Boral Limited
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Marulan South Limestone Mine Continued Operations
State Significant Development Application

V5

ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Cement Limited | March 2019



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V5

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Marulan South Limestone Mine Continued Operations

Stygofauna and Groundwater Dependent Ecosystem Assessment

Prepared for Boral Cement Ltd

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Cover photograph: Species of *Parabathynellidae, Syncarida, Crustacea*.

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Glossary

Term	Definition
Aquaclude	Geologic formation which contains water but cannot transmit it rapidly enough to furnish a significant supply.
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
Aquitard	A saturated but poorly permeable bed, formation, or group of formations that does not yield water freely to a well or a spring. An aquitard may transmit appreciable water to or from adjacent aquifers.
Baseflow	The component of stream flow that is sourced from groundwater discharging into the stream.
Bore	A cylindrical drill hole sunk into the ground from which water is pumped for use or monitoring.
Borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles.
Catchment	The area from which a surface watercourse or a groundwater system derives its water.
Critical habitat	A critical habitat as defined under the *Biodiversity Conservation Act 2016* includes, the whole or any part or parts of the area or areas of land comprising the habitat of an endangered species, population or ecological community or critically endangered species or ecological community that is critical to the survival of the species, population or ecological community.
Cumulative impacts	Combination of individual effects of the same kind due to multiple actions from various sources over time.
Direct impacts:	Those that directly affect the habitat and individuals. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat. When applying each factor, consideration must be given to all of the likely direct impacts of the proposed activity or development.
Ephemeral	Existing for a short duration of time.
Gaining stream	A stream where baseflow, or groundwater discharge, serves to maintain and even increase stream flow as one goes downstream (see losing stream).
Groundwater	Water located within an aquifer that is, held in the rocks and soil beneath the earth's surface.
Groundwater dependent ecosystem or GDE	Is a broad, overarching term encompassing all ecosystems that use groundwater either permanently or occasionally to survive. In this context the term covers a vast majority of terrestrial and aquatic ecosystems. Serov et al, 2012.
Hydrogeology	The study of subsurface water in its geological context.
Hydrology	The study of rainfall and surface water runoff processes.
Hyporheic zone	The ecotonal zone below and within the porous sand and gravel substrate of a river bed. This ecotonal zone often connects the surface running water system to that of the deep subterranean.
Hyporheos	The characteristic fauna that inhabit the hyporheic zone of rivers
Indirect impacts:	Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas. As with direct impacts, consideration must be given, when applying each factor, to all of the likely indirect impacts of the proposed activity or development.
Key threatening process	As defined under the *Biodiversity Conservation Act 2016*, a key threatening process is any listed process under the Act that adversely affects threatened species, populations or ecological communities, or that could cause species, populations or ecological communities that are not threatened to become threatened.
Losing stream	A stream where water is lost to the surrounding and underlying groundwater system (see gaining stream).
Obligate GDE	A GDE that is entirely dependent on groundwater. Typically most karst, wetland and hypogean/aquifer GDEs, all baseflow and some terrestrial GDEs will be obligate (see facultative GDEs).

Term	Definition
Permeability	The property or capacity of a porous rock, sediment, or soil for transmitting a fluid; it is a measure of the relative ease of fluid flow under unequal pressure.
Phreatic water	Water below the level at which all voids in the rock are completely filled with water
Phreatic zone	Zone where voids in the rock are completely filled with water. Also refers to deep groundwater.
Phreatobite	Are stygobites that are restricted to the deep groundwater substrata of alluvial aquifers (phreatic waters), Gilbert et al, 1994. All species within this classification have specialised morphological and physiological adaptations.
Piezometer	A narrow tube, pipe or borehole for measuring the moisture in a soil or water level in an aquifer.
Pollutant	Any matter that is not naturally present in the environment.
Run-off	The portion of water that drains away as surface flow.
Study Area:	Means the area which is likely to be affected by the Marulan Project, either directly or indirectly, and or unimpacted sites used for comparison for the impact assessment.
Stygofauna	This is an all-encompassing term for all animals that occur in subsurface waters, Ward et al., 2000.
Stygophiles	Having greater affinities with the groundwater environment than stygoxenes, because they appear to actively exploit resources in the groundwater system and /or actively seek protection from unfavourable situations in the surface environment resulting from biotic or stochastic processes. Stygophiles can be divided into: 1. Occasional or temporary hyporheos 2. Permanent hyporheos. The occasional or temporary hyporheos include individuals of the same species that could either spend their lives in the surface environment or spend a part of their lives in the surface environment and a part in groundwater (Ceratopogonidae fly larvae). The permanent hyporheos is present during all life stages in either groundwater or in benthic habitats (Gibert et al., 1994.) and possess specialist adaptations for living in this environment.
Surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
Threatened ecological community (TEC)	An ecological community identified by the B*iodiversity Conservation Act 2016* or Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 as critically endangered, endangered or vulnerable.
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

Abbreviations

Acronym	Term/Definition
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AUSRIVAS	Australian Rivers Assessment
BBAM	BioBanking Assessment Methodology
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BoM	Bureau of Meteorology
BMP	Biodiversity Management Plan
CMA	Catchment Management Authority
CML	Consolidated Mining Lease
DGRs	Director-General's requirements
DoEE	Commonwealth Department of Environment and Energy (formerly DoE)
DPI	Department of Primary Industries
DP&E	Department of Planning and Environment
DTIRIS	NSW Department of Trade and Investment, Regional Infrastructure and Services
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPA	NSW Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Act 1999*
EPT	Ephemoptera, Plecoptera, Trichoptera ratio
ha	Hectare/s
Km	kilometre
KTP	Key Threatening Process
LEP	Local Environment Plan
LGA	Local Government Area
ML	Megalitres
Mm	millimetre
MDS	Multidimensional scaling
MNES	Matters of National Environmental Significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*).
MOP	Mining Operations Plan
NoBE	Neutral of Beneficial Effect
NPWS	National Parks and Wildlife Service
OEH	Office of Environment and Heritage
PERMANOVA	Permutational Analysis of Variance
PSO	Planning Scheme Ordinance
REF	Review of Environmental Factors
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy
SIGNAL	Stream Invertebrate Grade Number Average Level
SIS	Species Impact Statement
SSD	State Significant Development

Acronym	Term/Definition
TEC	Threatened Ecological Community
tpa	Tonnes per annum
VCA	Voluntary Conservation Agreement

Executive summary

Boral Cement Limited (Boral) owns and operates the Marulan South Limestone Mine (the Mine). It is a long standing open cut Mine that has produced up to 3.38 million tonnes 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.

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 and continuing use rights.

Due to changes between the *Mining Act 1992* and the *Environmental Planning & Assessment Act 1979* (EP&A Act), when mining moves beyond the area covered by the current Mining Operations Plan, a development consent under the EP&A Act will need to be in place.

Boral is seeking approval for a 30 year Mine plan, including associated overburden emplacement areas, Mine water supply dam, and various associated infrastructure (the Project). A development application for a State Significant Development (SSD) is required along with an environmental assessment.

Aims

Niche Environment and Heritage (Niche) was commissioned by Boral to undertake an impact assessment of groundwater ecology in support of the Environmental Impact Assessment (EIS) for the proposed development. Specifically this report assesses whether the proposed development is likely to have a significant impact on groundwater ecological communities including the subterranean stygofauna community and the spring and riverine Groundwater Ecosystems and specific threatened species listed on the *NSW Fisheries Management Act 1994* (FM Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Results

The baseline sampling and assessment of the groundwater ecosystems that exist in the Study Area has confirmed that stygofauna and diverse spring communities are present in the area and need to be included within the management plans for the aquatic ecosystems. They however are unlikely to be present in the area of operation of the mine. In particular the surveys have demonstrated that:

- Stygofauna were not present within the impact zones of the area of operations.
- Stygofauna were not collected from within the deep aquifer of the limestone bearing zone.
- Stygofauna were present outside of the mining operations but not within the surrounding fractured rock aquifers associated with the mining area.
- 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 Project Area is low with hotspots of biodiversity with potentially a high degree of endemism.
- The ecological value of the spring's downslope of the mining area is high.
- There is connectivity between the alluvial aquifers and the shallow, fractured limestone aquifers.

- Water chemistry includes neutral to highly alkaline pH levels ranging from approximately 7-11 pH units.
- Aquifer habitat consists of fine grained substrate and course grained sediments.
- Although the geology and water chemistry is similar to other areas in the region that do contain stygofauna, the faunal composition is significantly different that the area can be considered a separate ecological community.
- The stream and groundwater fauna composition is dictated by the availability of suitable habitat along with stream and groundwater water chemistry.

Assessment of impacts

The results from this preliminary survey indicate that although stygofauna do not appear to be present within the area of operation they do occur locally. The results also indicate that the overall condition of the aquifers and their associated surface GDEs' including springs and river baseflow habitats is high. There are currently no apparent adverse effects on the aquatic groundwater faunas in any of the receiving streams as a result of any activities arising from the operations of the Marulan South Limestone Mine and a low environmental risk of impacts resulting from the proposed development.

Recommendations

Since stygofauna were not observed in the impact area, it is recommended that any monitoring focus upon the GDE's downstream (Bungonia Creek, Barbers Creek, Main Gully and springs). This could be conducted concurrently/as part of the aquatic ecology monitoring described in the Aquatic Ecology Assessment (Niche 2018).

1. Introduction

1.1 Overview

Boral Cement Limited (Boral) owns and operates the Marulan South Limestone Mine (the Mine). It is a long standing open cut Mine that has produced up to 3.38 million tonnes 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.

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 and continuing use rights.

Due to changes between the *Mining Act 1992* and the *Environmental Planning & Assessment Act 1979* (EP&A Act), when mining moves beyond the area covered by the current Mining Operations Plan, a development consent under the EP&A Act will need to be in place.

An Environmental Impact Statement has been prepared by Element Environment Pty Ltd on behalf of Boral for submission to the Department of Planning and Environment to satisfy the provisions of Part 4 of the EP&A Act. Boral is seeking approval for continued operations at the site through a development application for a State Significant Development including a 30 year Mine plan, associated overburden emplacement areas and a Mine water supply dam (hereafter referred to as 'the Project').

Boral is seeking to continue operations at the site through approval of a proposed 30 year Mine plan, establishment of associated overburden emplacement areas and a Mine water supply dam (hereafter collectively referred to as the Project). The Project constitutes a State Significant Development (SSD) and requires an Environmental Impact Statement (EIS). This Stygofauna and GDE Assessment Report is part of the EIS.

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to assess the ecological values and impacts to stygofauna and GDEs associated with the Project. This report assesses these impact under state and federal legislation, addresses the Secretary's Environmental Assessment Requirements (SEARs), and identifies avoidance, mitigation and offsets for the Project. Aquatic ecological values are addressed in the Aquatic Assessment (Niche 2018).

1.2 Site Description

1.2.1 Site Location

The Mine is located in Marulan South, 10 kilometres (km) south-east of Marulan, 35 km east of Goulburn and approximately 175 km south-west of Sydney, within the Goulburn Mulwaree Local Government Area (LGA) in the Southern Tablelands of NSW (Figure 1 and Figure 2).

Access to the Mine is via Marulan South Road, which connects the Mine and Boral's Peppertree Hard Rock Quarry (Peppertree Quarry) with the Hume Highway approximately 9 km to the northwest. Boral's private

rail line connects the Mine and Peppertree Quarry with the Main Southern Railway approximately 6 km to the north.

The Mine lease area has been subject to varying levels of disturbance associated with mining and agriculture works including vegetation clearing, Mine operations, installation of mining infrastructure, Mine access tracks, and power easements. Land use surrounding the Mine is a mixture of extractive industry, grazing, rural residential, commercial/industrial and conservation.

The summary of regional geographical, environmental and landscape context is provided below in Table 3.

Table 1. Regional geographic and context

Project area	Description
Bioregion	South Eastern Highlands – site lies wholly within this bioregion.
Botanical subregion	Bungonia - site lies wholly within this subregion.
Catchment Management Authority	Southern Rivers CMA
Mitchell Landscape	Bungonia Tableland and Gorge and Shoalhaven Gorge.
Local government areas	Goulburn Malwaree (NSW).
Nearby conservation areas	Bungonia State Conservation Area, Bungonia National Park to the south and Morton National Park to the east.
Surrounding land use	Mostly agricultural land to the west of the Project site. To the north Peppertree Quarry occurs, and to the south and east Bungonia State Conservation Area and Morton National Park.
Watercourses, drainage and catchment	Marulan Creek (4th order stream) and Tangarang Creek occur within the northern part of the Project site and flow into Barbers Creek (5th order) outside of the Project site to the east. Barbers Creek flows to the south-east into the Shoalhaven River (6th order). Bungonia Creek (5th order stream) occurs to the south of the Project site and flows east into the Shoalhaven River. Main Gully is a drainage line that, prior to mining, had a catchment area of 230 ha, much of which has been subsumed by prior mining or overburden emplacements, but remains the main drainage line for the southern part of the Project area.

1.2.2 Land use and ownership

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

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

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

Peppertree Quarry, owned by Boral Resources (NSW) Pty Limited, 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 1990's. 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 northeast of the mine along Long Point Road. These properties are separated from the mine by the deep Barbers Creek gorge. Sensitive receivers are shown in Figure 2.

1.2.3 Zoning

The majority of the site is zoned RU1 - Primary Production zone 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. Under this zone mining and extractive industries are prohibited development, although historically mining has occurred within these areas under "existing use rights" as mining and processing operations commenced well before the commencement of the Mulwaree Planning Scheme Ordinance (PSO) on 15 May 1970. Notwithstanding that both mining and extractive industries are prohibited in the E3 zone these activities are permissible pursuant to State Environmental Planning Policy (*Mining, Petroleum Production and Extractive Industries*) 2007. In accordance with Clause 7(1)(b)(i) of this SEPP mining can be carried out with consent in any zone which has agriculture as a permissible land use (with or without consent). Agriculture is permitted with consent in the E3 - Environmental Management zone under the Goulburn Mulwaree LEP 2009. Similarly Clause 7(3)(a) of this SEPP makes it clear that extractive industries can be carried out with consent in any zone which has agriculture as a permissible land use (with or without consent). Therefore both mining and extractive industries are land uses which can be carried out provided development consent is granted.

Boral operates the mine pursuant to Section 109 of the EP&A Act and the continuance of an existing use and its expansion is possible provided the necessary approvals are in place. Therefore, there are no environmental planning issues that would prohibit approval of expanded operations at the mine.

Importantly, the Project aims to improve the stability of existing overburden emplacements and improve rehabilitation outcomes over the entire site.

1.2.4 Topography and hydrology

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

The Project site and surrounds is characterised by the rolling hills of pasture and grazing lands interspersed with woodland 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. As such, local relief of Marulan South ranges from around 130 metres (m) Australian Height Datum (AHD) to over 630 m AHD.

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

downstream and enters the Pacific Ocean approximately 15 km east of Nowra (approximately 100 km downstream).

1.2.5 Geology

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, which were 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 (GSSE 2010b).

The limestone formation around Marulan South consist of a number of generally parallel and north-south striking beds dipping at 65-85 degrees to the west. The beds include the Mt. Frome limestone, sedimentary rocks, volcanic rocks and the Eastern limestone.

The Eastern limestone has the highest grade and was therefore selected for the commencement of mining. The limestone is bound to the east by the older Tallong shale beds and in the west by the younger shales, volcanic tuff and the Mt. Frome limestone. 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 intrusion, which is extracted by Peppertree Quarry.

1.2.6 Climate

Rainfall data for the climatic assessment was obtained from Bureau of Meteorology (BoM) Station 070263 (Goulburn TAFE), located approximately 35 km to the west of the mine as well as the two Boral weather stations, one located approximately 1.3 km west of the mine, just off Marulan South Road and the other located on the Peppertree Quarry site (Figure 2).

The mine is located in Australia's cool temperate climatic region, which is characterised by mild to warm summers and cold winters, with common frost and occasional snow fall.

The BoM weather station shows an average annual rainfall of 641.3 millimetres (mm). The mean maximum and minimum temperature in January is 27.8ºC and 13.6ºC, while the mean maximum and minimum temperature in July is 11.5ºC and 1.5ºC.

The most recent data over the past two reporting periods recorded from the mine's weather station, indicates that significant rainfall was concentrated during December 2012 to February 2013 and February 2014 to March 2014. The highest monthly rainfall of each of the past two reporting periods was 229 mm, recorded in June 2013 and 129 mm, recorded in March 2014. For the 2012/2013 period, total rainfall was 721.5 mm, while for the 2013/2014 period total rainfall was 486 mm.

1.3 Existing operation

The Marulan South Limestone Mine is sited on a high grade limestone resource. Subject to market demand the mine has typically produced 3 to 3.3 million tonnes of limestone and 120,000 to 200,000 tonnes 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.

Limestone and shale are extracted using open-cut hard rock drill and blast techniques. Material 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 located in the northern section 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, west of the open cut pits.

The current operations are 24 hour, 7 days per week with personnel employed on a series of 8, 10 and 12 hour shifts to cover the different operational aspects of the mine. Blasting is restricted to daylight hours and on weekdays, excluding public holidays.

1.4 The Project

1.4.1 Mining operations

Boral proposes to continue mining limestone from the Mine at a rate of up to 4 million tonnes per annum (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 tonnes per annum (tpa).

The proposed 30 year Mine plan accesses approximately 120 million tonnes 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 part of the South Pit, leaving the remainder of the South Pit for overburden emplacement and a visual barrier (Figure 3).

In addition to mining approximately 5 million tonnes of shale, the extraction of the limestone requires the removal of approximately 108 million tonnes of overburden over the 30 year period. This material will be emplaced within existing and proposed overburden emplacement areas (Figure 3).

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 propose to increase production of manufactured sand to approximately 1 million tpa.

Boral's adjoining 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 million tonnes of overburden

from the Mine after the removal of accessible limestone, Boral proposes to emplace up to 15 million tonnes of overburden from Peppertree Quarry within the Northern Overburden Emplacement (Figure 3).

The disturbance footprint in shown on Figure 4 and Figure 5.

1.4.2 Associated infrastructure

Processing

The existing facilities for processing limestone will continue to be utilised to produce a series of graded and blended limestone products that are despatched from site for use primarily in cement manufacture, steel making, commercial and agricultural applications.

Limestone processing facilities 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.

Kiln stone grade limestone will also continue 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.

Processing infrastructure and the reclaim and stockpile area at the northern end of the North Pit will be relocated during the life of the 30 year pit to enable full development of the Mine plan. The timing and location of this is presented in the EIS.

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.

Water supply

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 water supply dam on Marulan Creek (Figure 5). This dam would be located on Boral owned land north of Peppertree Quarry and utilises Boral's adjoining Tallong water pipeline to transfer water to the Mine. This dam would require the purchase of water entitlements.

Mine water demand will also be supplemented by Tallong Weir via the Tallong water pipeline.

