Many of these alternatives have been touched on when describing the polycentric decision making approach (**Section 7.1**) and are elaborated on in the following sections.

28.4.1 Focus on eastern limestone and mining eastern batters and south pit rim

An option that was considered briefly during the mine planning process but dispelled quickly due to the enormity of its potential social, environmental and/or economic impact involved focusing mining on the eastern limestone body and mining out the eastern batters and southern pit rim. Although this may have achieved a better overburden to limestone ratio and targets the highest grade limestone body, it would require daylighting the pit to Barbers Creek gorge to the east and Bungonia Creek gorge to the south.

28.4.2 Establishing overburden emplacements outside of Boral's landholdings

Another option that was also considered during the mine planning process and also dispelled quickly due to the enormity of its potential social, environmental and/or economic impacts involved purchasing extensive areas of privately owned land and establishing overburden emplacements outside of Boral's current landholdings. As the plateau lands to the west and far north-west of the mine support substantial areas of native vegetation, Boral would have to approach owners of private land that is cleared of native vegetation. However, much of this cleared land supports viable agricultural and other commercial businesses and even if some of these landowners were willing sellers, hauling overburden and creating over-burden emplacements to the west or far north-west would:

- consume substantially more land than the preferred Project as the overburden emplacements would likely have a larger disturbance footprint as they would need to be lower due to increased visibility from sensitive receivers, and buffer lands would also need to be purchased around the emplacements;
- result in significantly greater noise, air quality, visual and traffic impacts; and
- be economically unviable due to the significant land acquisition and overburden haulage costs.

28.4.3 Disposal of overburden off-site

Consideration was given to transporting all overburden from the mine to other disused mines and quarries and/or projects requiring substantial fill off-site. High level evaluation of this alternative estimates annual costs to transport overburden off-site to a void within 200 km of the mine would cost up to $75 M per annum or over $2 billion over the Project life.

Not only will this render the cost of mining unviable, but off-site disposal of overburden is constrained by:

- the number of train paths allocated to Boral's Marulan South Operations along the Main Southern Railway. Up to six train paths per day are allocated to the mine and are used/reserved entirely for transporting limestone products. It is unlikely that Boral would be able to acquire the additional approximately five train paths required to also transport overburden from the mine by train;

- capacity at the mine and on Boral's private rail line. Even if enough train paths could be acquired, there is not enough time each day to load and transport along Boral's private railway line, all the limestone product trains, Peppertree Quarry trains and an additional five overburden trains per day; and
- the availability of void space to backfill. With the number of major infrastructure projects in the Sydney region at the moment, which are forecasted to continue for some time, and the substantial tunnel boring projects forecast in the future that generate significant volumes of surplus material, there is and will continue to be significant competition for any available void space for spoiling overburden/fill material, especially near a railway line.

28.4.4 Mine water supply including Marulan Creek dam

Boral considered numerous alternatives to supplement the water supply from the proposed mine water storage dams, in order to meet the mines water demand which included:

- damming water in the south pit. This was discounted as a viable alternative as:
  - the pit floor is porous and would have to be sealed;
  - the south pit wouldn't be able to be used for overburden emplacement requiring additional out-of-pit emplacements and exposing the entire mine pit to views from Bungonia NP and in particular the Lookdown in perpetuity; and
  - The pumping head (vertical height that water would need to be pumped) is extreme.
- establishing a groundwater extraction well (pumping bore) network to the north of the mine, between the mine and Peppertree Quarry. Geological and groundwater monitoring data from Peppertree Quarry and the mine was used to inform the modelling of a hypothetical extraction well network (refer to **Section 9.1.2** and **Appendix H**). It was predicted that although it could potentially supplement it, an extraction well network would not produce sufficient water to meet the mine's water demand; and
- establishing an in-stream dam in Marulan Creek to the north of the mine. Constraints to the location of the dam included land ownership, and the steep, incised section of Marulan Creek to the east as it nears Barbers Creek gorge. The proposed Marulan Creek dam was initially designed in the ideal location from both geotechnical and volume perspectives. However, the Aboriginal heritage assessment and consultation process identified a cultural site immediately below the preferred dam wall location and after consultation with relevant Aboriginal parties, the dam wall was redesigned and moved further upstream to entirely avoid and establish a buffer to the cultural site. Marulan Creek dam was adopted as the only viable option to supplement mine water supply from the proposed water storage dams.

28.4.5 Steeper overburden emplacement batters & higher emplacements

In designing the overburden emplacements, consideration was given to steepening the emplacement batters to increase the height of the emplacements to hold the required volume of overburden while reducing the disturbance footprint. Geotechnical and other advice from soils, erosion and rehabilitation specialists advised against making the batters too steep as this would significantly increase the erosion, sedimentation and water quality risks associated with the Project and would reduce the likelihood of successful rehabilitation and establishing a long term stable vegetated landform.