Rail

No changes are proposed to the existing rail infrastructure. A 1.2 km long passing line was constructed at Medway Junction during construction of the Peppertree Quarry, which will also be used by the Mine to enhance access to the Main Southern Railway.

Road

Road access from the Mine to the Hume Highway is via Marulan South Road. The proposed Western Overburden Emplacement extends northwards over Marulan South Road. Boral propose to realign a section of Marulan South Road, to accommodate the northern portion of the proposed Western Overburden Emplacement (Figure 3).

All public roads within 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 will be de-proclaimed.

Power

Power supply to the Mine is via a high voltage power line that commences at 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 proposed Northern Overburden Emplacement (Figure 3).

1.4.3 Transport

The majority of 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.

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 a new shared road sales product stockpile area by the trucks carrying the limestone sand to Peppertree Quarry. A new shared road sales product stockpile area is proposed on the northern side of Marulan South Road, immediately west of the Mine and Peppertree Quarry entrances. This shared finished product stockpile area, includes a weighbridge and wheel wash and will service both the Mine and 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.

1.5 Approval process

The Project requires development consent under Part 4, Division 4.1 of the EP&A Act. Part 4 of the EP&A Act relates to development assessment. Division 4.1 specifically relates to the assessment of development deemed to be SSD. The Marulan South Project is a mining development which meets the requirements for SSD.

An application for SSD must be accompanied by an environmental impact statement (EIS), prepared in accordance with the NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

1.5.4 Secretary's environmental assessment requirements

This stygofauna and groundwater dependent ecosystem assessment has been prepared to address specific requirements provided in the Secretary's environmental assessment requirements (SEARs) for the SSD application. Table 2 below cross-references this report and the relevant SEARs.

Table 2 Relevant SEARs for this assessment

Requirement	Section addressed in report
Department of Planning and Environment	
An assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having	Section 1.7

Requirement	Section addressed in report
regard to the EPA's, NSW Office of Water's and Water NSW's requirements and the NSW Aquifer Interference Policy.	
An assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users.	The report primarily assesses the impact to GDEs and stygofauna and hypogean communities potentially affected by the project
An assessment of the likely impacts of the development on the environment, focussing on the specific issues identified below, including: • 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. A description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved.	This assessment uses two seasons (autumn and spring) of qualitative and quantitative aquatic ecological baseline data to describe the existing environment. Potential impacts are described and mitigation and management measures discussed. Refer to sections 4, 5, 6, 7, 8.
Environmental Protection Agency	
Describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and/or economic perspective.	The assessment addresses this requirement throughout the report from a groundwater ecological perspective.
For any potential impacts relevant for the assessment of the proposal provide a detailed analysis of the impacts of the proposal on the environment including the cumulative impact on the proposal on the receiving environment especially where there are sensitive receivers.	This is addressed in section 7 of this report.
Described the methodology used and assumptions made in undertaking this analysis and indicate the level of confidence in the predicted outcomes and the resilience of the environment to cope with the predicted impacts.	This is addressed in section 4.
Describe management and mitigation measures: Describe any mitigation measures and management options proposed to prevent, control, abate or mitigate identified environmental impacts associated with the proposal and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	This is addressed in section 8.
Office of Environment and Heritage	

Requirement	Section addressed in report
Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems and stygofauna.	The focus of this assessment Section 7.
NSW Office of Water	
Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	The report primarily assesses the presence of subterranean ecosystems and the current conditions of the aquifer and the surface GDEs. See Section 7.
Consideration of relevant policies and guidelines.	See Section 1.6

1.6 Policies and guidelines

Groundwater ecosystem dependence is an increasingly important component of surface and groundwater initiatives in NSW and has been incorporated within Groundwater Management Plans under the Water Reform Agenda.

The impact assessment for the Marulan South Limestone Mine Continued Operations Project is assessed as State Significant Development under Division 4.1 of the EP&A Act and addresses SEARs and guidelines as required under Schedule 2 EP& A Regulation 2000.

The NSW State Government also has an obligation under the WMA 2000 and the Groundwater Dependent Ecosystem Policy to "manage GDEs in such a way that it:

- Applies the principles of ecologically sustainable development.
- Protects, enhances and restores water sources, their associated ecosystem, ecological processes and biological diversity and their water quality.
- Integrates the management of water sources with the management of other aspects of the environment, including the land, its soils, its native vegetation and its native fauna."

The *Water Management Act 2000* also provides water management principles that are relevant to the management of GDEs. These include:

- Water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded.
- Habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored; the quality of all water sources should be protected and, wherever possible, enhanced.
- The cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised.
- The principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirement.

The following policies are relevant to the protection and management of GDEs in NSW:

- NSW State Groundwater Policy Framework document, Department of Land and Water Conservation, 1997. http://www.water.nsw.gov.au/Water-Management/Law-and-Policy/Keypolicies/.
- NSW State Groundwater Dependent Ecosystems Policy, Department of Land and Water Conservation, 2002. http://www.water.nsw.gov.au/Water-Management/Law-and-Policy/Keypolicies/.
- NSW Groundwater Quality Protection Policy, Department of Land and Water Conservation, 1998. http://www.water.nsw.gov.au/Water-Management/Law-and-Policy/Keypolicies/.

- NSW Wetlands Management Policy, Department of Environment, Climate Change and Water, 2010a.
- State Environmental Planning Policy No. 14 – Coastal Wetlands, SEPP 14.
- Risk assessment guidelines for groundwater dependent ecosystems – the conceptual framework NSW Office of Water, September 2012.
- NSW State Rivers and Estuaries Policy – NSW Water Resources Council NSW Government, 1993. http://www.water.nsw.gov.au/Water-Management/Law-and-Policy/Keypolicies/.
- Water Compliance Policy (NSW Office of Water, 2010a). http://www.water.nsw.gov.au/Water-Management/Law-and-Policy/Key-policies.
- NSW Water Extraction Monitoring Policy. http://www.water.nsw.gov.au/Waterlicensing/Metering/default.aspx.

The following legislation is also considered in this project for the protection and management of GDEs in NSW:

- *Biodiversity Conservation Act 2016*. This Act and its listings are used in the determination of the ecological value of a GDE, i.e. if a GDE contains a threatened species as listed under this Act; the GDE is taken to have higher ecological value.
- *Fisheries Management Act 1994*. This Act is relevant to the determination of the ecological value of a GDE (i.e. if the GDE contains a threatened species as listed under this Act, the GDE is taken to have higher ecological value).
- Draft New South Wales Biodiversity Strategy, Department of Environment, Climate Change and Water NSW and Industry and Investment NSW, 2010. The Strategy is directly relevant as its objectives include the: smarter biodiversity investment and improved partnerships whole of landscape planning effectively managing threats sustainable production environments.
- NSW Natural Resources Monitoring, Evaluation and Reporting Strategy 2010-2015.

1.7 Purpose of this report

The Marulan Project Environmental Impact Statement has been prepared in accordance with Division 4.1, Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) which ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision-making process.

This stygofauna and GDE assessment has been prepared as a requirement within the Secretary's environmental assessment requirements (SEARs) for the Marulan Limestone Mine Project (Application No. SSD 7009).. The assessment of the Project has been carried out for approval under the provision for State Significant Development within Part 4, Division 1 of the EP&A Act. Threatened biodiversity as listed on the NSW BC Act and FM Act have been considered in this assessment.

1.7.1 Impact assessment objectives

The aim of the stygofauna baseline surveys and impact assessment is to determine the presence of stygofauna within the area of current and proposed future developments and to assess the potential impacts of the proposed development on groundwater and groundwater fed (baseflow) stream ecology including aquatic threatened species, populations, communities or their habitats that are dependent on groundwater. The assessment addresses the impacts from the current open cut limestone mining operations and the potential impact form the proposed development.

The specific objectives were to:

- Describe the current characteristics of stream and groundwater ecology through quantitative and qualitative monitoring of stygofauna and baseflow, hyporheic fauna.

- Identify or determine the likelihood of occurrence of threatened species, populations, habitat and/or communities with in the study area.
- Assess whether these impacts will cause significant adverse effects to groundwater and baseflow stream ecology.
- Determine whether these impacts will significantly impair any identified threatened species, populations, habitat or communities.

2. Literature review

Groundwater constitutes an estimated 97% of all non-frozen freshwater on earth and supports a vast range of ecosystems that cover a large percentage of the landscape from the coast to the mountain tops. These include: unique subterranean communities (stygofauna) in caves and aquifer ecosystems; most rivers; wetlands; native vegetation; and even marine and estuarine environments. Groundwater dependent ecosystems (GDEs) are reliant on the high water quality and consistency of groundwater levels and pressure to survive. In turn, these ecosystems provide a range of environmental services that benefit the environment and ultimately, the community. These ecosystems also contain many highly sensitive, specialised and highly localised, endemic flora and fauna that cannot be found elsewhere and have little tolerance to change. They also include species that may represent remnants of ancient environments.

The uniqueness of Australia's biodiversity is encapsulated and magnified by its groundwater dependent biodiversity. Groundwater in an aquifer is a body of underground water but it is not isolated or stationary. Neither is it devoid of life or an inexhaustible supply of clean water. It flows in much the same way as a river from its surface recharge zone to its surface discharge areas and will transport impacts such as pollutants or reductions of quantity throughout the subsurface environments to the surface land and waters. Therefore, there is always a flow-on effect from one point of impact on the groundwater quantity or quality to the rest of the landscape. The parameters that make groundwater environments a separate entity to many surface water environments and which has contributed to the development of many specialised, highly endemic ecosystems, communities and species, is the relatively consistent nature of its flow, pressure, level, and water chemistry.

In completing this stygofauna assessment, a number of threatened species databases and previous documents relevant to the Project have been reviewed.

2.1 Effects of mining on stygofauna

Mining operations may incorporate a range of activities in their operations that may result in impacts on water resources, including some or all of the following (Serov et al. 2012):

- Below water table mining.
- Water supply development (e.g. groundwater, dewatering, surface water).
- Desalination for potable supply (with subsequent brine disposal).
- Dust suppression.
- Tailings disposal.
- Overburden emplacements.
- Backfilling and rehabilitation works.
- Water diversions and surface sealing.
- Hazardous and dangerous goods storage.
- Water storages including waste water ponds.
- Disturbance/removal of terrestrial vegetation.

In recognition of the above mining activities, direct effects on groundwater dependent ecosystems may be as follows:

- Quantity (groundwater levels, pressures and fluxes).

- Quality (changes outside of natural ranges, concentrations of salts, heavy metals and other toxic water quality constituents).
- Groundwater interactions (interactions between groundwater systems and between groundwater and surface systems).
- Physical disruption of aquifers (excavation of mining pits and underground workings, compaction of aquifer matrix through dewatering, increase in porosity by blasting, or overburden compaction).

The existence and extent of these water affecting activities, and their potential impact on local to regional scale groundwater resources will depend largely on the scale of the mining operation, mining method, and process water requirements, as well as the climatic and geological setting.

2.2 Stygofauna ecology

Stygofauna are intricately linked both ecologically and physiologically to the aquifer environment and are adapted to the relative stability of their surroundings. Compared to surface environments, groundwater fluctuates less both in level and physico-chemical variables such as electrical conductivity, temperature, and pH (Hancock et al. 2005). Groundwater is also generally lower in dissolved oxygen and has less readily available organic matter than surface water environments (Humphreys 2002). 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 (Hancock et al. 2005). Generally, stygofauna biodiversity is highest near the water table and declines with depth (Datry et al. 2005).

Stygofauna biodiversity is also higher in areas of recharge where the water table is close (< 20m) to the land surface (Humphreys 2001, Hancock and Boulton 2008). This is because the water table is likely to have the highest concentration of oxygen and organic matter. Stygofauna can occur at considerable depth below the water table, but are fewer in number, have lower diversity, and may change in community composition (Datry et al. 2005). In some karstic aquifers, where there is relatively high vertical exchange, or flow does not come into contact with large microbial surface areas (such as occurs in sedimentary aquifers), stygofaunal communities can occur at depths exceeding 100m (Humphreys 2001).

In Australia, stygofauna are known from alluvial, limestone, fractured rock, and calcrete aquifers (Eberhard & Spate 2005, Hancock et al. 2005; Humphreys 2008). As yet, no species are known from limestone aquifers associated with the limestone unit being mined at this location. Most limestone aquifers occur as fractured rock aquifers with minor to significant dissolution lines, often forming caves and large voids with a high degree of connectivity to the surface. Therefore these aquifers typically have high levels of dissolved oxygen, lower salinity and have a high biodiversity. The levels of biodiversity are determined by a number of factors including availability of space to live, which is dependent on the porosity of the sediments, degree of fracturing, or extent of cavity development. These requirements must be sufficient to enable fauna to move through the substrate.

2.3 Processes that threaten stygofauna

There are three critical factors that are essential requirements for stygofauna communities in aquifers.

1. Stable water quality/physicochemical parameters

Many groundwater species have evolved under strict physiochemical constraints and require a level of stability of these parameters for their continued existence. Stygofauna are able to tolerate natural

fluctuations in water parameters such as level, electrical conductivity, and temperature, and this has been demonstrated experimentally (Tomlinson et al. 2007) for stygofaunal amphipods, copepods, and syncarids. However, changes outside the natural range of water quality, water chemistry and levels such as rapid drawdown or changes to water chemistry such as a pollution plume are likely to have significant impacts on the community composition, biodiversity and overall sustainability of the community.

2. Surface connectivity

Groundwater communities require links to the surface environment to provide organic matter and oxygen. If that linkage is broken or disrupted, the stygofauna community in the area affected could decline over time.

3. Subterranean connectivity

The third critical factor is their high degree of endemicity (Humphreys 2008). This comes about because, unlike many surface-dwelling aquatic invertebrates, stygofauna do not have aerially dispersing life stages. To migrate between areas, stygofauna must be able to swim or crawl through the aquifer matrix. However, as aquifers are not homogenous in porosity and change over geological time, natural hydrological barriers within the matrix restrict their movement. Overtime, these natural barriers encourage genetic isolation and ultimately, speciation. Barriers, however, can also be created rapidly by changes in water levels or water chemistry/quality such as an area of lower porosity and sections of poor water quality. If any area is impacted by a disturbance that results in a loss of biodiversity, these new barriers to dispersal may prevent recolonization of the habitat.

Many species of stygofauna are restricted to small geographical areas. This is particularly the case in non-alluvial aquifers such as some of the limestone karsts of NSW (Eberhard & Spate 1995; Thurgate et al. 2001), and calcrete aquifers in Western Australia, where one or more species are known only from a single aquifer, or part of an aquifer (Humphreys 2002). This means that any process that threatens the aquifer, potentially threatens an entire species and community. There is also a high degree of endemism in alluvial aquifers, even between adjacent systems (Hancock and Boulton 2008). However, providing there is sufficient hydrological connectivity within the aquifer, and physico-chemical conditions are suitable, the distribution of species will not be restricted to small parts of an aquifer.

Stygofauna are potentially threatened by activities that change the quality or quantity of groundwater, disrupt connectivity between the surface and aquifer, or remove living space. These impacts to groundwater and aquifer conditions have become a particular issue for mining proponents over the last decade or so, principally because of the perceived biodiversity value of stygofauna and the fact that little is known of their environmental water requirements.

2.4 Other studies

The National Water Commission (NBC) has reported (RPS 2011) that extensive gaps exist in our knowledge of the distribution, composition and biodiversity value of Australian stygofauna. Despite this incomplete inventory it is apparent that stygofauna are present across a variety of Australian subsurface environments and are generally characterised by high diversity and local-scale endemicity. They are also often of high scientific interest; for example, the occurrence of the only known southern hemisphere representatives of several phylogenetic relict lineages.

In Australia, at least 750 stygofauna species have been described (Humphreys 2008), but this is a conservative estimate of total continental biodiversity as more than 66 % of known species come from just

two regions of Western Australia (Humphreys 2008) and large parts of Australia remain un-surveyed. In NSW there are approximately 400 species of stygofauna known, but this estimate will increase as more surveys are conducted and taxonomic knowledge improves. Knowledge of groundwater dependent ecosystems in eastern Australia is limited and patchy (e.g. Eberhard and Spate 1995; Thurgate et al. 2001; Hancock 2002; 2004, Hancock & Boulton 2008; Hose et al. 2005; SMEC 2006; Watts et al. 2007). At least two surveys (SMEC 2006; Hose 2008) have confirmed the presence of stygofaunal taxa (Anaspidacean Syncarida, Cyclopoid Copepoda, Harpacticoid Copepoda, Candonid Ostracoda, Acarina, Nematoda, Oligochaeta, Coleoptera (beetle) larva and Collembola) in the Upper Nepean region in recent years. With the exception of these two reports we are unaware of other studies of groundwater dependent ecosystems in fractured rock aquifers in eastern Australia, and even internationally, studies of groundwater ecosystems in fractured rock are scarce.

The SMEC (2006) Baseline Groundwater Dependent Ecosystem Evaluation Study provides a comprehensive assessment of the vegetation and terrestrial invertebrate assemblages of the upland swamps and the riverine macroinvertebrates in their study area, but knowledge of the fauna inhabiting the perched and regional groundwater within the swamps, sandstone aquifers and hyporheic zones is limited. As part of that study, SMEC (2006) sampled the sandstone aquifer and perched groundwater for stygofauna and obligate groundwater invertebrates. A new species of syncarid was identified from the perched water table in Butlers Swamp (bore 2M1p) and Cyclopoid copepods were collected from the shallow fractured sandstone aquifer (bore 2M2s, 24 m depth), also nearby to Butlers Swamp. Fauna were not recorded in samples from deeper bores 1A or 3B that fully penetrate the sandstone aquifer at other locations.

In 1992, the NSW National Parks and Wildlife Service began a program surveying the subterranean invertebrate fauna of NSW caves in order to determine the conservation status of each cave system. The result of this survey has been the discovery of sparse but widespread fauna containing significant distributional and phylogenetic relic species. This interest has also stimulated regional surveys in other locations including Tasmania as well as NSW which has uncovered a large and diverse subterranean and interstitial fauna.

The survey of the caves within the Bungonia Limestone Caves resulted in 28 cave species being recorded. Of these 28 taxa all but three were terrestrial cave species termed Troglofauna. These consisted predominantly of beetles, spiders, Pseudoscorpions, woodlice, and Hemiptera (True bugs), millipedes and leaf-hoppers (Amphipoda). As these species are terrestrial in their habitus they are not generally considered to be impacted by changes in groundwater quality although changes in groundwater quantity may impact cave humidity levels thus impacting these species. The only other possible impact on the troglofauna community is that of structural damage to the cave for reasons such as natural ground movement or as a result of activities such as blasting. As these caves are situated on the southern side of Bungonia Creek Gorge from the area of operations the possibility of adverse impacts from the mining operation is considered unlikely.

The three aquatic species that can be regarded as stygofauna included two snails and an isopod. Only one of these genera has been recorded during this study, the freshwater snail, *Austropyrgus*.