Chapter 29

Environmental management, monitoring and reporting

VOLUME 1

29 ENVIRONMENTAL MANAGEMENT, MONITORING AND REPORTING

29.1 Introduction

This chapter summarises the key management and mitigation measures for addressing the potential environmental impacts of the Project as required by the SEARs (**Table 29.1**).

Table 29.1: Environmental management and mitigation SEARs

Requirement	Section and appendix where addressed
▪ Consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS.	Chapter 29

As outlined in **Section 3.5**, the mine is managed in accordance with the 2018-2023 MOP and supporting REF for CML 16 and ML 1716 together with the conditions of consents, leases and licences, as well as various site environmental management/improvement plans.

Boral also maintains a comprehensive environmental monitoring network at and surrounding the mine (Figure 2.4). Data captured from these environmental monitors is used by mine management to monitor compliance with their EPL, MOP and associated REF and other regulatory requirements.

In conjunction with this SSD application, Boral will apply for a new mining authority. The grant of a mining authority will require a new MOP consistent with all new consents, authorisations and licence conditions. The MOP will be the overarching plan that guides mining operations within the Project site and mining lease boundaries.

29.2 Environmental management measures

The environmental management measures summarised in **Table 29.2** will be implemented during construction and operation of the Project.

Table 29.2: Summary of environmental management measures

Management measures
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; and ▪ the intersection at the proposed Road Sales Stockpile Area.
Operational (general) A MOP will be prepared prior to, and implemented during operation of the Project. The MOP will provide the framework for operational environmental management at the mine and will be prepared in accordance with *ESG3: Mining Operations Plan Guidelines September, 2013*. The MOP will also include environmental management measures for environmental issues that don’t require a separate management plan such as: ▪ noise management; ▪ blasting management; ▪ visual impact mitigation; ▪ traffic management and driver safety awareness training;

Management measures
▪ contamination prevention and existing contamination management; ▪ historic heritage management; ▪ greenhouse gas management; ▪ waste management; ▪ hazardous substance management.
Surface water ▪ The CEMP for the Marulan Creek dam, the relocated high voltage powerline and the Road Sales Stockpile Area intersection, will include an erosion and sediment control plan prepared in accordance with Landcom's (2004) *Managing Urban Stormwater: Soils and Construction.* ▪ 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.* ▪ A water management plan (WMP) will be prepared and implement for the mine and Marulan Creek dam which will detail the final water management system design, training, community consultation, complaint resolution protocols, strategies for performance improvement and responses to exceedances. ▪ The WMP will include a trigger action response plan which will identify triggers, actions and responses based on the water quality trigger values in Table 8.6 of the EIS. ▪ The WMP will include the requirement to undertake regular visual inspections of all temporary and permanent surface water management structures to identify any risks of failure or erosion.
Air quality An air quality management plan (AQMP) will be prepared and implemented at the mine. The AQMP will include the following management measures to minimise dust emissions: ▪ Include weather forecasting in daily planning to anticipate adverse weather and revise operations accordingly. ▪ Temporarily cease operations when high visible dust is being generated. ▪ Dampen dirt haul roads when dust is visible. ▪ Truck drivers will be trained to identify elevated dust generation and request the water cart to dampen dirt haul roads. ▪ Enforce 40 km/h truck speed limit when carrying covered loads. ▪ Enforce 20 km/h truck speed limit when carrying uncovered loads. ▪ Trucks with uncovered loads to be filled to maximum 300 mm below the freeboard. ▪ All drill rigs will be fitted with dust suppression/filtration, which will be inspected before use to ensure they are fully operational. ▪ Regular maintenance of water sprays. ▪ Regular cleaning and collection of spilt material at transfer points. ▪ Regular adjustment of conveyor belt speed to optimum level to minimise material loss. ▪ Develop standard stockpile operating procedures that minimise dust emissions. ▪ Continuous water spraying at stockpile stacking points. ▪ Trucks transporting finished products to the Hume Highway, are to use the wash station prior to leaving the Project site.
Soils and land capability ▪ Topsoil will be stripped from the locations and in the volumes summarised in Table 10.4 of the EIS. ▪ Topsoil will stripped, stockpiled and maintained as described in Appendix 5 of **Appendix I** to the EIS. ▪ Topsoil stripping, stockpiling and maintenance measures will be included in the MOP and/or rehabilitation management plan.
Aboriginal heritage ▪ An Aboriginal heritage management plan (AHMP) will be prepared and implemented at the mine, which will describe all Aboriginal sites in the Project site and measures for the management of these sites including protection, collection and salvage; induction of all personnel working on site; continued consultation with RAPs; protocols for the discovery of new Aboriginal sites and suspected human skeletal remains; and artefact management. ▪ Aboriginal sites within 20 m of ground disturbance will be demarcated by a qualified archaeologist, with high visibility poles installed 5 m from the item.