Table 3 Species list of fauna recorded associated with the Bungonia Limestone unit.

Class	Family	*Species*	Habitus	Locality	Reference
Gastropoda	Charopidae	*Elsothera funerea Cox*	Troglobite	Argyle Hole, Grill Cave	Wellings 1977

Gastropoda	Hydrobiidae	*Austropyrgus sp*	Stygobite	caves	Thurgate, et al, 2001
Gastropoda	Hydrobiidae	*Fluvidona spp.*	Stygobite	caves	Ponder pers.comm., S.Eberhard and A.Spate, 1995
Insecta	Carabidae	*undetermined*	Troglobite	Grill Cave	James et al.1976
Insecta	Carabidae	*N.jasperensis vicinus sp.*	Troglobite	caves	Moore, 1964
Insecta	Carabidae	*Notospeophonus jasperensis vicinus*	Troglobite	Fossil Cave	Moore 1964
Insecta	Carabidae	*Trechimorphus diemenensis*	Troglobite	caves	Moore 1964
Insecta	Staphylinidae	*undetermined*	Troglobite	Grill Cave	Hamilton-Smith 1976; Eberhard 1993
Insecta	Entomobryidae	*Genus Salina*	Troglobite	Chalk Cave	Wellings 1972
Insecta	Hypogastruridae	*Hypogastrura sp.*	Troglobite	Grill Cave	Wellings 1972
Insecta	Ceratocombidae	*Ceratocombus australiensis*	Troglobite	Argyle Hole, Fossil Cave	Hamilton-Smith 1967
Insecta	Rhaphidophoridae	*Cavernotettix sp.*	Troglobite	Phoenix Cave	Eberhard 1993; Smith 1982; Hamilton-Smith 1976; Spate, unpublished data
Insecta	Nicoletiidae	*Trinemura anemone*	Troglobite	Argyle Hole, Phoenix Cave, UNSWSS Hole	Smith 1988
Symphyla		*undetermined*	Troglobite	caves	Thurgate, et al, 2001
Arachnida	Cycloctenidae	*Cycloctenus abyssinus*	Troglobite	Grill Cave	Gray 1973; Gibian et al. 1988
Arachnida	Cycloctenidae	*Toxopsiella sp.*	Troglobite	Chalk Cave	Gray 1973
Arachnida	Mimetidae	*Mimetus sp.*	Troglobite	Grill Cave	Gray 1973
Arachnida	Stiphidiidae	*Stiphidion facetum*	Troglobite	Drum Cave, Fossil Cave, Mass Cave	Eberhard 1993; Gibian et al. 1988; Gray 1973; Smith 1982; Spate, unpublished data

Arachnida	Theridiidae	*Icona sp.nov. 1*	Troglobite	caves	Thurgate, et al, 2001
Arachnida	Theridiidae	*Icona spp.*	Troglobite	Flying Fortress Cave, Fossil Cave, Grill Cave, Hogans Cave	Eberhard 1993; Gibian et al. 1988; Gray 1973; Smith 1982
Arachnida	Uloboridae	*Philiponela pantherinus*	Troglobite	Grill Cave	Gray 1973; Gibian et al. 1988
Arachnida	Triaenonychidae	*Holonuncia seriata*	Troglobite	caves	Hunt 1992
Arachnida	Chthoniidae	*Tyranochthonius cavicola sp.*	Troglobite	caves	Beier, 1962
Diplopoda		*undetermined*	Troglobite	Grill Cave, Phoenix Cave	Eberhard 1993; Wellings 1977; Smith 1982; Gibian et al.1988; Hamilton-Smith 1976; Spate, unpublished data
Diplopoda		*undetermined*	Troglobite	Grill Cave, Phoenix Cave	Eberhard 1993; Wellings 1977; Smith 1982; Gibian et al.1988; Hamilton-Smith 1976; Spate, unpublished data
Malacostraca	Talitridae	*undetermined*	Troglobite	Grill Cave, Fossil-Hogans Hole	Wellings 1977
Malacostraca	Styloniscidae	*undetermined*	Stygobite	caves	Thurgate, et al, 2001
Malacostraca	Oniscidea	*undetermined*	Troglobite	caves	Wellings 1977; Eberhard 1993

2.5 Terminology used in this report

Stygofauna can be classified by the degree to which they are dependent on groundwater. Those that are completely dependent on groundwater are termed stygobites and consist predominantly of crustaceans. Those that rely on groundwater to a lesser extent and can live in mixed surface and groundwater are termed stygoxenes or stygophiles depending on their adaptation to the subterranean environment

(Marmonier et al. 1993). The distinction is often ambiguous because it is difficult to know the degree of surface/groundwater mixing in an aquifer, and the classifications are regularly disputed (Sket 2010). However, classifications based on affiliation to groundwater can be useful when assessing the conservation status of species and their vulnerability to potential impacts and in this report we adopt the following definitions:

Stygoxenes are organisms that have no affinities with groundwater systems but regularly occur by accident in caves and alluvial sediments. Some planktonic groups (e.g. Calanoida Copepoda) and a variety of benthic crustacean and insect species (e.g. Simullid larvae, Caenidae Mayflies) may passively infiltrate alluvial sediments (Gibert et al.1994).

Stygophiles have greater affinities with the groundwater environment than stygoxenes because they appear to actively exploit resources in the groundwater system and/or actively seek protection from unfavourable surface water conditions. Stygophiles can be divided into occasional/temporary hyporheos and permanent hyporheos.

2.5.1 Definitions of habitus

Occasional or temporary hyporheos - The occasional or temporary hyporheos include individuals that could either spend their lives in the surface environment or spend a part of their lives in the sub-surface environment (e.g. Ceratopogonidae larvae). The permanent hyporheos is present during all life stages in either groundwater or benthic habitats (Gibert et al.1994) and possess specialist adaptations for living in this environment (Gibert et al.1994).

Stygobites - Stygobites are obligate subterranean species, restricted to subterranean environments and typically possessing specialised character traits related to a subterranean existence (troglomorphisms), such as reduced or absent eyes and pigmentation, and enhanced non-optic sensory structures.

Phreatobites - Phreatobites are stygobites that are restricted to the deep groundwater substrata of alluvial aquifers (phreatic waters). All species within this classification have specialised morphological and physiological adaptations (Gibert et al 1994).

Stygofauna - Stygofauna is an all-encompassing term for animals that occur in subsurface waters (Ward et al. 2000).

3. Study area and survey sites

The Study Area for the purposes of this report includes all watercourses and aquifers that occur within and adjacent to the area of the mining operation (Figure 6). This area encompasses the water courses of Barbers Creek, Bungonia Creek and Main Gully adjacent to the mining operations as well as three bores adjacent to but outside the area of operations (Bores GW103697, GW100656, GW108850) (Figure 6).

3.1 General description

The Marulan Limestone Mine assessment area is located within the headwaters of Barbers Creek and Bungonia Creek in the Shoalhaven River catchment. The surface area of the plateau is mainly cleared for agriculture whereas the slopes and riparian zone of the streams are relatively undisturbed native bushland. Surface vegetation is mainly dry sclerophyll woody vegetation on the ridge lines and a variety of dry and wet sclerophyll vegetation located mainly on the valley sides with numerous limestone cliffs on the upper slopes associated with Bungonia Limestone.

The area has a long history of limestone mining. Limestone mining in the area began in 1869 with major developments emerging in the 1920's. Limestone was initially mined to supply raw material for cement manufacturing and steel making. By 1953 two mines were well established supplying limestone for cement, steel making, agriculture, glass making, quicklime and hydrated lime manufacture. The Marulan South Limestone Mine is sited on a high grade limestone resource. The mine is currently producing 3 to 3.3 million tonnes of limestone and 120,000 to 200,000 of shale per annum.

3.2 Site Geology

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

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

The granodiorite has also metamorphosed the limestone to varying degrees across the site. A number of intrusive dolerite dykes are present at the site.

The contact with the overlying siltstone and limestone units is known to be faulted within the mine area, becoming a conformable contact further south. Where the margins of the limestone are bounded by faults, the fault affected zones have been noted to be up to 50 metres thick, consisting of broken and shattered sidewall rock and limestone. The fracture planes are filled with assorted clays and other materials introduced following the removal of limestone by solution.

3.3 Groundwater

There are two basic sources of groundwater within the Project area: shallow, unconsolidated aquifers and deep, consolidated aquifers. The shallow unconsolidated aquifer is mainly within the weathered zone where the groundwater exists in the pore spaces within the sediment or regolith (AGE 2018).

Groundwater within the deep, bedrock aquifer exists mainly in rock fractures caused by geologic and structural movement, associated with intrusive volcanic or dissolution of limestone (AGE 2018).

Groundwater sources in the Project area are managed under the 2011 Greater Metropolitan Region Groundwater Sources Water Sharing Plan. Under this particular WSP, the Project area falls fully within Goulburn Fractured Rock Groundwater Source (GFRGS) and based on Aquifer Interference Policy, the aquifer is classified as 'low-productivity' groundwater source (AGE 2018).

3.3.1 Ionic composition and Isotope analysis

Ionic composition analysis conducted by AGE (2018) identified three distinct groundwater types based on the major cation-anion ratios which can be grouped from the following host rock geological units:

- Tangerang Formation (Tuff) which is magnesium-potassium-sodium-bicarbonate dominant water.
- Tangerang Formation (Carne Dacite) which is magnesium-potassium-sodium-chloride dominant water.
- Eastern Limestone and the Adaminaby Group sandstone which are calcium-bicarbonate dominant water.

Analysis of surface water collected at Main Gully below the blow hole suggests the source of this water is from the limestone karst system and most likely associated with the fractured limestone aquifer.

Isotope analysis of MW1, MW2, 'Blow Hole' Sampling Point and the 'Main Gully Sampling Point' within Bungonia Gorge indicated that:

- Groundwater from the limestone at the mine is young water less than 100 years old.
- The dominant recharge source is from direct rainfall and overland flow from up-gradient catchments.
- Recharge of the spring sampled is relatively quickly indicating that recharge is likely to be the exposed limestone within 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 in the order of 20 years.

3.4 Study sites

A total of 11 bores were examined in this study and 8 sampled for stygofauna inside the areas of operation (Figure 6). The bores types included piezometers or monitoring bores as well as production bores fitted with pumps. The piezometers are constructed with a plastic casing extending the length of the bore with a terminal cap to prevent sediment entering from the bottom. The section of the casing that corresponds with the water bearing zone, that is required to be monitored, is equipped with slots to allow the water to enter. Most bores contained water level loggers, which were removed prior to sampling for stygofauna and later replaced. The survey sites are listed below in Table 4.

Table 4 Survey site details

Locality Name	Site Code	EASTING	NORTHING	Alt(m)	SWL (m)	Total Depth (m)	Water column (m)	Site Status	Habitat	Sampling	Substrate
MW1	MW-1	228111	6147568	440.11	19.33	61.45	42.12	Impact	Bore	net/bailer	Limestone
MW02	MW-02	227722	6146555	380.22	39.45	60.2	21.55	Impact	Bore	net/bailer	Limestone
MW3S	MW-3S	226618	6148365	618.37	19.25	49.2	29.75	Impact	Bore	net/bailer	Granite weathered
MW3D	MW-3D	226608	6148370	618.38	19.16	102	82.84	Impact	Bore	net/bailer	Granite Fractured
MW04S	MW-04	226718	6147140	596.33	32.92	38.92	7.08	Impact	Bore	net/bailer	Granite weathered
MW04D	MW-04D	226717	6147129	595.46	50.21	124	73.79	Impact	Bore	net/bailer	Granite Fractured
MW5	MW-5	227826	6148352	574.41	23.2	98	74.8	Impact	Bore	net/bailer	Granite weathered
MW6	MW-6	228482	6147186	567.71	100.7	128	27.3	Impact	Bore	net/bailer	Granite Fractured
PR8 Residential receiver	GW103697	226412.95	6149788.1	625.973	?	60	?	Control	Bore	pump	Granite
Boral owned rural residential property (B5)	GW100656	226797.51	6148600.8	623.823	?	60	?	Control	Bore	pump	Granite
C3 Commercial receiver	GW108850	226103.57	6148723.7	625.407	10	?	?	Control	Bore	pump	Granite
Barbers Creek lower	Barb-3	229421	6147546	199	1	na	na	Impact	Surface pool	handnet	Clastics
Barbers Creek upper	Barb-4	229593	6148328	238	1	na	na	Control	Hyporheic	sieve	Granodiorite
Gabion Baskets Stream, Barbers Creek	Barb-1	229534	6148124	197	1	na	na	Impact	Surface pool	handnet	Clastics

Gabion Baskets stream, upper	Gab-1	228625.8	6147806.5	494	1	na	na	Impact	Surface pool	handnet	Limestone
Bungonia Creek Lower	Bung-5	229086	6145713	135	1	na	na	Impact	Surface pool	handnet	Clastics
Bungonia Ck, u/s Main Gully	Bung-8	227508.04	6145628	198	1	na	na	Control	Surface pool	handnet	Limestone
Bungonia Creek Upper, Priority 5	Bung-P5	226411.68	6146107.1	237	1	na	na	Control	Surface pool	handnet	Sandstone
Bungonia Creek Upper	Bung-6	227379	6145506	169	1	na	na	Control	Hyporheic	handnet	Sandstone
Red Track spring	Bung-10	226614.58	6145634.7	228	1	na	na	Control	Surface pool	handnet	Sandstone
Riparian pool d/s Main Gully, Bungonia Ck	Main-1	227484.84	6145565.6	176	1	na	na	Impact	Surface pool	handnet	Limestone
Main Gully, Bungonia Ck,	Main-2	227508.04	6145628	198	1	na	na	Impact	Surface pool	handnet	Limestone
Main Gully, spring head in upper section	Main-3	227153.1	6146256.7	500	1	na	na	Control	Surface pool	handnet	Limestone

3.4.1 Bore survey sites

Control sites

GW108850 - C3 Commercial receivers (Plate 3c)

A production bore situated approximately 160m SSW from the main office, next to construction shed/container. Pump fitted, unknown depth, surface water level is 10.03m (P Dvoracek pers. comm 2015). A water and stygofauna sample was taken by running the pump and running the water through a sieve for 10 minutes.

GW100656 - Boral owned private residential property – B5 (Plate 3b)

A production bore approximately 60m west of the house in the small depression. Pump fitted, unable to measure depth to water (P Dvoracek pers. comm 2015). A water and stygofauna sample was taken by running the pump and running the water through a sieve for 10 minutes.

GW103697 - PR8 Residential receiver Plate 3a)

A production bore located approximately 40m east from the side of the southernmost poultry shed. Pump fitted, not possible to measure depth to water. Water used for poultry production (cooling, drinking) approximately 60m deep (P Dvoracek pers. comm 2015). A water and stygofauna sample was taken by running the pump and running the water through a sieve for 10 minutes.

Impact sites

Details of the location, lithology and bore depths, refer to Table 4.

Groundwater levels (Graphs 1-3)

AGE (2018) made the following observations of water levels based on 3 years of monitoring:

The water level fluctuations measured in the bores installed within the pit contrast strongly with the bores outside the pit. The water levels under the pit floor, particularly MW2 (located within the South pit) respond rapidly to rainfall events with groundwater levels rising over 10 m in some instances, and then slowly decline over a period of days/weeks back to the static water level. This response is due to the accumulated runoff that ponds on the pit floor which then seeps over a period of approximately two weeks into the underlying limestone. The low storage within the limestone results in rapidly rising groundwater levels following accumulation of runoff within the South Pit.

In contrast, MW1 (located within the North Pit) initially responds more gradually, rising and declining more slowly following responses to rainfall recharge events and accumulation of runoff within the North Pit.

Water level fluctuations from sampling events are also evident on the MW1 hydrograph. The high rainfall event in September 2015 which resulted in water temporarily ponding within the pit, is visible on both MW1 and MW2 hydrographs. Although MW1 was entirely submerged, the bore hydrograph shows the maximum groundwater level at 430.75 mAHD, which is about 9.4 m below the level of the pit floor. This response suggests that runoff accumulated within the pit drained preferentially through larger fractures, and that the less permeable matrix which MW1 monitors was not fully recharged by the rainfall event. This would indicate poor hydraulic connection between the limestone matrix (in which the MW1 was placed) and surrounding fractured rock matrix.

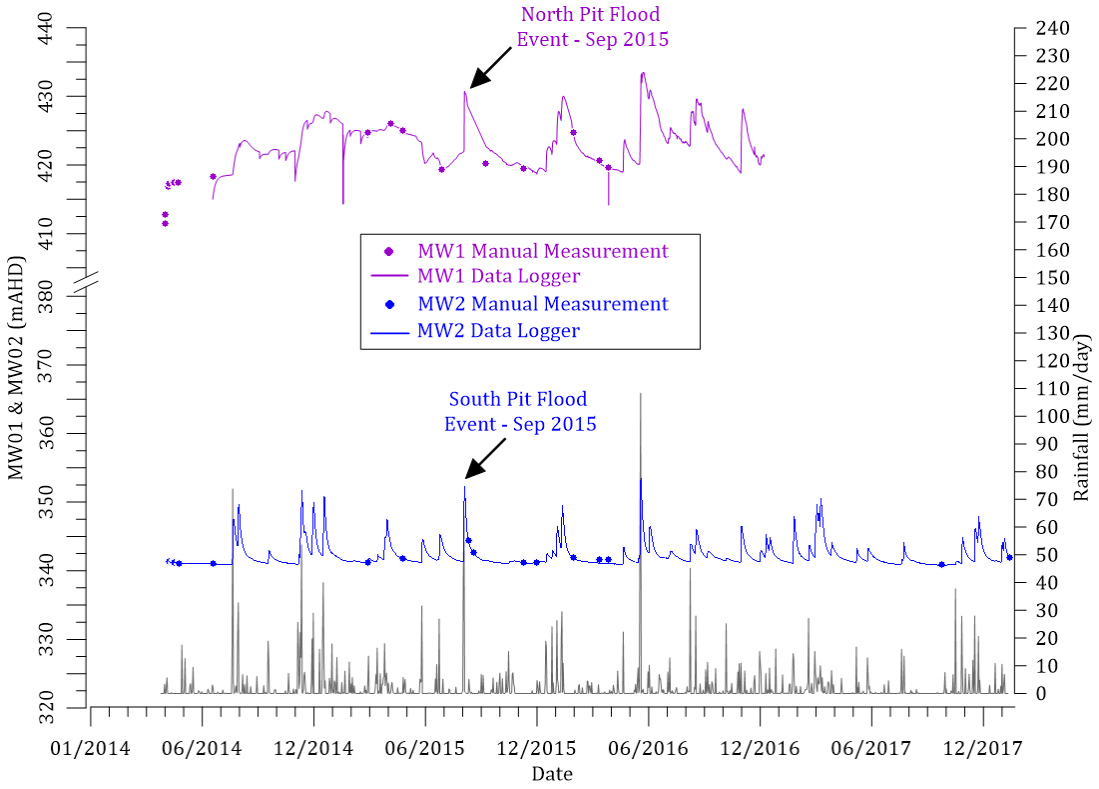
The hydrograph response for MW1 to rainfall events changes in the latter half of 2015 to one similar to that for MW2, showing quicker water level rises and declines. One explanation for this change could be the development of blast induced fractures altering the hydraulic properties of the limestone matrix

surrounding MW1, hydraulically connecting this block of limestone with the main fracture system within the floor of the North Pit.

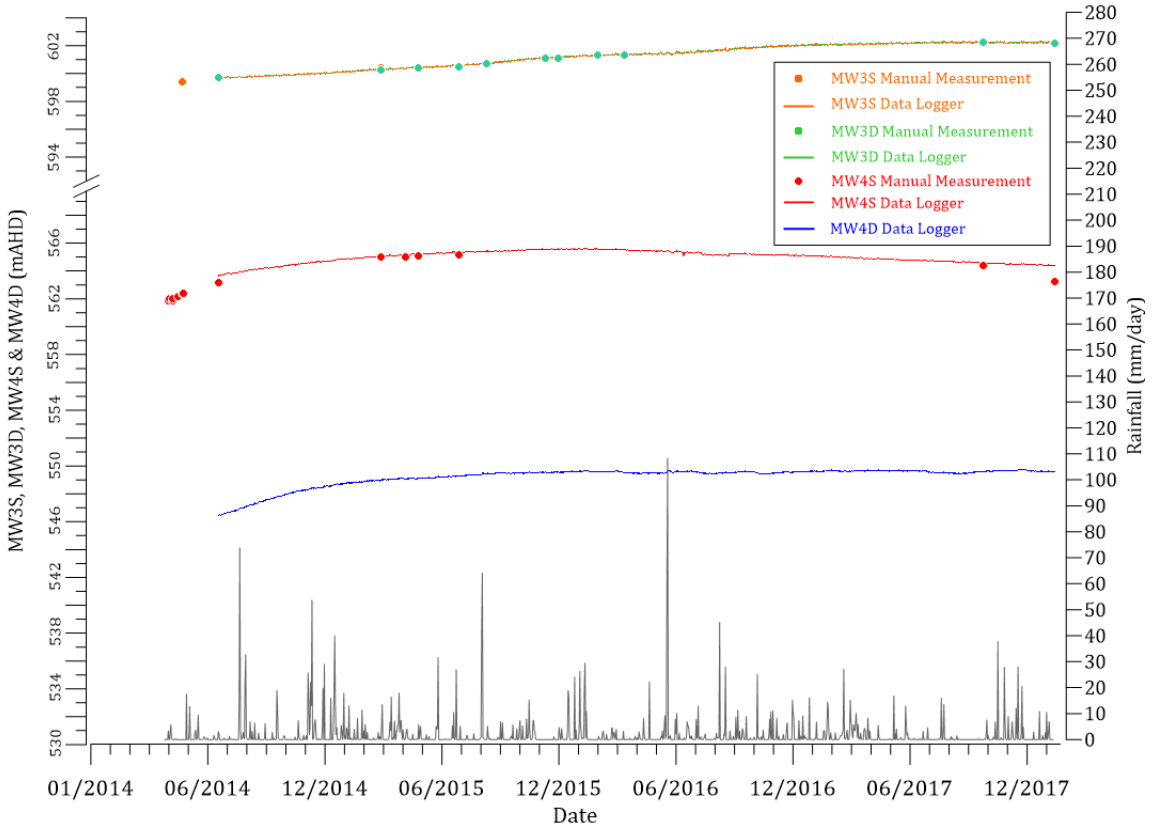
The recharge of MW2 bore during the 2015 event where water ponded at the base of the pit was entirely consistent with previous observed recharge events and shows very good hydraulic connectivity with surrounding rock, indicating secondary (fracture related) porosity.

The water levels measured in the bores adjacent the pit do not show any significant response to individual rainfall events, but have recorded a slow increase (MW3S, MW3D, and MW4D) in the water levels over the baseline monitoring period. This indicates that a slight recharge to the aquifer occurs either by slow lateral flow from surrounding areas and/or from slow vertical seepage through the overlying weathered regolith layer to the underlying saturated zone. In contrast, the hydrographs for MW4S and MW5 show an overall slight decrease in groundwater levels.

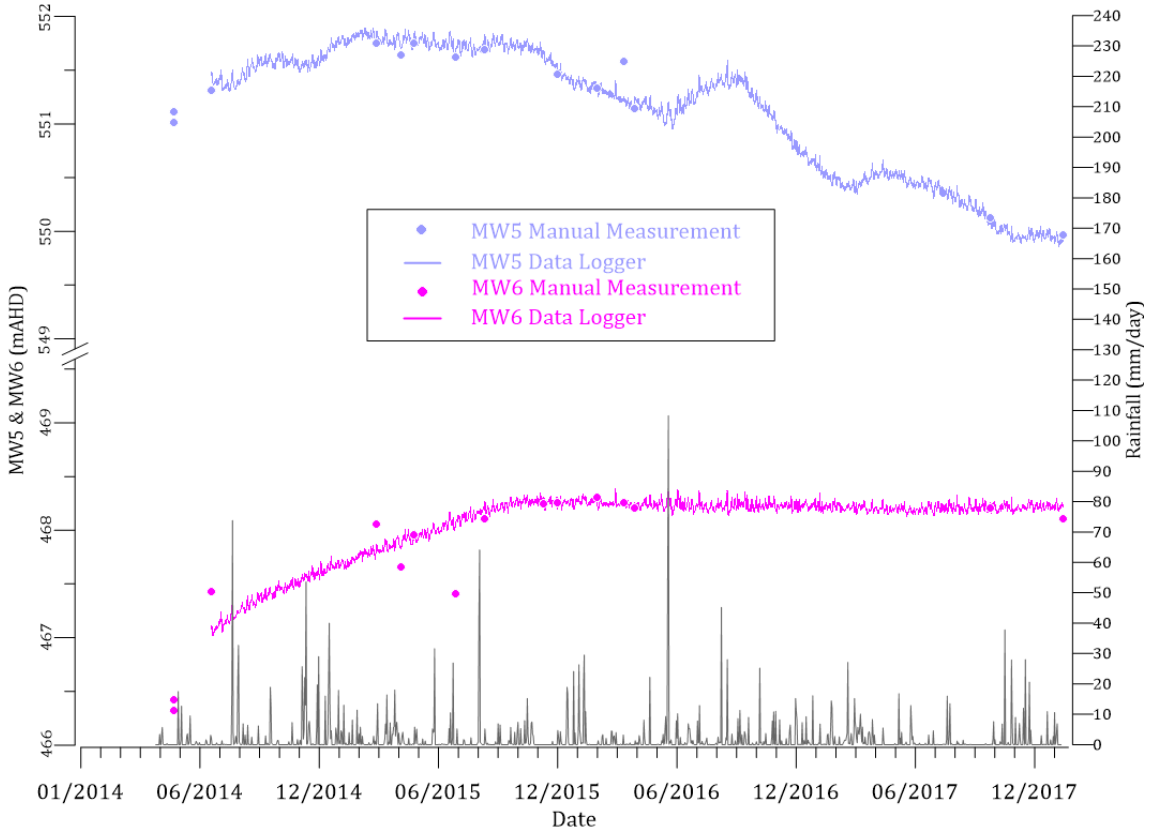
This data suggests the regolith layer acts as a temporary store of recharging rainfall, buffering the fluctuations in groundwater levels below the regolith. In contrast, within the pit area where the regolith has been removed, the fluctuations are more rapid as this buffering layer is not present.



Graph 1 Hydrographs of in-pit monitoring bore water levels (MW1-MW2). Graphs supplied by P. Dvoracek, AGE 2018.



Graph 2 Hydrograph of water levels from monitoring bores adjacent to mine (MW3-MW4)Graphs supplied by P. Dvoracek, AGE 2018



Graph 3 Hydrograph of water levels from monitoring bores adjacent to mine (MW5-MW6). Graphs supplied by P. Dvoracek, AGE.

3.4.2 Springs and hyporheic survey sites

Barbers Creek sites

Barbers Creek upper (Plate 4b) and Barbers Creek lower (Plate 4a)

Barbers Creek upper and lower sites (Figure 6) are bedrock and large boulder dominated with patches of fine sands and gravels. There is little hyporheic habitat although the large boulders and cobbles would provide significant refugia during periods of flooding. Water quality was high with little or no algae development and very low turbidity levels. The geology is a mix of slate, quartzite, phyllite with lenses of conglomerate. There are no significant/obvious springs present except for the unnamed stream that drains into Barbers Creek in the south-east corner of the area of operation and passes through a wall of gabion baskets below the edge of the plateau (see below). The most obvious biodiversity in the stream was the proliferation of snails and Ephemeroptera on rock and cobble surfaces. The visible snails were predominantly the introduced *Haitia acuta*.

Gabion Baskets stream, upper

The upper section of the unnamed stream is a spring site that passes through the gabion baskets which is fed from the historical overburden emplacements ('Eastern Batters') east of the mine pit (Figure 6). The stream was spring fed which had a significant flow. The substrate consisted of fine silts, sands and fractured rocks forming a series of pool and riffle sequences. Water quality was high with neutral pH, no algae development and very low turbidity. The aquatic fauna was surprisingly rich with Coleoptera, Ephemeroptera, and Trichoptera the dominant components.

Gabion Baskets Stream, lower, Barbers Creek (Plate 4c, 4d)

The lower section of the unnamed stream is a spring site that forms a number of small perennial pools at the base of a steep escarpment within the riparian zone of Barbers Creek (Figure 6). The pools are bedrock dominated with a thick layer of fine clay and silt and contain a number of macrophytes. Water quality is high with very low turbidity although large amounts of algae are present in the largest upstream pool at the base of the cliff. This site has a high biodiversity and is recommended as part of any ongoing monitoring program. The fauna consists predominantly of a number of snail species, Coleoptera, Ephemeroptera and Hemiptera.

Bungonia Creek sites

Red Track spring (Plate 6a, 6b)

This site is a spring site located at the base of the Red Track leading from the Bungonia Caves Reserve down to Bungonia Creek (Figure 6). The spring was sampled as a control site to compare with the springs on the north side of Bungonia Creek. The spring originates approximately halfway down the track and finishes at the base of the track where it meets Bungonia Creek. This spring was only sampled at one location at the beginning of the track in a small pool. The pool substrate is predominantly bedrock or boulders with a fine organic silt base. The dominant fauna was the small Hydrobiidae snails. In addition to this site there was evidence a short distance downstream of a number of cavernous discharge points in the rock faces of temporary springs or discharge zones coming out of the Bungonia Limestone. There was no water at these sites at the time of the survey.

Bungonia Gorge seep/Fern Community (Plate 6c, 6d)

This spring is located at the upstream side of the Bungonia Gorge (Figure 6). The spring was a seepage zone on the cliff face and was delineated by the grove of fishbone ferns and a perennial seepage. Limited biota were collected from this site.

Bungonia Creek Upper, Priority 5 (Plate 5c)

The site is a spring that forms a small stream that enters Bungonia Creek approximately 1.5 km upstream of the Main Gully confluence (Figure 6). The streambed is predominantly bedrock and large boulders with a thin silt and allochthonous material base. Water quality is high with very low turbidity, low conductivity and neutral pH. There is no algae development and moderate biodiversity of Ephemeroptera, Coleoptera and snail species.

Bungonia Creek Upper (Plate 5d) and Bungonia Ck, u/s Main Gully (Plate 5b)

These sites (Bung 6 and Bung 10)are located above the confluence Main Gully on Bungonia Creek (Figure 6). They had a small stream of water in the creek bed with bedrock and large boulder substrate. There were small areas containing lenses of fine sands. Water quality appeared high with very low turbidity and little to no algae development. The rock surfaces are usually covered in a brown diatomous brown biofilm and numerous snail species, in particular the small micromollusc family Hydrobiidae as well as mayflies Ephemeroptera.

Bungonia Creek Lower (Plate 5a)

The section of Bungonia Creek below the confluence of Main Gully (Figure 6) is limestone bedrock dominated with large to very large boulders and very limited fine sediment deposition in the form of small deposits of course sands. There is significant development of green filamentous algae in the pools and riffles indicating an increase in nutrients. Water quality is high with very low turbidity, mildly alkaline pH

and low levels of salinity. As with the sites surveyed upstream the fauna is dominated by the Gastropods, in particular the Hydrobiidae.

Main Gully sites

Main Gully, spring head in upper section (Plate 7c, 7d)

Main Gully originates NW of the Western Overburden Emplacement and flows past the southern end of the South Pit into Bungonia Creek. A number of small springs feed into Main Gully below the edge of the plateau emanating from the Bungonia Limestone Unit (Figure 6). The spring discharge zone is identified by the presence of fern and macrophyte communities. The water quality is high with very low turbidity, neutral pH and low electrical conductivity. The seeps contain a high biodiversity of essentially riverine macroinvertebrates including a number of Trichoptera families, Ephemeroptera, Odonata and Gastropods.

Main Gully, Bungonia Ck, (Plate 7b)

Main Gully drains the area of operation and terminates in Bungonia Creek downstream of the Bungonia slot canyon (Figure 6). The stream is perennial and fed by a number of springs emanating from the Bungonia Limestone Unit and originates NW of the Western Overburden Emplacement. Upstream of the confluence of Main Gully and Bungonia Creek the Main Gully stream bed is composed of yellow white clay and cobbles. The substrate is covered in a thin, calcareous layer as is the allochthonous material and even the aquatic snail shells. This layer or floc also extends into Bungonia Creek. Water quality appears high with very low turbidity, mildly alkaline pH, low electrical conductivity and no apparent algae development although the stream is heavily shaded by native riparian vegetation. The biodiversity in this section is depauperate with the dominant fauna being the small micromollusc of the Family Hydrobiidae although numbers observed were far less than in other spring locations.

Riparian pool d/s Main Gully, Bungonia Ck (Plate 7a)

The terminal section of Main Gully before it enters Bungonia Creek enters a boulder lined riparian zone where it spreads out into a series of channels and seeps that form perennial soaks and small wetlands. These soaks contain a number of small macrophyte species and a small diversity of aquatic invertebrates. Water quality is high with very low turbidity and no algae formation.

4. Field survey and assessment methods

The stygofauna and groundwater dependent ecosystem impact assessment methods were structured to specifically reflect current relevant legislation, specific guidelines; and to address requirements from the SEARs. These methods include monitoring design and impact assessment criteria. The primary objectives of the study are to:

- Determine whether any substantial stygofauna (and targeted hyporheic) communities exist within the aquifers associated with the area of proposed development as well as in both the upstream and downstream of the likely area of influence of any groundwater impact.
- Determination of species ranges if stygofauna exist, identifying conservation values such as short range endemics.
- Determine the factors influencing stygofauna distribution such as water quality (DO, pH, conductivity, temperature), aquifer structure, and connectivity to rivers.
- Recommend any future work programs to potentially investigate and/or monitor this ecosystem over time.

4.1 Field sampling

In order to sample a habitat effectively it is often necessary to use a combination of techniques to comprehensively collect all possible biota as the stygofaunal/ groundwater dependent community occupies a range of habitat niches. For routine surveying or monitoring of bores and wells a submersible pump or hand pump, bailer (1) and or plankton nets (Mathieu et al. 1991) are the preferred devices. Whereas for hyporheic zones and spring sites hand pumps/syringe devices, hand nets and artificial substrates are preferred. The sampling techniques used for the Marulan stygofauna and groundwater dependent fauna surveys are described below.

4.1.1 Phreatic/hypogean zone

The phreatic zone is the subsurface area within an aquifer where voids in the rock are completely filled with water. This is occupied by phreatobites. Phreatobites have adapted to tolerate suboxic conditions (dissolved oxygen concentration (DO) less than 3.0 milligrams per litre) or limited food supply (Malard and Hervant 1999; Hervant and Renault 200; Datry et al. 2005) and even hypoxia (DO less than 0.01milligrams per litre) (Thomlinson & Boulton, 2008). Dissolved oxygen (DO) concentrations below 1.0 to 0.5 mg/l are the critical threshold for most groundwater fauna (metazoans) (Hahn 2006). The stygofauna community was sampled using two standardised methods and one non-standard method.

The first technique is the Phreatobiology Net. This is the standard technique that has been used successfully overseas and in Australia (Bou, 1974). The method used conforms to WA guideline [2003 & 2007] requirements. This method involves using a weighted long haul or plankton net with a 150 μm mesh. Sampling consisted of dropping the net down to the bottom of the bore and taking at least three consecutive hauls from the entire water column at each bore. Upon removal from the bore the net is washed of sediment and animals and the contents of the sampling jar (the weighted container at the bottom of the net) are decanted through a 150 μm mesh sieve. The contents of the sieve are then transferred to a labelled sample jar and preserved with 100% ethanol.

The second method is the use of a groundwater bailer. A bailer is typically used by hydrogeologists to take water samples from bores for water quality/water chemistry analysis. The bailer used for this study is 1 meter long by 40mm clear plastic tube with a running ball valve at the bottom. The advantage of using a bailer is twofold. The main reason for using a bailer is that it is able to sample the bottom sediment of a

bore that cannot be sampled by a haul net and therefore enables the collection of cryptic invertebrates that do not inhabit the water column or sides of the bore. The second advantage is that in shallow bores down to 5 meters in sediments with low transitivity porosity) a bailer is able to sample the entire contents of a bore and thereby confidently collect all animals within the bore. The contents of the bailer are emptied into a cleaned bucket from which the water is then decanted through a 150 μm mesh sieve. The contents of the sieve are transferred to a labelled sample jar and preserved with 100% ethanol. Following sampling and preservation of the sample and prior to the next sampling all equipment including the bailer, net and sieves must be rinsed clean with clean water via a spray bottle to remove any sediment and animals that may have remained attached to the sampling devices. This is to reduce the possibility of cross contamination of organisms (stygofauna or bacteria) or pollutants from one aquifer or bore to another.

The third (non-standard) method was used on one bore that had a pump (works) attached which did not allow the use of the previous two methods. This involved pumping water through the pump to the surface for approximately ten minutes, which removed an estimated two bore volumes. This was drained through a 150µl sieve. The resulting sediment was washed into a container and preserved in 100% ethanol. The pump and pipe work was not removed from the bore and therefore the entire water column was not sampled using either the bailer or phreatobiology net as in the other two sites.