Management measures

- Signs stating "Environmentally sensitive area; do not disturb; contact the Mine Manager for more information" will be attached to the poles.
- Thirty-two areas of artefact scatters and isolated finds will be collected by a qualified archaeologist prior to disturbance.
- Sites MSL 046, MSL 047; MSL 057, MSL 045 and MSL 048 and the surrounding area of high archaeological sensitivity will be salvaged prior to disturbance.
- Site MSL 055 and surrounding area of moderate archaeology sensitivity will be salvaged.
- Permanent fencing will be erected 20 m from the outer edge of the cultural site on Marulan Creek prior to the commencement of construction in the vicinity of the site. Signage will be attached to the exclusion fencing that states 'Significant environmental area – no unauthorised entry permitted'. The fencing type and location is to be outlined in the AHMP. Other management measures that will be included in the AHMP, that have the potential to reveal culturally sensitive information, have been excluded from the EIS.
- Further consultation with relevant Aboriginal cultural knowledge holders will be undertaken by an intangible cultural heritage specialist to determine whether they are satisfied that the proposed approach to maintaining environmental flows in Marulan Creek down stream of the dam will mitigate any previously perceived impacts on the cultural site.

Terrestrial biodiversity

- A biodiversity management plan (BMP) will be prepared and implemented at the mine.
- A biodiversity offset strategy will be finalised and implemented to retire the ecosystem and species credits summarised in Table 12.3 and Table 12.4 of the EIS.

Visual amenity

- New overburden emplacement lifts will commence on the emplacement area margins visible from identified sensitive visual receptors and will progress as sequential rows of tipped material away from the view direction.
- Tree screens will be established as soon as possible on the foot slopes of the WOE and NOE, to assist in mitigating the visual impact of the early stages of emplacement development, containing light spill from vehicles (see below) and rapidly establishing a vegetated appearance, which will be carried upward as the lifts increase the heights of the emplacements.
- A lighting strategy will be prepared and implemented at the mine to reduce lighting to the lowest level possible that also maintains an appropriate standard of safety and security and to minimise obtrusive lighting.
- Mobile lights will be in the red to yellow spectra, will be shrouded and pointed downwards.
- The outer slopes of the SOE will be vegetated as soon as possible.
- Design adjustments to change the vertical alignment of the realigned section of Marulan South Road or the construction of vegetated earth bunds on the southern side of the road, will be investigated during detailed design, in consultation with the potentially affected land owners, to avoid or at least minimise visual impacts from vehicles from the mine travelling west on the realigned section of Marulan South Road at night.

Traffic

- A CEMP including construction traffic management measures will be prepared prior to and implemented during the construction of the realigned section of Marulan South Road and the intersection at the proposed Road Sales Stockpile Area.
- Driver safety awareness training will continue to be implemented at the mine for all Boral and contract drivers using Marulan South Road.

Contamination

- AEC 16 (asbestos kerb of the bowling green) will be inspected by a qualified occupational hygienist whom will identify and remove asbestos and issue a clearance certificate and findings will be added to the mine's asbestos register.
- Where there is an absence of grass or vegetation within AEC16, a layer of 10 cm of clean suitable material will be placed and vegetation encouraged to grow.
- Damage to the asbestos kerb of the bowling green will be repaired and the entire kerb painted to prevent further deterioration of the asbestos containing structure.
- If the UST at AEC 5 is removed it must be remediated and validated in accordance with the Protection of the NSW Environment Operations (Underground Petroleum Storage Systems) Regulation 2014.

Management measures
▪ The pumping line from the Marulan Creek dam to the Tallong Water Pipeline (AEC 12) must be connected by an appropriately qualified and experienced person to prevent exposure of ACM. ▪ All potential contaminants will be removed from equipment as part of the decommissioning of machinery and spare parts prior to being placed in the Old Machinery/Scrap Yard (AEC 17). Where this is not practical, appropriate containment, signage and management should be implemented. Recovered hydrocarbons and ACM must be handled, stored, transported and disposed of appropriately. ▪ An unexpected contamination finds protocol will be prepared and implemented at the mine.
Historic heritage Historic heritage management measures for the heritage items outlined in **Table 16.2** and Figure 16.2 of the EIS including: ▪ Photographic archival recording and archaeological recording of sites to be impacted. ▪ Removal and storage of moveable heritage items that are to be impacted. ▪ Fencing and signposting sites within 20 m of the disturbance footprint that are to be avoided.
Greenhouse gas Boral will investigate the following recommended GHG management actions and will implement these where possible: ▪ Installation of day/night light sensors for lighting control. ▪ Construction materials will be sourced locally where possible to reduce transport emissions. ▪ Waste will be recycled where possible. ▪ Construction and operations will be planned to avoid double handling of materials and minimise haulage distances. ▪ Recycled or low impact materials will be used where possible to reduce emissions associated with embodied energy. ▪ The purchase of energy efficient and/or alternative fuel equipment will be investigated. ▪ Designs of new infrastructure and buildings will consider energy efficiency.
Waste The following waste management measures will be included in the MOP: ▪ Waste from the Project will be managed in accordance with EPA's (2014) Waste Classification Guidelines including classification and tracking during off-site disposal. ▪ Receptacles for general waste, hazardous waste and recyclable materials will be provided at the mine to allow separation of waste streams. ▪ Waste streams will be sorted to maximise the reuse/recycling potential and minimise disposal costs. ▪ Waste will be covered, stored and removed in a timely manner to prevent attraction of native animals or vermin. ▪ Waste will only be disposed at licensed waste facilities. ▪ Fuel, lubricant or hydraulic fluid spills will be collected using absorbent material and the contaminated material disposed at a licensed waste facility. ▪ Hazardous or contaminated wastes will be removed and disposed in accordance with the state and national regulations and guidelines and best practice for the removal of these materials. ▪ Hazardous materials will only be removed by suitably qualified licensed and experienced contractors. ▪ Personnel will be required to notify the Mine Manager, and follow SafeWork NSW procedures for the handling and transport of asbestos containing material to an EPA approved facility. ▪ Documents and records of the transport and disposal of waste will be kept as proof of correct disposal and for environmental auditing purposes. ▪ Waste handling, transport and disposal will be in accordance with the requirements of the POEO Act, WARR Act and relevant OEH, EPA or WorkCover Guidelines, including Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes (EPA, 1999).
Hazards and risks ▪ The Marulan South Operations Bushfire Management Plan will be revised to reflect the Project and implemented at the mine. ▪ There will be an annual bushfire risk assessment before the start of the bushfire season.

Management measures
▪ Hotworks will be restricted to workshops, hardstands or at least 20 m from vegetation during total fire bans. ▪ Designated hotwork areas will be assessed in accordance with HSEQ-6-06-F01 Designated Hot Work Area Risk Assessment. ▪ All firefighting equipment will be inspected during total fire bans and there will be a toolbox talk or briefing on hotwork restrictions and fire hazards. ▪ There will be no driving over vegetation, mowing/slashing or earthworks in vegetation during total fire bans or on 'catastrophic fire danger' rated days. ▪ There will be a risk assessment of all site operations, consideration of closing the mine and sending personnel home, inspections and tests of firefighting equipment and communication with Marulan RFS during 'catastrophic fire danger' rated days. ▪ A radio will be kept and maintained in the administration building to receive fire information from 666 ABC Radio Canberra on days of very high fire danger or above. ▪ All personnel will complete awareness training on hazardous substance management, emergency response and the use of spill kits. ▪ Hazardous materials (including hydrocarbons and LPG) will be transported to and from the Project site by a licenced contractor, and stored and handled in accordance with relevant regulatory requirements, Australian Standards including but not limited to, AS1940 Storage and Handling of Flammable and Combustible Liquids, 2004 and the ADG Code. ▪ All hazardous substances or chemicals imported to site shall be accompanied by a SDS. ▪ A database will be maintained to assist in the recording and management of chemicals and hazardous substances stored at the Project site. ▪ Storage facilities, vehicles and transport vessels used on-site are to be regularly inspected for leaks, spills or other damage. ▪ Storage facilities are to be inspected annually by an independent and suitably accredited inspector. ▪ Spill response kits will be maintained, clearly identified and readily accessible on site for use in case of accidental spillage. Key staff will be skilled in their location as well as usage, application and disposal of contaminated material. ▪ During construction activities, all potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) will be stored in appropriate containers in vehicles, or designated and bunded storage areas. ▪ Refuelling, fuel decanting and vehicle maintenance work will be in compounds where possible. If refuelling in the field is necessary, it will be done in a designated area away from waterways and drainage lines with spill response kits immediately available. ▪ Equipment will not be used if there are any signs of fuel, oil or hydraulic leaks. Leaks will be repaired immediately or the equipment will be removed from site.
Rehabilitation ▪ A rehabilitation management plan (RMP) will be prepared and implemented at the mine and will include all rehabilitation management measures included in **Section 26.2** of the EIS and **Appendix I**. ▪ A trigger action response plan is included in the 2017–2023 MOP and will be included in future MOPs, which identifies trigger events or indicators related to threats to rehabilitation, and provides appropriate response strategies.

29.3 Environmental monitoring

Environmental monitoring summarised in **Table 29.3** will be implemented during construction and operation of the Project. Requirements for monitoring will be included in the MOP or relevant management plan (where prepared for particular environmental issues).