4.1.2 The spring or groundwater discharge zones.

Springs represent a window into the groundwater environments and faunal communities. They are the ecotones between groundwater and surface water ecosystems, and can contain mixed community assemblages of organisms from the groundwater (phreatic) zone, the epigean (surface water) zone and fauna that is specifically adapted to springs (crenobiont taxa) (PASCALIS 2003). There are many types of springs from the commonly perceived point source discharge zone with free flowing water out of a hole to extensive slow seepage zones that can be gravity fed spring water to artesian pressure fed springs. Flow can be permanent or intermittent. (PASCALIS 2003). Springs may be either fed by groundwater from unconsolidated sediments or through fractures or faults in bedrock or dissolution voids (karstic systems). In order to adequately sample springs it is necessary to use a combination of techniques due to the strong within and between site community heterogeneity. The suggested techniques include:

- Sampling the benthic layer around the spring using a standard aquatic macroinvertebrate net including the bed sediment.
- Hand collecting from any allochthonous material such as woody debris and collecting and washing leaf litter and aquatic vegetation such as mosses.

The sampling protocol will be to take the sample of substrate that has been collected using the above methods, fixing it in 100% ethanol in the field and returned to the laboratory for sorting and identification under a stereomicroscope.

Spring sampling sites

In order to confidently collect as complete range of spring fauna as possible a further suggestion is to sample springs along the length of a watercourse in order to assess any altitudinal cross section of possible faunal communities and to use these springs as altitudinal gauges of possible drawdown during pumping i.e. if the pumping commences and the top springs stop flowing then there is an impact from the pumping that will impact on the riverine ecosystems. The theory of this suggestion is that if the stratigraphy of the bedrock is lamella (i.e. layered sandstone and shale sedimentary sequences) and horizontal (or gently inclined) and the river is incising the bedrock at a greater angle than that of the bedrock strata (i.e. down through the sequence) then the groundwater fauna in the springs will be representatives from different layers/sequences or communities within the aquifer.

Therefore, a survey of spring faunas was conducted to determine 1) the communities associated with the springs 2) the heterogeneity or similarity of the communities and possible zoning downstream that may be used as a monitoring tool in later programs. After examination of the area, 10 sites have been selected for sampling.

4.1.3 Hyporheic zone.

The Hyporheic Zone is the ecotone zone below and within the porous sand and gravel substrate of a riverbed. The fauna that inhabits this ecotone is thus termed the hyporheos. The hyporheos represents a diverse range of organisms from surface macroinvertebrates to groundwater Crustacea to Oligochaeta depending on the depth and origin of the water parameters i.e. whether the water is groundwater or surface water dominated.

The hyporheic zone is a highly variable and fluid ecotone that is controlled by the river flow rates, groundwater baseflow, whether the river is a gaining or losing system, sediment type, sediment porosity and water chemistry/quality, habitat connectivity with other habitats and the longevity of the habitat. Two to four collections were conducted at each riffle zone depending on habitat availability across the bottom of the riffle zone. This area has been shown to contain the highest concentration of groundwater fauna (Boulton 2003, 2004) as it represents the upwelling zone of a river bed as opposed to the top of a riffle which is the downwelling zone.

Each hyporheic sample is taken using the Chappuis Method whereby a hole is dug in the side of the bank or sandbar and allowed to fill with water. When there is sufficient water it is decanted out through a 150 µm mesh sieve. The contents of the sieve are transferred to a labelled sample jar and preserved with 100% ethanol. Following sampling and preservation of the sample and prior to the next sampling all equipment including the bailer, net and sieves must be rinsed clean with clean water via a spray bottle to remove any sediment and animals that may have remained attached to the sampling devices. This is to reduce the possibility of cross contamination of organisms (stygofauna or bacteria) or pollutants from one aquifer or bore to another.

The principle of the method is to create a cone of depression in order to stimulate flow within the substrate which disturbs the sediment and maintains an interstitial flow that is sufficient to dislodge subsurface invertebrates (PASCALIS 2003).

4.2 Laboratory methodology

4.2.4 Identification

All samples are preserved in the field with 100% ethanol and returned to the laboratory where each sample is sorted under a stereomicroscope and stored in 100% alcohol. All specimens are identified to the lowest possible taxonomic level, generally to genus, where possible. Specimens are identified under a compound microscope using a combination of current taxonomic works and keys such as Williams (1981) and the taxonomic identification series (Serov 2002) produced by the Murray Darling Freshwater Research Centre as well as the authors taxonomic expertise and experience.

4.2.5 Physico-chemical data

Physical and chemical parameter data is supplied by Boral Cement Ltd from their regular water quality monitoring program. Water samples were collected in the field and analyzed by a NATA accredited Laboratory. In addition each surface stream and spring site was also point sampled insitu for water quality parameters (temperature, dissolved oxygen, conductivity and ph) using a calibrated multi-probe water quality meter during the second round of sampling. Bore surface water level (SWL) and depth data was

collected in the field during the initial survey and water level (SWL) and water quality data was collected at each site during the second round of sampling. The following parameters were collected:

- temperature (°C)
- dissolved oxygen (mg/l)
- conductivity (µS/cm)
- pH (pH units)

4.3 Data analysis

4.3.6 Impact assessment methodology

Mining developments, in which stygofauna are considered to be a relevant environmental factor need to be assessed with respect to the extent of the proposed groundwater drawdown zone and the likely impacts on groundwater quality and quantity. Both of these activities, over time, may impact stygofauna habitat. While stygofauna are able to tolerate natural fluctuations in water parameters such as water level, electrical conductivity, and temperature, it has been demonstrated both in Australia and overseas that stygofaunal species are detrimentally impacted by changes outside the natural range of water level, quality, and water chemistry. Changes such as rapid drawdown and pollution plumes can have impacts on the community composition, biodiversity and overall sustainability of the community.

Groundwater communities also require links to the surface environment to provide organic matter and oxygen. If that linkage is broken or disrupted, the stygofauna community in the area affected could decline over time. A high degree of endemism can occur in aquifers, even within the same system or between adjacent systems. However, providing there is sufficient hydrological connectivity within and along the flow path of the aquifer, and the physico-chemical conditions are suitable and remain stable, the distribution of species will not be restricted to small parts of an aquifer.

The ecological valuation and risk assessment process used to assess the risk and potential impacts of the proposed development for the identified GDEs is the "Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov *et al*, 2012)". This methodology was developed by the NSW Office of Water to:

- Assist agency staff support the requirements of the *Water Management Act 2000.*
- Provide methods to identify and value groundwater dependent ecosystems (GDEs) to assist reporting against the state-wide Target for Groundwater that:

'By 2015 there is an improvement in the ability of groundwater systems to support groundwater dependent ecosystems and designated beneficial uses', NSW Natural Resources Monitoring, Evaluation and Reporting Strategy 2010–2015.

- Provide a risk assessment framework for GDEs for the National Water Commission Project Coastal Groundwater Quality and Groundwater Dependent Ecosystems (GDE).
- The conceptual framework allows potential and actual impacts of proposed activities on GDEs to be assessed in accordance with the WM Act (Chapter 1.3 of the Act) and other relevant legislation. (Serov *et al* 2012).

In summary, GDEs are first identified and classified and the level of dependency on groundwater for individual GDEs inferred. Once the current ecological value of individual aquifers has been determined, the ecological value of the GDEs associated with that aquifer must then be assessed. The individual value of each GDE within the aquifer can also be assessed as a stand-alone unit. Following an assessment of the aquifer and associated GDE's current value, the potential future impact of a proposed activity on the

aquifer and associated GDEs must then be determined. The magnitude of risk from that activity to the ecological value of the GDE(s) and aquifer is then determined. Finally, the Risk Matrix is applied to determine the most appropriate management response for a given environmental value.

4.3.7 Aquifer risk assessment

The aquifer risk assessment considered the risk that the impacts of open cut mining and catchment alteration places on the groundwater source and its dependent groundwater dependent ecosystems (GDEs). In this process the ecological value of a GDE is assessed in association with the risk that a groundwater source and associated GDEs would be under from these impacts, which is turn dictates the level of management action required. That is, if the aquifer has a high conservation value or a number of high priority GDEs and therefore is of high ecological value, its value has a high risk of being altered by the Project. Conversely if a groundwater source/GDE has low ecological value then there is a low risk of altering its value by the Project. This assessment was completed for each groundwater source and identifies risks to three main aquifer assets according to several attributes as follows:

- Ecological Assets
    - Risk of a change in groundwater levels/pressures on GDEs,
    - Risk of a change in the timing of groundwater level fluctuations on GDEs,
    - Risk of changing base flow conditions on GDEs.
    - Risk of changing aquifer flow paths.
- Water Quality Assets
    - Risk of changing the chemical conditions of the water source,
    - Risk on the water source by a change in the freshwater/salt water interface, and
    - Likelihood of a change in beneficial use of the water source.
- Aquifer Integrity Assets
    - Risk of substrate compaction.

The ecological valuation and risk assessment process is outlined in the flow diagram below. The numbers below each action refer to the section within the Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov et al. 2012).

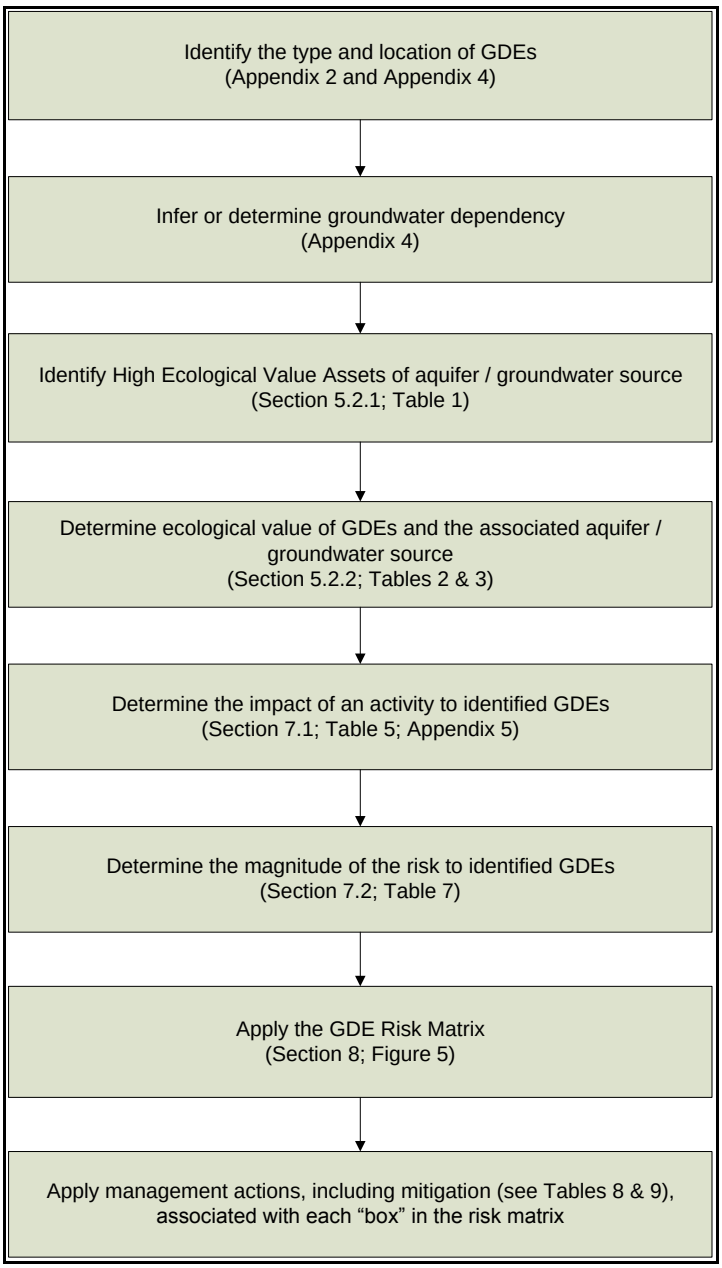


Diagram 1 Ecological valuation and risk assessment process. Serov et al. 2012

4.3.8 Comparative indices (Number of Taxa)

Number of Taxa. All macroinvertebrate taxa are separated and counted. The number of families present generally decreases with decreasing water quality and is used as a comparative measure of community change over time.

EPT Richness. The EPT (Ephemeroptera, Plecoptera and Trichoptera) score is based on the observation that the majority of these taxa are particularly pollution sensitive (Lenat 1988).

Silt Tolerant Species. The silt tolerant taxa values are best examined against the total number of taxa sampled from each site i.e. the silt tolerant ratio, as the variation of values is significantly reduced compared with examining the number of taxa alone. This index is used as a comparative measure of community changes over time.

4.4 Assumptions and limitations

This report is a preliminary baseline assessment only at this stage, which focuses solely on the Study Area. Groundwater bore and spring sites sampled are assumed to be representative of the groundwater and stream ecosystems present across the area of consideration, temporally and spatially. While every effort was given to maximize the representativeness of the system it does not cover the full extent of the bores and streams in the Study Area. Temporal variations between autumn and spring also cannot be assessed at this stage as there has been no seasonal replication.

5. Field survey results

The stygofauna and spring/hyporheic baseline survey program included two rounds of survey in order to firstly cover enough sites to identify the presence of stygofauna within the Study Area and secondly to repeat a number of sites to confirm and expand the findings of the first round. The first round of surveys commenced in November 2014 and the second in March 2015. The surveys included 23 sites separated into 11 bores and 10 spring sites and two hyporheic sites. The sites were selected to cover as broad a coverage of the Study Area as possible, with sites located both within and outside (controls) the potential area of impact, as well the broadest range of habitat types. The bore types range from shallow observation piezometers accessing groundwater situated in the Bungonia Limestone aquifers to deeper bores that sampled the weathered and fractured Granites..

5.1 Environmental physico-chemical conditions

5.1.1 Field water quality parameters

All physico-chemical parameters were remarkably consistent over the length of the Study Area (Table 5) and were comparable with the previous surveys (RPS 2014) and long term monitoring conducted by International Environmental Consultants (IEC) and reported on in Advisian (2018). The river sites water chemistry was well within the minimum requirements as set out by the ANZECC and ARMCANZ guidelines (2000). At the time of sampling Bungonia Creek and Barbers creek were flowing well and at normal levels. The two key water quality parameters of pH, and electrical conductivity (EC) were measured during the surveys using a hand held multi-parameter water quality meter and the results presented below in Table 5 and Graph 4-6.

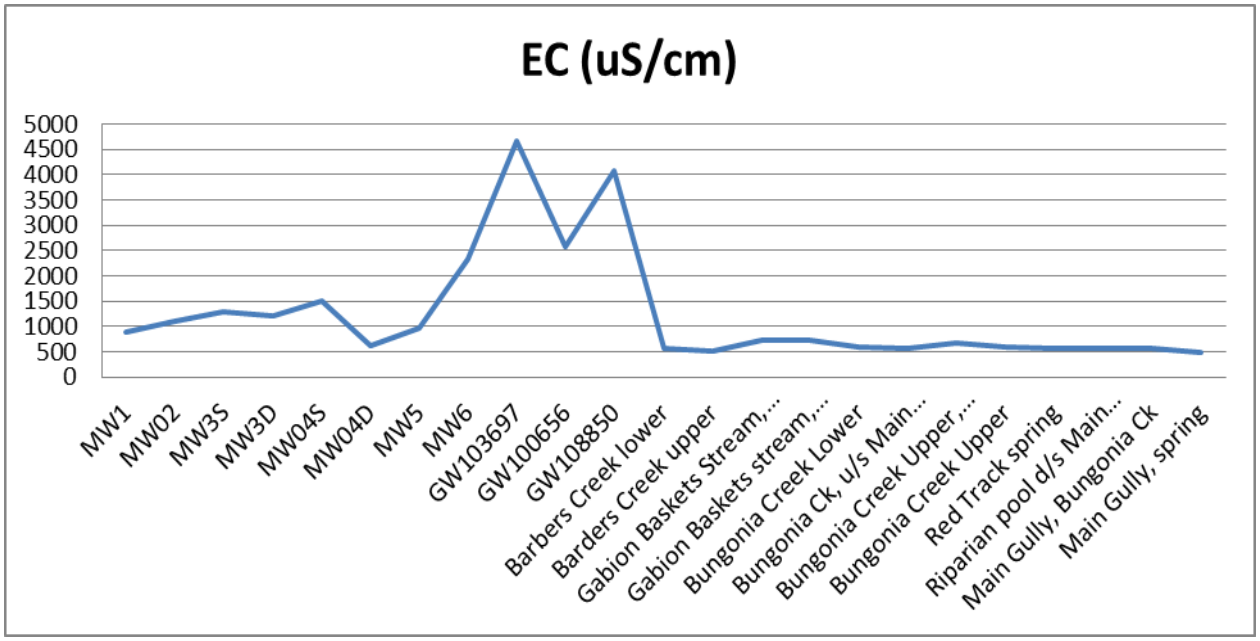
Table 5 Physico-chemical data from each site collected in March, 2015. ND = Not Determined

Location	Date	pH	EC (uS/cm)	Alkalinity
MW1	12/03/2015	6.91	893	280
MW02	12/03/2015	7.66	1096	117
MW3S	12/03/2015	7.03	1283	262
MW3D	12/03/2015	7.15	1214	418
MW04S	12/03/2015	6.87	1495	281
MW04D	12/03/2015	7.66	607	464
MW5	12/03/2015	10.6	973	70
MW6	11/11/2014	7.54	2330	768
PR8 Residential receiver	26/03/2015	6.98	4667	ND
Boral owned rural residential property (B5)	26/03/2015	7.21	2568	ND
C3 Commercial receiver	26/03/2015	7.2	4075	ND
Barbers Creek lower	26/03/2015	8.13	553	145
Barbers Creek upper	26/03/2015	8.04	509	125
Gabion Baskets Stream, lower, Barbers Creek	26/03/2015	7.95	721	ND
Gabion Baskets stream, upper	26/03/2015	7.87	734	ND
Bungonia Creek Lower	13/03/2015	7.55	581	146

Bungonia Ck, u/s Main Gully	13/03/2015	7.54	567	ND
Bungonia Creek Upper, Priority 5	13/03/2015	6.95	682	ND
Bungonia Creek Upper	26/02/2015	7.78	589	168
Red Track spring	13/03/2015	7.86	572	ND
Riparian pool d/s Main Gully, Bungonia Ck	13/03/2015	7.91	568	ND
Main Gully, Bungonia Ck,	13/03/2015	8.07	567	169
Main Gully, spring head in upper section	12/03/2015	7.89	489	ND

5.1.2 Conductivity

The field EC measurements are comparable with previous measurements by RPS (2014) , as well as longer term monitoring by IEC and reported on in AGE (2018) and Advisian (2018). The field measurement demonstrated fresh to brackish groundwater with an EC range of 489-734µS/cm for the river and spring sites and 607-4667µS/cm for the bore sites. Graph 4 illustrates the variations in conductivity recorded as part of this study program for all sites. The river and spring sites below the area of operations were almost identical during this period demonstrating there were only minor differences in salt loads below the influence of the mining operations during 2014-15. The river sites in Bungonia and Barbers Creeks recorded consistently low values. The low EC values in rivers and springs sites in the south east area of the Study Area are indicative of high connectivity with the surface and short residence times for the water within the lithology's, particularly the fractured limestone. The high EC values demonstrated to the west of the study area are indicative of reduced connectivity with the surface and a longer residence time within the strata, in particular the fractured/weathered western granodiorite.

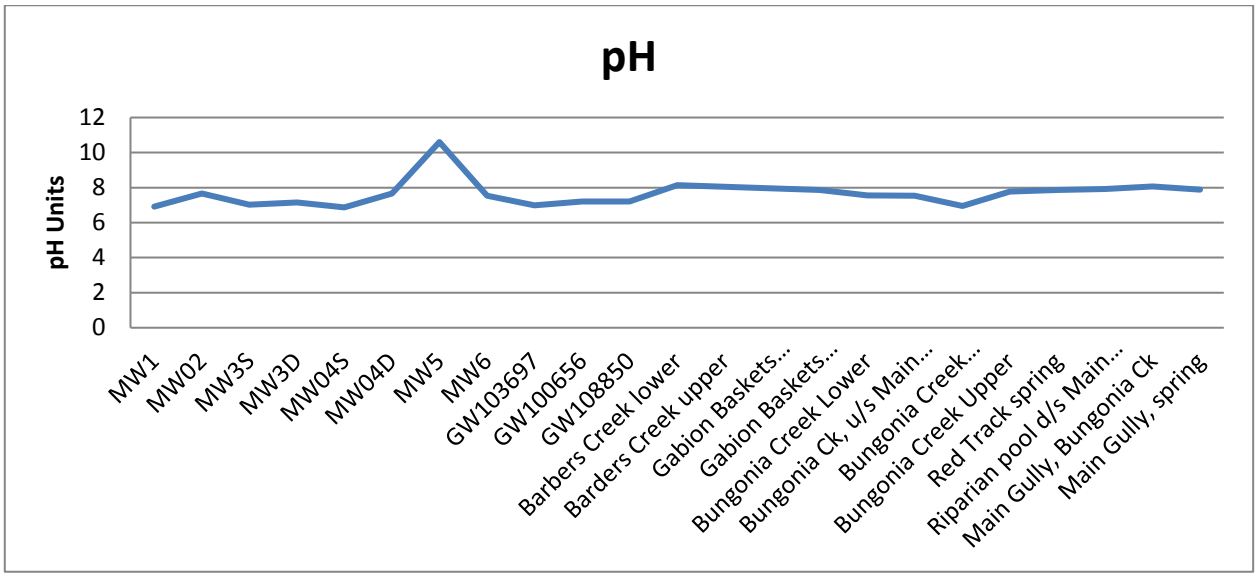


Graph 4 Variations in conductivity at each of the sites examined in 2015

5.1.3 pH

With the exception of MW5, the pH range is shown to be marginally alkaline with a pH range of 7.94 – 8.9 and was consistent with long term monitoring conducted by AGE (2018). The pH (Graph 5) has remained very consistent over the period of the study. There has been very little fluctuation of pH throughout the

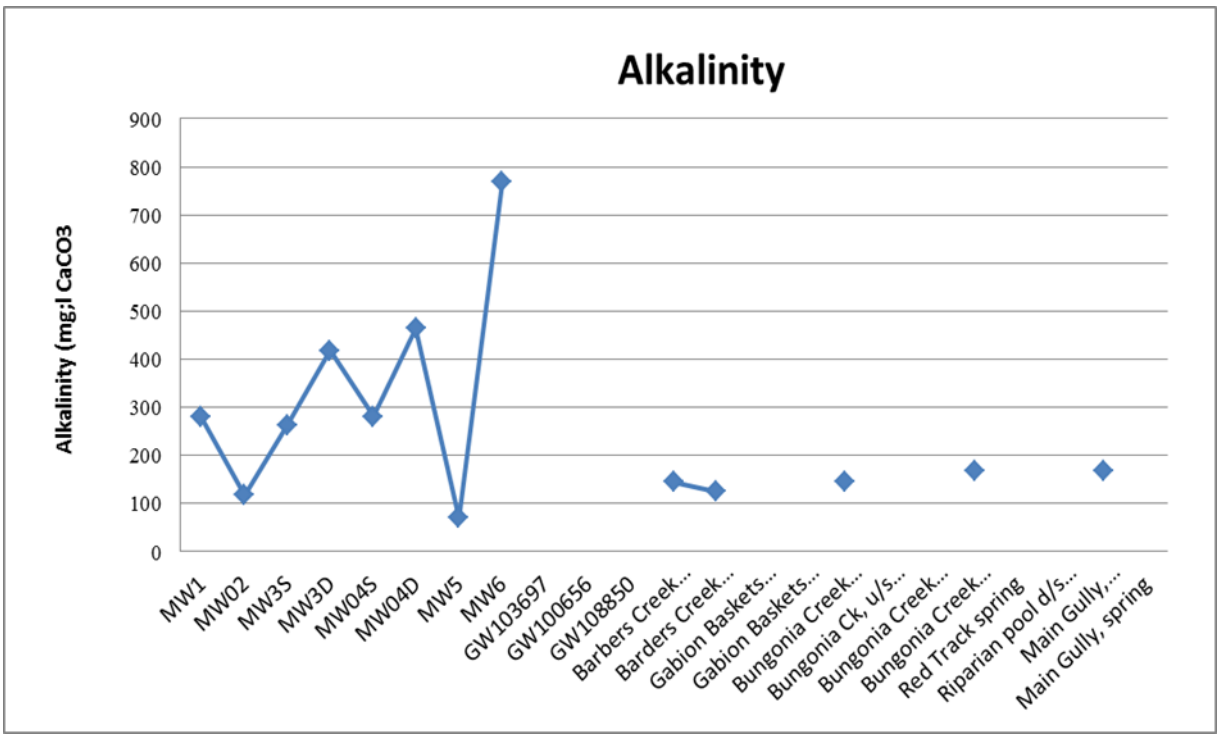
system over time and it is therefore not considered to have any major impact on stream biodiversity. The fluctuations recorded in pH are attributed to rainfall where the pH has shifted from weakly alkaline to slightly acidic levels at all sites. The highest value of 8.13 was recorded at Lower Barbers Creek and the lowest value of 6.87 was at Bore MW04S. The high pH level (10.6) observed at MW5 is possibly a reflection of weathering and prior baking processes at the contact between the granite and limestone. The rivers and springs recorded slightly elevated alkaline values compared with the groundwater with the rivers and springs recording a range from 8.13 to 7.54 whereas the groundwater ranged from 6.87 to 7.66. While all the springs and seeps are groundwater fed the pH is generally indicative of the groundwater source with the high values associated with the limestone units and the lower values indicative of the igneous units such as the granites. This is illustrated by comparing the springs in Main Gully which recorded 8 compared with the spring site Bungonia priority 5 which recorded a low of 6.95 indicating that this stream is substantially baseflow fed by the western granodiorites.



Graph 5 Variations in pH at each of the sites examined in 2015

5.1.4 Alkalinity

Minimal data was recorded for alkalinity. Alkalinity is the water's capacity to resist changes in pH that would make the water more acidic. This capacity is commonly known as “buffering capacity” and partly explains the consistent pH values recorded in the river sites. Alkalinity of natural water is determined by the soil and bedrock through which it passes. In streams, the fluctuations are related to the relative proportions of surface water and rainfall mixing where the alkalinity levels show an inverse relationship to river flow or rainfall events. Therefore, the fluctuations illustrated in Graph 6 show alkalinity increasing in the bore sites with lower flow rates and contact with igneous geologies and recording low values for sites with high, consistent flow rates and contact with limestone lithology's. The consistent semi neutral pH levels evident in previous graphs demonstrate that alkalinity levels have been sufficient to buffer the rivers from any significant changes across the sites.



Graph 6 Variations in alkalinity at each of the sites examined in 2015

5.2 Results - ecological response

5.2.1 Macroinvertebrate data

A total of 53 macroinvertebrate taxa representing 42 families were recorded from the 23 sites. The results of the survey and the indices values are summarised in Table 6. The bore sites within the area of operation contained no stygofauna. The only bore that registered fauna was Bore GW103697 which is located outside the area of operations and potential impacts. The other bore that registered fauna contained two species of soil invertebrate that are regarded as incidental only. The remaining 50 species were associated with the spring and riverine habitats in the Bungonia and Barbers Creek valleys to the south and east of the Marulan Limestone Mine area of operation, respectively.

Table 6 Macroinvertebrate indices results for 2014- 2015.

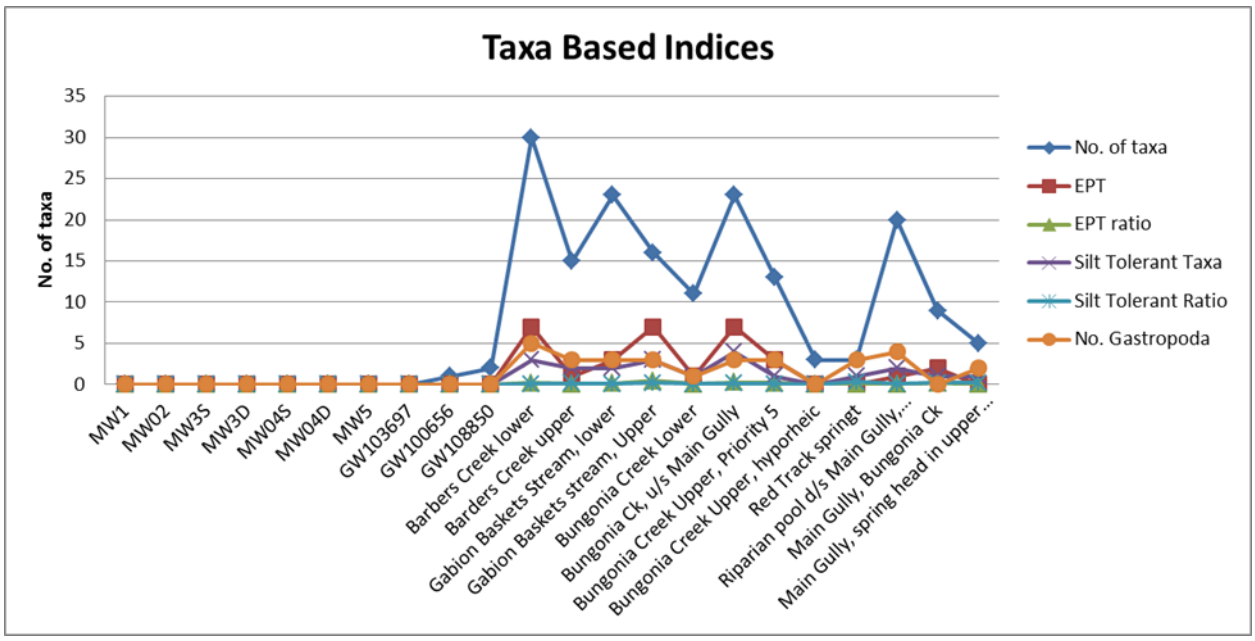
Locality	No. of taxa	EPT	EPT ratio	Silt Tolerant Taxa	Silt Tolerant Ratio	No. Gastropoda
MW1	0	0	0	0	0	0
MW02	0	0	0	0	0	0
MW3S	0	0	0	0	0	0
MW3D	0	0	0	0	0	0
MW04S	0	0	0	0	0	0
MW04D	0	0	0	0	0	0
MW5	0	0	0	0	0	0
MW06	No sample	0	0	0	0	0
GW103697	0	0	0	0	0	0
GW100656	1	0	0	0	0	0

GW108850	2	0	0	0	0	0
Barbers Creek lower	30	7	0.23	3	0.1	5
Barbers Creek upper	15	1	0.07	2	0.13	3
Gabion Baskets Stream, lower	23	3	0.13	2	0.09	3
Gabion Baskets stream, Upper	16	7	0.44	3	0.19	3
Bungonia Creek Lower	11	1	0.09	1	0.09	1
Bungonia Ck, u/s Main Gully	23	7	0.3	4	0.17	3
Bungonia Creek Upper, Priority 5	13	3	0.23	1	0.08	3
Bungonia Creek Upper, hyporheic	3	0	0	0	0	0
Red Track spring	3	0	0	1	0.33	3
Riparian pool d/s Main Gully, Bungonia Ck	20	1	0.05	2	0.1	4
Main Gully, Bungonia Ck	9	2	0.22	1	0.22	0
Main Gully, spring head in upper section	5	0	0	1	0.2	2

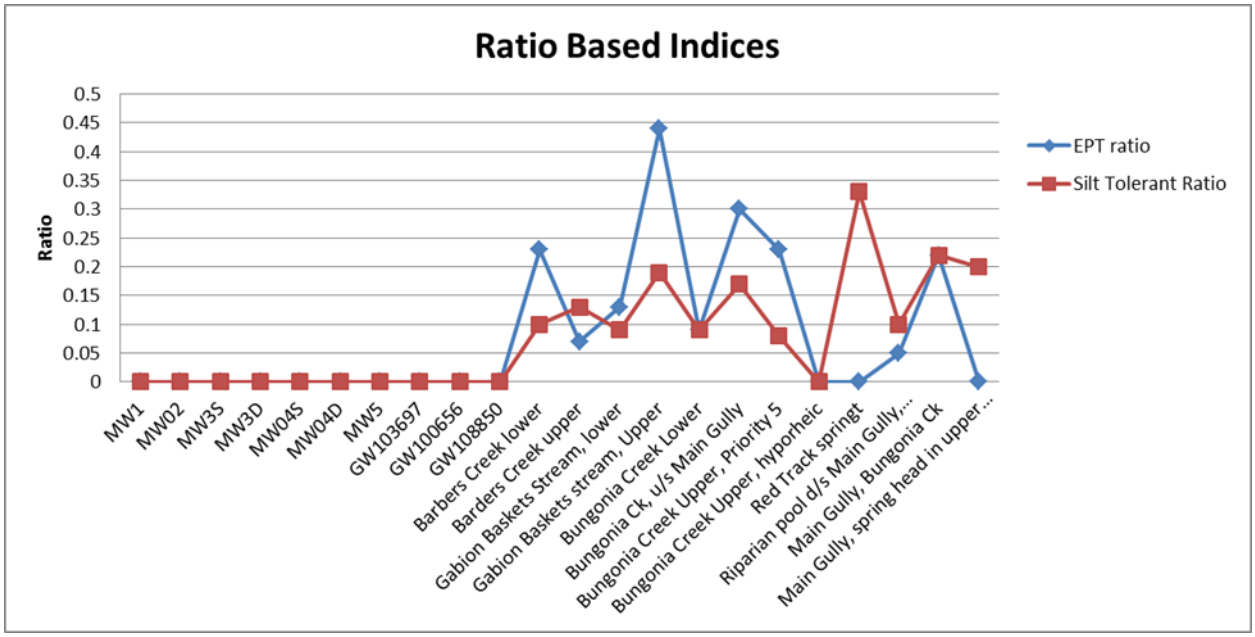
The aquatic macroinvertebrate taxa recorded are listed in Appendix 1. The fauna recorded represents a community consisting generally of species tolerant of moderate levels of disturbance. At all sites, the communities were dominated by predator feeding groups such as Coleoptera, Hemiptera and the detritivore 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 both the river systems and the springs were particularly notable as they indicate the abundance of habitat, good water quality and a lack of fine sediments. Overall there is a greater biodiversity of aquatic fauna within the lower sections of both streams and those sites associated with springs. The biodiversity is comparable between the two river systems. Springs and seepage zones also prove to be aquatic biodiversity hotspots in areas some distance from the main rivers.

A notable absence within the fauna was the Plecoptera (Stoneflies) although these were reported from the riffle habitats in the rivers (M. Russell, pers com.). This group of EPT taxa are particularly sensitive to habitat disturbance and changes in flow conditions. The mayfly families Leptophlebiidae were recorded from both river sites although were reduced in number or absent from Main Gully. The Baetidae (Ephemeroptera) were only present in Bungonia Creek upstream of the confluence with Main Gully and in the upper site of the gabion baskets stream. The family Caenidae was only recorded in the lower section of Barbers Creek. These groups are allocated the highest rating (9) in the SIGNAL index, as they are highly sensitive to pollution/disturbance.

The biodiversity values (i.e. number of taxa) are illustrated in Graph 7. The total numbers of taxa have shown comparable values for the lower riverine and springs sites and a reduced number associated with the Main Gully sites. The highest biodiversity was recorded at the Lower Barbers Creek site, the lower spring sites on the gabion basket spring and upstream of Main Gully on Bungonia Creek although both streams were comparable. The highest value for the EPT ratio (Graph 8) was recorded at the upper site on the Gabion Baskets stream and again upstream of Main Gully on Bungonia Creek.



Graph 7 Variations in taxa based indices at each of the sites examined in 2014-15



Graph 8 Variations in ratio based indices at each of the sites examined in 2014-15

5.2.2 Community structure and other observations

The community structure observed during this survey in each of the springs is similar across the riverine ad springs sites. The commonly recorded taxa belong to the following groups: the worm family Enchytraeidae, the snails *Haitia acuta* and Hydrobiidae, beetle families Scirtidae, Dytiscidae, Diptera families Chironomidae and Tipulida, the Ephemeroptera family, Leptophlebiidae, the Trichoptera family Helicopsychidae and Hydroptilidae and Cyclopidae and flatworm family Dugesiidae. The chironomid subfamilies Chironominae and Tanypodinae form the dominant component of all the Chironomidae recorded in the still or low velocity water sites whereas the Orthocladinae, Tanypodinae and the Blackfly (Simuliidae) dominated the rivers sites where slightly higher velocities produced minimal silt build up and recorded higher water quality. Under low flow conditions there is normally an increase in dipteran groups due to the low, stable flow conditions and an increase in the concentration of nutrients. This is also normally reflected in an

increase in green filamentous algae and diatom growth, particularly within the riffle sections. This was observed to a minor degree at the sites downstream of Main Gully on Bungonia Creek.

It is interesting to note that the Chironomidae was spatially separated with the subfamily Tanypodinae occurring in most riverine and spring locations except for main Gully which was occupied by the subfamily Chironominae. This is interesting as the Chironominae has a higher tolerance to silt habitats. Most of these taxa are indicators of still water environments in the case of the beetle, Diptera and Trichoptera groups.

Other species that are noticeably present in this round of survey include the Trichoptera Families Helicopsychidae, and Hydroptilidae, and the Dragon fly family Megapodagrionidae. These groups are a normal component of the riffle habitat during periods of higher flows, however in this study were found in very small spring locations at high elevations away from the main river channels.

Some notably sensitive taxa were found as usual in most or all river sites. These are associated with pristine or near pristine systems. These include: the Midge subfamily Orthocladinae; the aquatic beetle families Elmidae (Site M1-M5); the ephemeropteran family Leptophlebiidae; the trichopteran family's Leptoceridae, Helicopsychidae, and Calamoceratidae; as well as the hydrobiid snail *Austropyrgus bungoniensis*. Most of the EPT and shredder taxa register 8 - 10 on the SIGNAL index, as they are highly sensitive to pollution. The consistently high number of taxa within these groups, which commonly account for between 10-44% of the community composition, indicates that Barbers Creek, Bungonia Creek and the springs which originate from the Mine side of the streams are in good condition.