Table 29.3 Summary of environmental monitoring

Environmental 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

Environmental monitoring
used by the mine including evapotranspiration and solar radiation are recorded at the Peppertree Quarry weather station.
Surface 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. ▪ 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 the 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. ▪ 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/or the CEMP. ▪ Flow meters will be installed on water transfer pipelines and water use points to record flow rates and total flows and readings will be taken at least monthly. ▪ Water levels in mine water dams will be recorded monthly. ▪ Water level and flow data will be used to confirm the accuracy of the water balance and predict water supply shortfalls. ▪ 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.
Groundwater ▪ Ongoing quarterly groundwater monitoring will continue in the existing groundwater well network for the parameters and at the locations identified in **Table 2.4** and **Figure 2.4** of the EIS and will involve: - downloading data from the pressure transducers, which electronically record water levels; - sampling for acidity, salinity, major cations, major anions, metals and fluoride. ▪ Changes to groundwater levels and quality will be investigated if monitoring results deviate from historical monitoring results. ▪ Groundwater monitoring wells which are removed during mining will be replaced over the life of the Project if determined to be necessary by an appropriately qualified groundwater specialist. ▪ Groundwater monitoring requirements will be included in the WMP.
Aquatic biodiversity and stygofauna ▪ The aquatic biodiversity and stygofauna survey locations will be surveyed in autumn and spring for one year after the start of the 30-year mine plan to add to the baseline data and capture temporal variation in stream and GDE health. ▪ If a water quality trigger threshold is exceeded in consecutive monitoring events and if additional assessment finds that the change in water quality may be mining induced, then Boral will contact a suitable qualified aquatic ecologist to determine if the exceedance is likely to affect aquatic ecology and design/conduct an aquatic ecological monitoring study if required. ▪ Monitoring will: - Be conducted up and downstream of the impacted site. - Be consistent with the BMP and WMP developed for the Project. - Use methods appropriate for the level of assessment. - Be conducted at a frequency and over a timeframe appropriate for the level of assessment. - Aquatic biodiversity monitoring requirements will be included in the BMP.
Air quality ▪ Air quality monitoring will continue at Boral's air quality monitoring network which includes a combination of the mine's and Peppertree Quarry's monitoring sites (Figure 2.4). Monitoring equipment includes two HVAS that measures PM_{10} and TSP and six dust deposition gauges. The location, number and type of air quality monitoring equipment will be assessed by a suitably qualified air quality specialist when preparing the AQMP and recommended adjustments to the current air quality monitoring network will be included in the AQMP.
Greenhouse gas

Environmental monitoring
▪ Boral will continue to monitor and report energy use and greenhouse gas emissions associated with the Project under its obligations under the NGER Act.
Noise and blasting
▪ A noise and blast compliance monitoring program will be implemented which will address compliance with trigger levels, measurement and assessment of maximum noise levels and blast vibration and overpressure levels.
Rehabilitation
▪ The ecosystem function analysis monitoring method is used at the mine, and will continue to be used for the Project as detailed in **Section 26.2.6**. Rehabilitation monitoring will be included in the RMP and the future MOP and will consider the objectives and completion criteria outcomes in **Section 26.1.2** and **Appendix I** to the EIS.

29.4 Environmental reporting

The principal reporting mechanism for the Project with be the submission of an Annual Environmental Management Report, which will be prepared and submitted to DPE-DRG in accordance with conditions of the new mining lease and will include reporting on all key environmental matters assessed in the EIS.

Other environmental reporting may be required in accordance with the varied/new EPL and/or conditions of approval of the SSD application.

Chapter 30

Conclusion

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30 CONCLUSION

The Project is justified on economic, social and environmental grounds, as demonstrated with its consistency with the objects of the EP&A Act and ecologically sustainable development.

The Project will enable continued mining of a resource that is of vital importance to the development of NSW and the associated continued employment of the mine’s workforce. It is economically viable and technically feasible to mine a portion of the remaining limestone resource for another 30 years.

The Project will not result in significant residual impacts on most environmental aspects, including amenity impacts associated with noise, air quality and visual exposure.

The Project will have residual impacts on terrestrial biodiversity, which will be offset in accordance with NSW and Commonwealth policy. This offsetting will have the benefit of protecting areas of similar threatened ecological community into perpetuity.

Residual impacts on items of historic heritage will be compensated through archival recording of items to be impacted, which will contribute to understanding of the development of the mining industry in the Southern Highlands and NSW.

The economic analysis of the Project demonstrated that it will be socio-economically beneficial to the nation, State and local community. The Project will have net social benefits to Australia of $492 M and to NSW of $321 M including employment benefits. This benefit will include 198 direct and indirect local jobs and 364 direct and indirect jobs in NSW.