5.2.3 Ecotone distribution

The epigean environment is totally restricted to the bounds of the river and is characterised by: high dissolved oxygen levels; a diurnal pattern of light and dark; highly variable water quality: high levels of energy in the form of both allochthonous and autochthonous input; and taxa that do not enter far into the hyporheic zone due to minimal adaptations to this habitat. The hyporheic environment is more broadly distributed under and adjacent to the river but its area is dependent on the substrate porosity and the direction of water flow i.e. whether the water is flowing from the aquifer into the river (a gaining stream) and from the river to the aquifer (a losing stream). The hyporheic environment is characterised by: relatively high DO; permanent darkness; variable water quality; and relatively high energy levels from allochthonous input and to a much smaller extent, autochthonous input, from the surface waters. The organisms also have specialist adaptations for living in permanently dark, spatially restrictive environments. The depauperate nature of the biodiversity found in the hyporheic sites is due to the fine grain nature of the substrate. Hyporheic sampling was significantly restricted in both stream systems due the very large boulders and bedrock that made up a majority of stream bed. The small number of taxa and numbers of specimens collected at each river site indicates a depauperate fauna within the alluvium but a strong level of connectivity between the limestone aquifers and the river.

The largest but apparently most depauperate environment associated with the Marulan Mine Study Area is the hypogean (true groundwater) ecosystem. It is characterised by having: very low DO, permanent darkness, highly stable water quality, and low energy levels from allochthonous input and bacteria. The faunas are highly specialised and consist predominantly of Crustaceans and Oligochaetes. In this study, only a single species of crustacean was collected in one bore. This is indicative of the habitat constraints rather than on water level or water quality. The limestone aquifer may not possess fauna at the localities of the bores sampled possibly due to the substrate consisting of massive limestone with limited secondary porosity through fine fractures as well as inappropriate water chemistry. All bores held significantly deep water profiles and indeed the one bore that recorded fauna also recorded the highest electrical

conductivity of the bores sampled. This in itself is an indication that the fauna was most likely associated with the fractured or weathered granites or granodiorite complex to the west of the mining operation and not the Bungonia Limestone.

The fauna composition indicates a shallow/hyporheic groundwater system where the river system is experiencing a gaining flow situation whereby the groundwater is feeding into the river. The porosity of the aquifer substrate appears to be one of the significant factors in determining the fauna composition. The low porosity of the fractures zones and seeming lack of unconsolidated sediments within the limestone is indicated by the small size of the phreatic fauna collected. Although the fauna is depauperate it still forms a relatively consistent composition between habitats.

The surveys recorded fauna from 14 of the 23 sites. The fauna composition included: Oligochaeta (freshwater worms); a number of insect orders including aquatic beetles, fly larvae, mayflies, dragonflies; soil invertebrates including Collembola, aquatic microcrustaceans such as Copepods and Ostracods (Seed Shrimps) and Syncarida; Gordian worms; and flatworms. These included species that are classed by ecotones as stygobite, stygoxenes, and edaphobites.

Although the fauna is depauperate it formed relatively consistent compositions between habitats and formed 3 distinct ecotonal units. These being the Stygobites groundwater fauna, the Spring Fauna - Riverine Macroinvertebrate fauna, and the incidental Edaphobite Soil Fauna. These ecotones are described below in more detail.

Ecotone 1 - stygobites – sites: (GW103697).

Of the sites that registered fauna only 1 bore (GW103697) registered stygofauna. The small number of specimens collected at this site indicates a depauperate fauna within the aquifer at the bore sites and a minimal level of connectivity within the aquifer, possibly due to the substrate consisting of massive limestone with limited secondary porosity through fine fractures. The porosity of the aquifer substrate appears to be one of the significant factors in determining the fauna composition. The low porosity of the fracture zones and seeming lack of unconsolidated sediments within the limestone is indicated by the small size of the phreatic fauna collected.

This first ecotone is characterised by the community of obligate groundwater fauna represented by Family Parabathynellidae. This faunal assemblage can be found in the shallow hypogean (true groundwater) ecosystem.

Syncarida

The Division Syncarida is one of the most interesting invertebrate groups found in Australian inland waters. They are an ancient group that branched off from the main stream of the Eumalacostraca or higher Crustacea at a very early period perhaps as far back as the Late Devonian about 400-380mya, with today's extant taxa still retaining this primitive body structure.

The current classification of the Syncarida is broken up into: the minute, interstitial Bathynellacea, which have a worldwide distribution and are suggested to be the most primitive; the fossil Palaeocaridacea which were restricted to North America and Europe during the Carboniferous to Permian approximately 360-250mya and the Anaspidacea. The Anaspidacea have a distinctly Gondwana distribution from NZ, Australia and South America and include the shrimp like *Anaspides* and *Allanaspides*, found only in Tasmania. The koonungids from the streams and caves in southern Victoria and Southern South Australia and sphagnum bogs in Tasmania, to the Psammaspididae, known currently from 10 undescribed species in caves in NSW (Eberhard and Spate 1995) and one hyporheic species in northern NSW (Schminke 1974) and one in

Northern Tasmania. And finally, the Stygocaridinea, which are only about 1-2mm long and are found in NZ, one species from Victoria and the remainder in South America.

The syncarids have always been indicators of cool temperate permanently wet habitats as they have no stage in their life cycle that can tolerate desiccation. Tasmania and SE Australia, in particular, has the most diverse syncarid fauna in the world that inhabit a plethora of environments from highland tarns and lakes, to rivers, swamps, caves and even the interstitial environment of underground waters and springs.

The syncarid fauna collected from the limestone aquifer represent the main species of obligate groundwater fauna. The species collected will be new, as there have been no described species from this area. The syncarids collected belong to the family Parabathynellidae.

The importance of the discoveries of this obligate groundwater fauna is that they represent relics of a bygone era and give us a glimpse of another time before the browning of Australia, to a time when Australia was covered in lush, wet, rainforest with numerous waterways, swamps and deltas.

The fact that the groundwater habitats have served as refuges and centres of speciation in fluctuating environments of generally increasing and spreading aridity, particularly in the Pleistocene, provides tools for studying the past history of particular taxa. The syncarids are one of those groups because they have a wide distribution at the family and generic level but appear to be highly restricted at the species level due to their inability to withstand any degree of desiccation in any stage of their life cycle. In effect they represent biological time capsules.

Ecotone 2 - spring fauna– Sites: (Barb-3, Barb-4, Barb-1, Gab-1, Bung-5, Bung-8, Bung-6, Bung-10, Main-1, Main-2, and Main-3).

These habitat types contain a relatively consistent assemblage of surface water macroinvertebrate species that are associated with perennial, slow moving or still face water bodies with high water quality and soft silty sediments and high organic (allochthonous) content on the substrate.

Gastropoda

Austropyrgus bungoniensis is a species of minute freshwater snail with an operculum, an aquatic gastropod mollusc or micromollusc in the Hydrobiidae family. This species is endemic to southern New South Wales, Australia. It is known from streams and springs flowing from the Bungonia Gorge Caves (Clark 2011).

The species collected, *Austropyrgus bungoniensis,* has also been listed (Clark 2011) as a threatened species in the IUCN red list of Threatened Species, however has been assessed as Least Concern. This species has an estimated extent of occurrence of less than 2,500 km^2, but its distribution falls within Bungonia State Conservation Area. It is considered to be very abundant and no major threats are impacting on its population or habitat. It is therefore unlikely that this species is experiencing significant population declines.

It is unlikely that any major threats are impacting on its population or habitat (S. Clark pers. comm. 2010). This species is endemic to southern New South Wales, Australia (Clark et al. 2003). It is known from streams and springs flowing from the Bungonia Gorge Caves (Clark et al*.* 2003). It is likely that this species occurs in areas of similar habitats near to the type locality (S. Clark pers. comm. 2010).

Oligochaeta

Groundwater habitats have played an important role in the evolution of freshwater oligochaetes. Indeed, Lafont (1989) suggested that groundwater might have been the primary source of colonisation of all freshwater oligochaete ancestors. Whether this is true or not, groundwater habitats are a rich source of

oligochaete diversity, and many of the more "interesting" species in Australasia seem to be predominantly groundwater-dwelling forms (Brinkhurst 1971).

The relatively small size (1-5mm) of the Oligochaete (worm) species present indicates a low to moderate connectivity within the river/aquifer environment. The shallow water table levels within the riverine hyporheic zone and the presence of the family of Enchytraeidae suggests a direct association/connectivity with a slow base flow river system with a shallow alluvial water table. There is very little known about the diversity and distribution of freshwater Enchytraeidae, therefore the identification can only be given to the family level. Subterranean Oligochaetes are an increasingly important component of Australia's groundwater fauna that contain a large number of short range endemic species with large faunas along the continental marginal areas, particular in the southwest and eastern seaboards.

In terms of their ranking within current surface water environmental sensitivity indices such as the SIGNAL Index ranking, they can only be assessed at the Order level of Oligochaeta which has a ranking of 2. This equates to a family which is quite tolerant of environmental disturbance. This, however, is misleading as the family is usually associated with high water quality environments.

Although primarily phreatobites i.e. belonging to the shallow groundwater ecotone, this family can also be found within the riverine, hyporheic zones in areas of groundwater discharge where the discharge can be either point source springs or diffuse discharge through a moderate to course grained substrate such as sand or gravels (Gilbert 1994).

Platyhelminthes

Worldwide there is a substantial stygobitic flatworm fauna (Gourbault 1986). As in many other groups, there has been little work to describe Australian species and further work is required. Stygobitic species are recognised by a reduction in pigmentation and a loss or reduction of eyes.

Copepoda

The Copepoda are a subclass of Crustacea comprising over 10,000 known species (Williamson and Read 2001). Copepoda are predominantly marine, although 3 of the 10 orders are widespread and abundant in freshwater habitats. These are the Calanoida, Cyclopoida and Harpacticoida. The first order occurs in the water column as plankton only, whereas the latter two are common in benthic habitats of surface waters and are important components of many groundwater communities.

The Copepoda Cyclopidae is normally associated with fine to course sandy substrates of still water environments of rivers, wetlands, the hyporheic zone and shallow groundwaters. Although they are a ubiquitous component of these habitats, their small size means that they are often overlooked and undercounted. In terms of management, therefore, they are potentially very useful bioindicators, particular of base flow fed streams or alluvial aquifers or flow through wetlands, as they are sensitive to changes in the environment (Tomlinson & Boulton 2008).

Coleoptera

Of the more than 300,000 different species of beetles described worldwide, only about 9,500 are aquatic in their adult and/or larval stages. The recorded beetles belong to five families (Dytiscidae, Hydrophilidae, Psephenidae, Scirtidae and Elmidae. Elmidae are commonly encountered in hyporheic and spring samples, with several undescribed species of true stygobites recently being discovered in eastern and north west NSW. There are several known genera of true groundwater Elmidae around the world (Spangler 1981, 1986).

Diptera

The Tipulidae are a very diverse but poorly studied group of Diptera that have an aquatic larval stage and a wing arboreal adult stage. They have poor dispersal capabilities and are normally associated with the riparian zone and corridor. In terms of water quality, the Tipulidae are ranked as a 5 within the SIGNAL - HU97B (Chessman et al. 1997), which is indicative of a relatively disturbance tolerant family. They are, however, normally associate with river pool and wetland environments with good water quality, soft sediments and large quantities of allochthonous material (leaf packs).

Ecotone 3 – edaphobites – soil fauna. Sites:

One bore site recorded the presence of terrestrial invertebrates (GW108850). The dominant group collected belonged to the primitive soil insects, the Collembola. The Collembola specimens collected from the area belongs to the families Isotomidae. These are a large family of Collembola, with all subfamilies occurring in Australia. They are common in leaf litter. They are typically detrital or fungal feeders associated with the ground litter layer and tree bark. Their presence in the samples is most likely coincidental either by falling in or occupying the vegetation adjacent to the bore or living within the bore above the water table, as they have a preference for humid environments. As they are terrestrial soil and leaf litter fauna and not associated with groundwater environments no further description will be given.

6. Discussion

6.3 Discussion of results

The results of the current survey indicate that stygofauna was not identified within the confines of the current area of operation of the Marulan Limestone Mine or the area of the proposed extension, however stygofauna were found in one location nearby. In addition to stygofauna a number of groundwater dependent springs were identified in both surrounding downslope water catchments that included Bungonia Creek and Barbers Creek. The spring ecosystems downslope of the mining operations were identified to be in healthy condition and possess a healthy, highly complex and diverse aquatic ecosystem. They were also found to comparable to spring ecosystems within the control areas on the upstream of the mine and on the southern side of Bungonia Creek.

All aerobic organisms require a specific range of conditions in order to survive and function including a physical living space, an energy source or food, and oxygen. If these specific parameters for life are changed then a change to the community structure of an ecosystem is to be anticipated. Surface aquatic invertebrate communities for example have long been recognised as being ideally suited for the assessment of environmental health and condition in riverine ecosystems for the following reasons:

- They are diverse.
- They occupy every available niche within a water body.
- They are one of the major contributors to the processing of energy through an ecosystem. They respond directly to physico-chemical changes within the aquatic environment.
- The composition of these communities reliably reflects both natural and threatening processes operating within a catchment.
- The specific range of habitat requirements of each species dictate the distribution of each component of both the species and community levels, which enables their diversity to be used as an indicator of a water body's connectivity and condition within a catchment.

Stygofauna communities possess all of the above features. It has been acknowledged that they are intrinsically adapted to their specialised environment both in terms of their specialised morphology, physiologies, habitat requirements and long life cycles. Therefore the link between flow conditions, geochemical conditions and the abundance, diversity and composition of the stygofauna community should be anticipated and utilised.

The major threat identified in this study to both the stygofauna community outside the area of operations and the groundwater dependent springs downslope of the operations is the potential impact of groundwater loss through either drawdown or changes in the aquifer structure. This can potentially result in an increase in through-flow which would lead to decreasing groundwater levels in the aquifers and can have impacts on flow in streams that are hydraulically connected to the aquifers or loss in habitat within the aquifer matrix. These impacts range from a reduction in base flow to a change from a gaining to a losing stream or to a complete cessation of flow. The consequences in terms of stream flow are obvious, particular in regards to the ecology of the springs and instream surface water ecosystems. In recent years it has been realized that these changes may also cause changes in groundwater chemistry. For example dissolved and particulate organic matter in the stream water may percolate into the streambed and the aquifer and may lead to a consumption of oxygen and reducing conditions.

Physico-chemical variables are also unlikely to be the sole determinants of species distributions and community assemblages. Dispersal constraints (Belyea and Lancaster 1999), such as hydrological

disconnection (Sheldon and Thoms 2006), could isolate parent populations from which populations observed at any particular sampling time are derived. Lag effects are likely, so that the species presence and abundance data collected at any sampling time could result from previous rather than current physico chemical conditions. There might also be multiple points of population or community stability due to varying influences of different combinations of driving variables as environmental conditions change.

Hydraulic conductivity also determines the availability of electron donors for biogeochemical processes. Interstitial storage of dissolved organic matter and the availability of dissolved oxygen are influenced by particle size and pore size (Maridet et al. 1996). Larger particle size and high porosity allow higher flows and higher availability of oxygen but reduce entrapment and retention of nutrients.

In fractured rock and karstic aquifers, uneven porosity due to the distribution of fissures, fractures and solutional conduits creates preferential flow paths, which create spatial heterogeneity in biogeochemical cycling. Spatial and temporal variability in groundwater flow paths is also influenced by surface microtopography and by stream channel morphology. The functional diversity of subsurface ecological processes is thus determined by shifting gradients in oxygen, nutrients and physico-chemical conditions, which create pockets of oxia and anoxia, nitrification and denitrification.

As in other ecosystems, heterogeneity in subsurface environments is a critical determinant of ecosystem function. Disturbance to the groundwater regime, including disruption of patterns of hydrological connectivity and sediment wetting/drying cycles might potentially alter spatial and temporal patterns of groundwater flow, flux and quality, with implications for rates of organic matter mineralisation and nutrient cycling.

Prolonged desiccation of sediments caused by water table drawdown can alter the balance between aerobic and anaerobic processes and change the composition of microbial populations, reducing the incidence or rate of anaerobic metabolism. Disturbance to the groundwater regime can alter the rate and nature of subsurface ecological processes, resulting in reduced availability of carbon, nitrogen and phosphorus, with flow-on effects for biodiversity and ecosystem services, not only within the aquifer, but also in connected ecosystems including rivers, riparian zones and estuaries.

6.4 Changes in Biological Diversity

The presence, composition and complexity of fauna of spring and phreatic habitats are determined by a number of factors. These factors can include: flow duration or permanence of the water source, the size, substrate type and depth and longevity of the phreatic environment; the connectivity of the phreatic and hyporheic habitats both along the river corridor and within the riparian zone i.e. whether the river is a gaining or losing system. This is particular relevant to ephemeral or intermittent streams where the drying of streams and the interruption of water infiltration into adjacent-shallow subsurface areas reduce the suitability of the habitat for a range of aquatic organisms. As the flow reliability reduces so does the number and type of organisms present, resulting in the community only being represented by a few epigean species that can survive the dry period until the next rewetting.

The quantity and quality of the various kinds of pressures on groundwater systems are able to induce drastic changes in the diversity of organisms living underground. Two types of such changes can impact an aquifers water quality parameters and its associated ecosystem, namely (1) decline in groundwater-dwelling organism and groundwater dependent spring populations leading to species extinctions and (2) penetration of alien species belonging to surface-water communities. Both processes determine changes in the functioning of groundwater systems, generally reducing the efficiency of some ecosystem processes.

Mining developments, in which stygofauna and spring fauna are considered to be a relevant environmental factor, need to be closely assessed with respect to the extent of groundwater drawdown zone and the likely impacts on groundwater quality. Both of these activities, over time, may cause prospective habitat to be degraded or lost with the potential for significant impact on groundwater communities. Groundwater dependent fauna are able to tolerate natural fluctuations in water parameters such as water level, electrical conductivity, and temperature, and this has been demonstrated experimentally (Tomlinson unpublished) for stygofaunal amphipods, copepods, and syncarids. However, changes outside the natural range of water quality, water chemistry and levels such as rapid drawdown or changes to water chemistry such as a pollution plume are likely to have impacts on the community composition, biodiversity and overall sustainability of the community.

Groundwater communities also require links to the surface environment to provide organic matter and oxygen. If that linkage is broken or disrupted, the groundwater community in the area affected could decline over time. A high degree of endemism can occur in aquifers, even within the same system or between adjacent systems (Hancock and Boulton 2008). However, providing there is sufficient hydrological connectivity within and along the flow path of the aquifer, and the physico-chemical conditions are suitable and remain stable, the distribution of species will not be restricted to small parts of an aquifer.