Chapter 31

References

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31 REFERENCES

Advisian. (2019). *Marulan South Limesone Mine Continued Operations – Surface Water Assessment for Mine Plan 2.* Prepared for Boral Cement Limited.

McKenzie NJ, Grundy MJ, Webster R, Ringrose-Voase AJ(2008). *Guidelines for Surveying Soil and Land Resources.* CSIRO Publishing.

Australasian Groundwater and Environmental Consultants. (2019). *Marulan South Limestone Mine Continued Operations Groundwater Technical Study.* Prepared for Element Environment.

Australia ICOMOS. (2013). *Australia ICOMOS Charter for Places of Cultural Significance, The Burra Charter.* Australian International Council on Monuments and Sites.

Australian and New Zealand Environment and Conservation Council. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* ANZECC and ARMCANZ.

Australian and New Zealand Environment Council. (1990). *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration .*

Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia. (2000). *Strategic Framework for Mine Closure.*

Australian Institute of Health and Welfare. (2018). *My Hospitals*. Retrieved November 1, 2018, from https://www.myhospitals.gov.au

Austroads. (2015). *Guide to Road Design.* Austroads.

Boral Cement Limited. (2017). *Marulan South Limestone Mine 2018-2023 Mining Operations Plan.*

Boral Cement Limited. (2018). *Annual Environmental Management Report.* Boral Cement Limited.

Bureau of Meteorology . (2001). *Map of Climate Zones of Australia*. Retrieved from Bureau of Meteorology : http://www.bom.gov.au/climate/how/newproducts/images/zones.shtml

Bureau of Meteorology. (2001). *Map of Climate Zones of Australia*. Retrieved from Bureau of Meteorology: http://www.bom.gov.au/climate/how/newproducts/images/zones.shtml

CRC for Contamination Assessment and Remediation of the Environment. (2011). *Technical Report No. 10 - Health screening levels for petroleum hydrocarbons in soil and groundwater.* CRC CARE.

Department of Environment and Climate Change. (2008a). *Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries.* NSW Government.

Department of Environment and Climate Change. (2008b). *Managing Urban Stormwater - Soils and Construction - Volume 2D Main road construction.* NSW Government.

Department of Environment and Conservation. (2005). *Draft guidelines for Aboriginal cultural heritage assessment and community consultation.* NSW Government.

Department of Environment Climate Change and Water. (2011). *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW.* NSW Government.

Department of Environment, Climate Change and Water. (2010). *Code of practice for archaeological investigationof Aboriginal objects in NSW.* NSW Government.

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education. (2012). *Australian National Greenhouse Accounts - National Greenhouse Accounts Factors.* Australian Government.

Department of Industry, Tourism and Resources. (2006). *Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry.* Commonwealth of Australia.

Department of Industry, Tourism and Resources. (2006). *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry.* Commonwealth of Australia.

Department of Primary Industries – Water. (2012). *Controlled activities guidelines.* NSW Government.

Department of Sustainability, Environment, Water, Population and Communites . (2012). *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy .* Australian Government.

Department of Urban Affairs and Planning. (1998). *Managing Land Contamination – Planning Guidelines – SEPP 55-Remediation of Land.* NSW Government.

Deprtment of Environment and Conservation. (Approved methods for the Sampling and Analysis of Water Pollutants in NSW). *2004.* NSW Government.

Edge Environment. (2018). *Marulan South Limestone Mine continued Operations - Greenhouse Gas Emmissions Assessment.* Prepared for Element Environment.

Element Environment. (2015). *Marulan South Limestone Mine Continued Operations - State Significant Development Application - Preliminary Environmental Assessment.* Report prepared for Boral.

Element Environment. (2019). *Marulan South Limestone Mine Continued Operations SSD - Social Impact Assessment.* Prepared for Boral Cement Limited.

EMM Consulting. (2018a). *Marulan South Limestone Mine Continued Operations Project - Aboriginal cultural heritage assessment.* Report prepared for Boral Cement Limited.

EMM Consulting. (2018b). *Marulan South Limestone Mine Continued Operation Project – historic heritage assessment and statement of heritage impact.* Report prepared for Boral Cement Limited.

Geological Survey of NSW. (2012). *Goulburn 1:250,000 geology explanatory notes (Sheet SI/55-12, 2nd Edition).* NSW Trade & Investment - Resources & Energy.

GeoRes. (2018). *Marulan South Limestone Mine – Geological Report for DRE's input to SEARs.* Report prepared for Boral Cement Limited.

Gillespie Economics. (2019). *Marulan South Limestone Mine Continued Operations - Economic Assessment.* Prepared for Boral Cement Limited.

Healthy Rivers Commission. (1999). *Independent Inquiry into the Shoalhaven River System.* NSW Government.

Heritage Branch. (2009). *Assessing Significance for Historical Archaeological Sites and 'Relics'.* NSW Government .

Heritage Office. (1996). *NSW Heritage Manual.* NSW Government – Heritage Office and Department of Urban Affairs and Planning.

Heritage Office. (2004). *Investigating Heritage Significance.* NSW Government.

Heritage Office. (2004). *Statements of Heritage Impact .* NSW Government.

Isbell. (2002). *Australian Soil Classification .* CSIRO Publishing.

LAMAC. (2018). *Marulan South Limestone Mine Continued Operations Project – Soil, Land Resources and Rehabilitation Assessment.* Report prepared for Boral Cement Limited.

National Committee on Soil and Terrain. (2009). *Australian Soil and Land Survey Handbook .* CSIRO Publishing.

National Environment Protection Council. (2013). *National Environmental Protection (Assessment of Contamination) Measure .* Australian Government.

National Health and Medical Research Council. (1992). *Australian and New Zealand Guidleines for the Assessment and Management of Contaminated Sites.* Australian Government.

National Transport Commission. (2017). *The Australian Dangerous Goods Code Edition 7.5.* Transport and Infrastructure Council.

National Water Commission . (2012). *Australian Groundwater Modelling Guidelines.* Australian Government.

Natural Resources Access Regulator. (2018). *Controlled activity guidelines.* NSW Government.

Niche Environment and Heritage. (2018b). *Marulan South Limestone Mine Continued Operations Aquatic Assessment.* Prepared for Boral Cement Limited.

Niche Environment and Heritage. (2018c). *Marulan South Limestone Mine Continued Operations Stygofauna and Groundwater Dependent Ecosystem Assessment.* Prepared for Boral Cement Limited.

Niche Environment and Heritage. (2019a). *Marulan South Limestone Mine Continued Operations - Biodiversity Development Assessment Report.* Niche Environment and Heritage.

NSW Department of Environment and Climate Change . (2009). *Interim Construction Noise Guidelines.* NSW Government.

NSW Department of Environment and Climate Change. (2004). *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft.* NSW Government.

NSW Department of Environment and Climate Change. (2007). *Threatened species assessment guidelines - the assessment of significance.* NSW Government.

NSW Department of Environment and Climate Change. (2007). *Threatened Species Assessment Guidelines: the Assessment of Significance.* NSW Government.

NSW Department of Environment and Conservation. (2004). *Biodiversity survey and assessment: Guidelines for developments and activities - working draft.* NSW Government.

NSW Department of Environment and Conservation. (2004). *NSW Australia River Assessment System (AUSRIVAS) Sampling and Processing Manual .* NSW Government.

NSW Department of Environment and Conservation. (2005). *Aboriginal scarred trees in NSW.* NSW Government.

NSW Department of Environment, Climate Change and Water. (2009). *Threatened Species Survey and Assessment Guidelines; Field Survey Methods for Fauna – Amphibians.* NSW Government.

NSW Department of Environment, Climate Change and Water. (2011). *NSW Road Noise Policy.* NSW Government.

NSW Department of Land and Water Conservation. (2002). *NSW State Groundwater Dependent Ecosystems Policy .* NSW Government.

NSW Department of Planning . (2011). *Applying SEPP 33.* NSW Government.

NSW Department of Planning. (2003). *Aquatic ecology in environmental impact assessment.* NSW Government.

NSW Department of Planning and Environment. (2015). *Guidelines for the economic assessment of mining and coal seam gas proposals.* NSW Government.

NSW Department of Planning and Environment. (2017). *Social impact assessment guideline - For State significant mining, petroleum production and extractive industry development.* NSW Government.

NSW Department of Primary Industries . (2013). *Policy and guidelines for fish habitat conservation and management.* NSW Government.

NSW Environment Protection Authority . (2017). *Noise Pilcy for Industry.* NSW Government.

NSW Environment Protection Authority. (2013). *Rail Infrastructure Noise Guideline.* NSW Government.

NSW Environment Protection Authority. (2014). *Waste Classification Guidelines.* NSW Government.

NSW EPA. (2017). *Approved methods for the modelling and assessment of air pollutants in New South Wales.* NSW Government.

NSW Government. (2012a). *Strategic Regional Land Use Policy.* NSW Government.

NSW Government. (2012b). *NSW Aquifer Interference Policy: NSW Government policy for the licensing and assessment of aquifer interference activities.* NSW Government.

NSW Government. (2013). *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land.*

NSW Government. (2014). *NSW Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments.*

NSW Government. (2018). *Draft Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments.*

NSW Office of Environment and Heritage. (2014). *NSW Biodiversity Offset Policy for Major Projects.* NSW Government.

NSW Office of Environment and Heritage. (2018). *Biodiversity Assessment Method Operation Manual – Stage 1.* NSW Government.

NSW Office of Water. (2012). *Risk Assessment Guidelines for Groundwater Dependent Ecosystems .* NSW Government.

NSW Southern Rivers Catchment Management Authority. (2013). *Southern Rivers Catchment Action Plan 2013 – 2023.* NSW Government.

NSW Trade and Investment. (2013). *ESG3: Mining Operations Plan (MOP) Guidelines.* NSW Government.

Office of Environment and Heritage. (2010). *Aboriginal cultural heritage consultation requirements for proponents .* NSW Government.

Office of Environment and Heritage. (2011). *Guidelines for Consultants Reporting on Contaminated Sites.* NSW Government.

Office of Environment and Heritage. (2012). *The Land and Soil Capability Assessment Scheme: Second Approximation - A General Rural Land Evaluation System for New South Wales.* NSW Government.

Planning NSW. (2002). *Guideline for economic effects and evaluation in EIA.* NSW Government.

Richard Lamb and Associates . (2018). *Marulan South Minestone Mine SSD 7009 Continued Operations - Visual Impact Assessment.* Prepared for Boral Cement Limited.

Roads and Maritime Services. (2002). *Guide to Traffic Generating Developments.* NSW Government.

Roads and Traffic Authority. (N.D.). *Road Design Guideline.* NSW Government.

Sydney Catchment Authroity. (2015). *Neutral or Beneficial Effect on Water Quality Assessment Guideline.* NSW Government.

Todoroski Air Sciences. (2019). *Air Quality Impact Assessment - Marulan South Limestone Mine Continued Operations.* Prepared for Boral Cement Limited.

Transport and Urban Planning. (2019). *Traffic Impact Assessment for Continued Operations of Marulan South Limestone Mine.* Prepared for Boral Cement Limited.

Underwood, A. J. (1994). *Ecological Applications 4, 3-15.*

Wilkinson Murray. (2019). *Marulan South Limestone Mine Continued Operations Project - Marulan SSD Noise and Blasting Assessment.* Prepared for Element Environment.

ZOIC. (2018). *Phase 1 and 2 Environmental Site Assessment – Marulan South Limestone Mine Continued Operations.* Prepared for Boral Cement Limited.

Chapter 32

Abbreviations

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32 ABBREVIATIONS

Abbreviation	Definition
ACHA	Aboriginal Cultural Heritage Assessment
AEC	Areas of Environmental Concern
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
AIP	NSW Aquifer Interference Policy
ANZECC	Australian and New Zealand Environment and Conservation Council
APCMA	Australian Portland Cement Manufactures of Australia
AST	Aboveground Storage Tank
AWBM	Australian Water Balance Model
Boral	Boral Cement Limited
BCSC	Blue Circle Southern Cement Limited
BHP	BHP Billiton Ltd
BOM	Bureau of Meteorology
BSAL	Biophysical Strategic Agricultural Land
CML16	Consolidated Mining Lease Number 16
DA	Development Application
DECCW	Department of Environment Climate Change and Water (now OEH)
DP	Deposited Plan
DPE	Department of Planning and Environment
DRE	Department of Resources and Energy
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environment Protection Authority
EP&A Act	The NSW Environmental Planning and Assessment Act 1979
EP&A Regulation	The NSW Environmental Planning and Assessment Regulation 2000
EPBC Act	Commonwealth Environmental Protection and Biodiversity Conservation Act 1999
EPL	Environment Protection Licence
GDE	Groundwater Dependent Ecosystems
GHG	Greenhouse gas
ha	Hectare
ICNG	Interim Construction Noise Guideline (DECC 2009)
INP	Industrial Noise Policy
km	Kilometre
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
m	Metre
MLA	Mining Lease Application
MOP	Mining Operations Plan
MNES	Matters of National Environmental Significance

Abbreviation	Definition
Mtpa	Million Tonnes Per Annum
NGERS	National Greenhouse and Energy Reporting Scheme
NPI	National Pollutant Inventory
NSW	New South Wales
OEH	Office of Environment and Heritage
PAC	Planning Assessment Commission
PEA	Preliminary Environmental Assessment
$PM_{2.5}$	Particulate matter less than or equal to 2.5 micrometres in aerodynamic diameter
PM_{10}	Particulate matter less than or equal to 10 micrometres in aerodynamic diameter
POEO Act	Protection of Environment Operations Act 1997
PSO	Planning Scheme Ordinance
RMS	NSW Roads and Maritime Services
RNP	NSW Road Noise Policy (EPA 2011)
SAQP	Sampling Analysis and Quality Plan
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SPC	South Portland Cement
SWL	Sound Power Level
tpa	Tonnes Per Annum
TSP	Total Suspended Particulate

CAMBIUM GROUP