The overall condition values at each spring site for the indices used have demonstrated a consistently high retention of sensitive taxa groups remaining within each site. These indice values of the biodiversity and water chemistry results indicate that the water quality has remained high and the overall environmental condition of the catchment, groundwater contribution, stream structure and riparian zone has remained intact and undisturbed. The consistency in the numbers of the more sensitive EPT and shredder taxa and the continuation of high water quality indicate that the spring and riverine ecosystem condition values to be in a healthy condition.

Therefore, the results of the current survey demonstrate that the continued presence of high numbers of EPT taxa and low numbers of silt tolerant species recorded at most spring sites above and below the mining operations indicates that both river systems and the groundwater discharges are still healthy. It must be noted however that these ecosystems are more vulnerable to changes in inflows than the rivers due to their almost obligate dependence on groundwater in terms of both quality and quantity for survival. The springs however, will be vulnerable to changes in groundwater as they have much smaller catchments and do not have the same scale of resources, permanence of flow levels and variety of niches. As a result they are more likely to be impacted by decreases in flow or changes in environmental conditions.

In conclusion, the results from the current survey suggest that the overall biodiversity of the spring/hyporheic communities and river environmental conditions is high and that there are no apparent current adverse effects as a result of any activities arising from the operations of the Marulan Limestone Mine.

7. Impact assessment

7.1 Stygofauna and GDE impact assessment

The following impact assessment has been conducted using the "Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov *et al*, 2012)" and incorporating a consideration of the Threatened Species Assessment Guidelines (DECC 2007). These guidelines have been utilised here in relation to affected threatened biodiversity as listed in the BC Act.

7.2 Potential impacts

The assessment of the value and risk to stygofauna and spring/hyporheic community at each of the sites surveyed as well as an overall assessment of the shallow aquifers that supply the water to the identified GDEs of the groundwater dependent ecosystems is presented in Table 7. The blue colour represents the bore site that registered positive to stygofauna, the yellow represents the spring/hyporheic sites that registered positive for fauna, and grey represent negative results i.e. no fauna was collected.

Table 7 Marulan South Mine ecological value and risk assessment table.

Locality Name	Habitat	Survey Result	Ecological Value	Ecological Risk	Matrix Ranking
MW1	Bore	Negative	Low	Low	G
MW02	Bore	Negative	Low	Low	G
MW3S	Bore	Negative	Low	Low	G
MW3D	Bore	Negative	Low	Low	G
MW04S	Bore	Negative	Low	Low	G
MW04D	Bore	Negative	Low	Low	G
MW5	Bore	Negative	Low	Low	G
GW103697	Bore	Stygofauna	Low	Low	G
GW100656	Bore	Negative	Low	Low	G
GW108850	Bore	Negative	Low	Low	G
Barbers Creek lower	Surface pool	Spring fauna	High	Low	A
Barbers Creek upper	Hyporheic	Hyporheic	High	Low	A
Gabion Baskets Stream, Barbers Creek	Surface pool	Spring fauna	High	Low	A
Gabion Baskets stream, upper	Surface pool	Spring fauna	High	Low	A
Bungonia Creek Lower	Surface pool	Spring fauna	High	Low	A
Bungonia Ck, u/s Main Gully	Surface pool	Spring fauna	High	Low	A
Bungonia Creek Upper, Priority 5	Surface pool	Spring fauna	High	Low	A
Bungonia Creek Upper	Hyporheic	Hyporheic	Low	Low	G
Red Track spring	Surface pool	Spring fauna	High	Low	A
Riparian pool d/s Main Gully, Bungonia Ck	Surface pool	Spring fauna	High	Low	A
Main Gully, Bungonia Ck,	Surface pool	Spring fauna	High	Low	A
Overall Risk				Low	

The ecological and risk assessment was based on current data and is a snapshot of the current condition of the aquatic and subterranean environments as of mid-2013 and conclusion of the groundwater assessment and technical studies conducted by AGE (2018).

Results of groundwater modelling (AGE 2018) predict only a slight increase in pit inflows from the larger Project mine pit as mining occurs in essentially 'dry' limestone from which groundwater is only removed from groundwater contained in the porous spaces of the limestone. Modelled drawdown at the end of mining only marginally overlay the zones with high potential for groundwater interaction towards Barbers Creek and Bungonia Gorge, and the drawdown is minor i.e. the 1 m drawdown contour only extends approximately 290 m from the eastern edge of the current mine pit. AGE (2018) also found that impacts to groundwater quality are not anticipated as the recharge mechanism to the limestone will not be altered significantly suggesting groundwater quality will remain unchanged. Furthermore geochemical assessment indicated that the overburden rock and limestone mined at the site will have a minimal, if not negligible, impact on the downstream groundwater quality (AGE 2018). Similarly, springs identified at the base of the steep slopes of Bungonia Gorge are unlikely to be impacted as the recharge through the pit floor will continue to recharge the limestone and the springs.

All of the bore sites registered low ecological value for stygofauna due to either no fauna collected at all or the faunal community was in very small numbers and very low biodiversity. This result still recognises the presence of endemic species at GW103697. This general result was the same across both the area of potential impact within the mining lease and at the control sites outside of the lease area. The risk assessment recorded a low value for all sites which recorded no fauna. A low value was recorded for only one river site (Bungonia Creek upper, hyporheic) due to the depauperate fauna. All of the riverine springs/hyporheic sites recorded a low level of risk as these site are all associated with the shallow alluvial aquifer and disconnected from the deeper regional aquifer (RPS 2014, AGE 2018). An overall value and risk assessment was also conducted focusing on the shallow aquifers as a whole to place the sites into a landscape perspective and to demonstrate the condition and ecosystem function performed by the aquifers. The results of this assessment demonstrated that the aquifers are in good condition in regards to water levels, water quality, as well as supporting a range of groundwater dependent ecosystems type and subtypes. As with the individual sites that supported subterranean fauna the aquifers within the overlying shale units and the shallow sandstone unit are at low risk of impact from the mining activity as listed below:

- Four GDE types were identified in the study area including:
    - Subsurface Phreatic aquifer ecosystems
    - Baseflow Stream (Surface Ecosystems)
    - Baseflow Stream (Hyporheic Ecosystems)
    - Phreatophytes - Groundwater Dependent Terrestrial Vegetation

In summary, in terms of the stygofauna community across the area of interest the following points are noted:

- Limited and localised subterranean ecosystems in the aquifer were identified to exist, although none are currently listed as endemic, relictual, rare, or endangered biota (fauna or flora) populations or communities as listed under the BC Act, FM Act or the Commonwealth EPBC Act. The single species has been identified by an acknowledged expert Taxonomist/Regional Ecologist as being important.
- The ecological values of the sites that contain stygofauna were generally low although there was connectivity between the shallow aquifers within the overlying limestone and the underlying granites and the associated rivers.

- The risk of the proposed development to these subterranean ecosystems and the associated spring ecosystems was rated as low. This is attributed to the shallow aquifers that support these ecosystems being separated from the deeper aquifers by an Aquaclude and as most of the spring sites are situated on the periphery of the operations area and therefore at a lesser risk from subduction or bedrock cracking
- There was insufficient data to determine whether past land use practices have impacted aquifers and associated GDEs or to the nature of these impacts. These values were categorised as unknown in the identification of the ecological values of the Aquifer/Groundwater Source section of the assessment. As there was no long term physicochemical data such as time series water level and quality fluctuations the confidence of the overall risk assessment is moderate. It is likely that the GDEs are in a moderate condition given the limited development in the area.
- Only one bore recorded one species of stygofauna.
- Nine spring sites outside the proposed mining operation also recorded similar fauna that recorded in the Bungonia Caves complex suggesting a direct connection between the caves and the river systems
- The fauna in both Barbers Creek and Bungonia Creek and the spring sites indicate that two springs are perennial.

7.3 Cumulative impacts

Cumulative effects may result from a number of activities interacting with the environment. The nature and scale of these effects can vary depending on factors such as the type of activity performed, the proximity of activities to each other and the characteristics of the surrounding natural, social and economic environments. They may also be caused by the synergistic and antagonistic effects of different individual activities, as well as the temporal or spatial characteristics of the activities. Importantly, cumulative effects are not necessarily just additive. The implication of multiple mining actives in one region is that impacts may overlap and result in larger impacts than would be expected for a single mining operation (cumulative effects). In the case of the expansion of the Mine these cumulative impacts cannot be determined with the currently available data, however based on the paucity of stygofauna observed and the limited impacts on groundwater and surface water, the cumulative impact is expected to be minimal.. A monitoring program is outlined in the following section.

8. Avoidance, management and mitigation

Since stygofauna were not observed in the impact area, it is recommended that the program focus upon the GDE's downstream (Bungonia Creek, Barbers Creek, Main Gully and springs). This could be conducted concurrently/as part of the aquatic ecology monitoring described in the Aquatic Ecology Assessment (Niche 2018). This report recommended the following:

- Conduct aquatic baseline monitoring in autumn and spring for one year prior to or at the start the 30 year mine plan. This will add to existing baseline data and further capture temporal variation in stream health to which future monitoring can be compared.
- If a water quality trigger threshold is exceeded in consecutive monitoring events (in accordance with Surface Water/Groundwater Management Plan and Trigger Action Response Plan TARP) and if additional assessment finds that the change in water quality may be mining induced, then Boral should 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 should:
    - Be conducted up and downstream of the impacted site in question.
    - Be consistent with the Biodiversity Management Plan and Surface Water Management Plan 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.

9. Conclusions

The baseline sampling and assessment of the groundwater ecosystems that exist in the Study Area has confirmed that stygofauna and diverse spring communities are present in the area. They however are unlikely to be present in the area of operation of the mine. In particular the surveys have demonstrated that:

- Stygofauna were not present within the impact zones of the area of operations.
- Stygofauna were not collected from within the deep aquifer of the limestone bearing zone.
- Stygofauna were present outside of the mining operations but not within the surrounding fractured rock aquifers associated with the mining area.
- 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 hotspots of biodiversity with potentially a high degree of endemism.
- The ecological value of the spring's downslope of the mining area is high.
- There is connectivity between the alluvial aquifers and the shallow, fractured limestone aquifers.
- Water chemistry includes neutral to highly alkaline pH levels ranging from approximately 7-11 pH units.
- Aquifer habitat consists of fine grained substrate and course grained sediments.
- Although the geology and water chemistry is similar to other areas in the region that do contain stygofauna, the faunal composition is significantly different that the area can be considered a separate ecological community.
- The stream and groundwater fauna composition is dictated by the availability of suitable habitat along with stream and groundwater water chemistry.

In conclusion, the results from this preliminary survey indicate that although stygofauna do not appear to be present within the area of operation they do occur locally. The results also indicate that the overall condition of the aquifers and their associated surface GDEs' including springs and river baseflow habitats is high. There are currently no apparent adverse effects on the aquatic groundwater faunas in any of the receiving streams as a result of any activities arising from the operations of the Marulan South Limestone Mine and a low environmental risk of impacts resulting from the proposed development.

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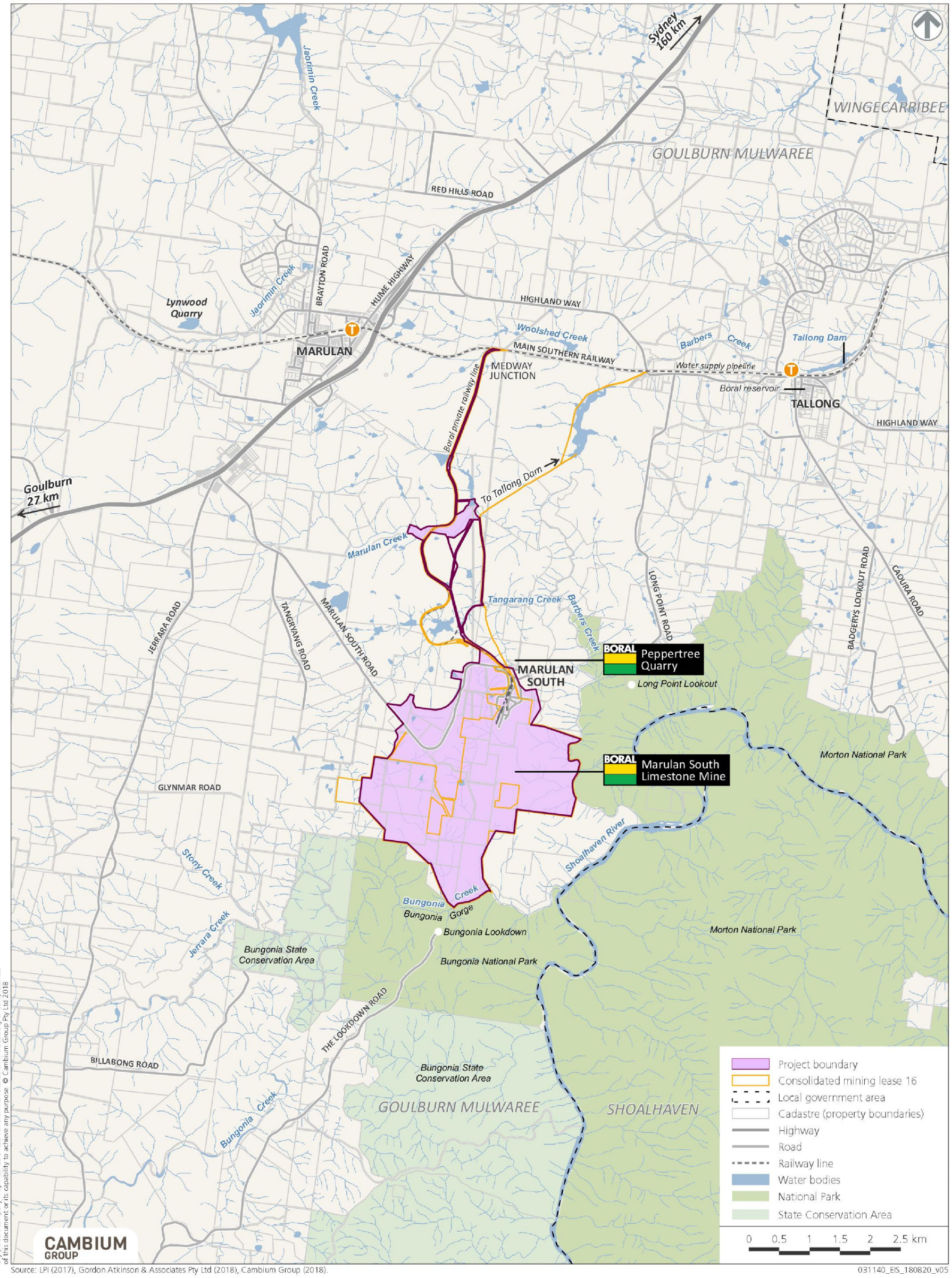
Figures

Regional context

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



Drawn by: PR Project Manager: MR Project Number: 2155 Date: 11/26/2018

Regional context

Marulan South Limestone Mine Continued Operations

FIGURE 1

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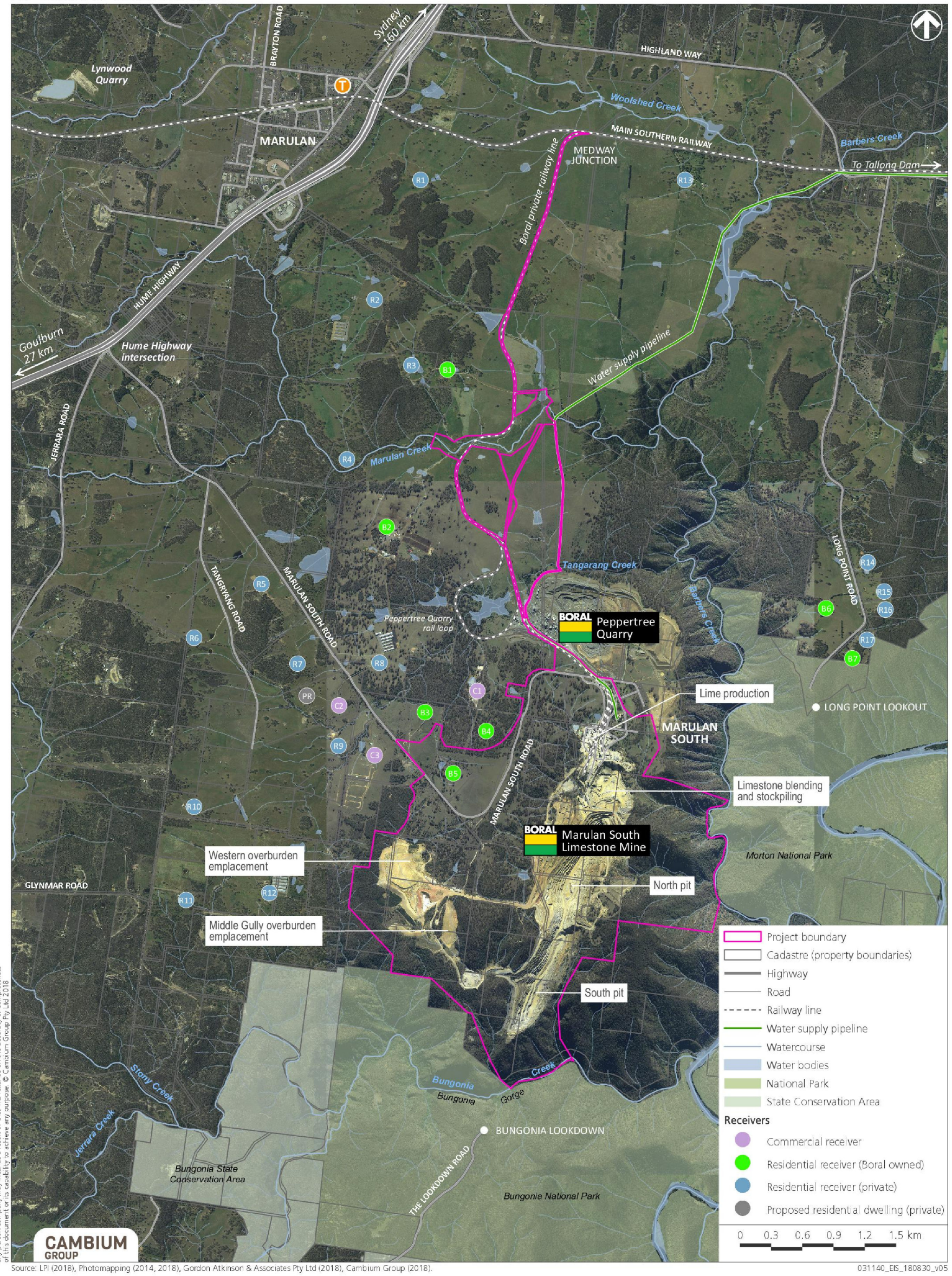
Local context

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



Drawn by: PR Project Manager: MR Project Number: 2155 Date: 11/26/2018

Local context

Marulan South Limestone Mine Continued Operations

FIGURE 2

Environment and Heritage

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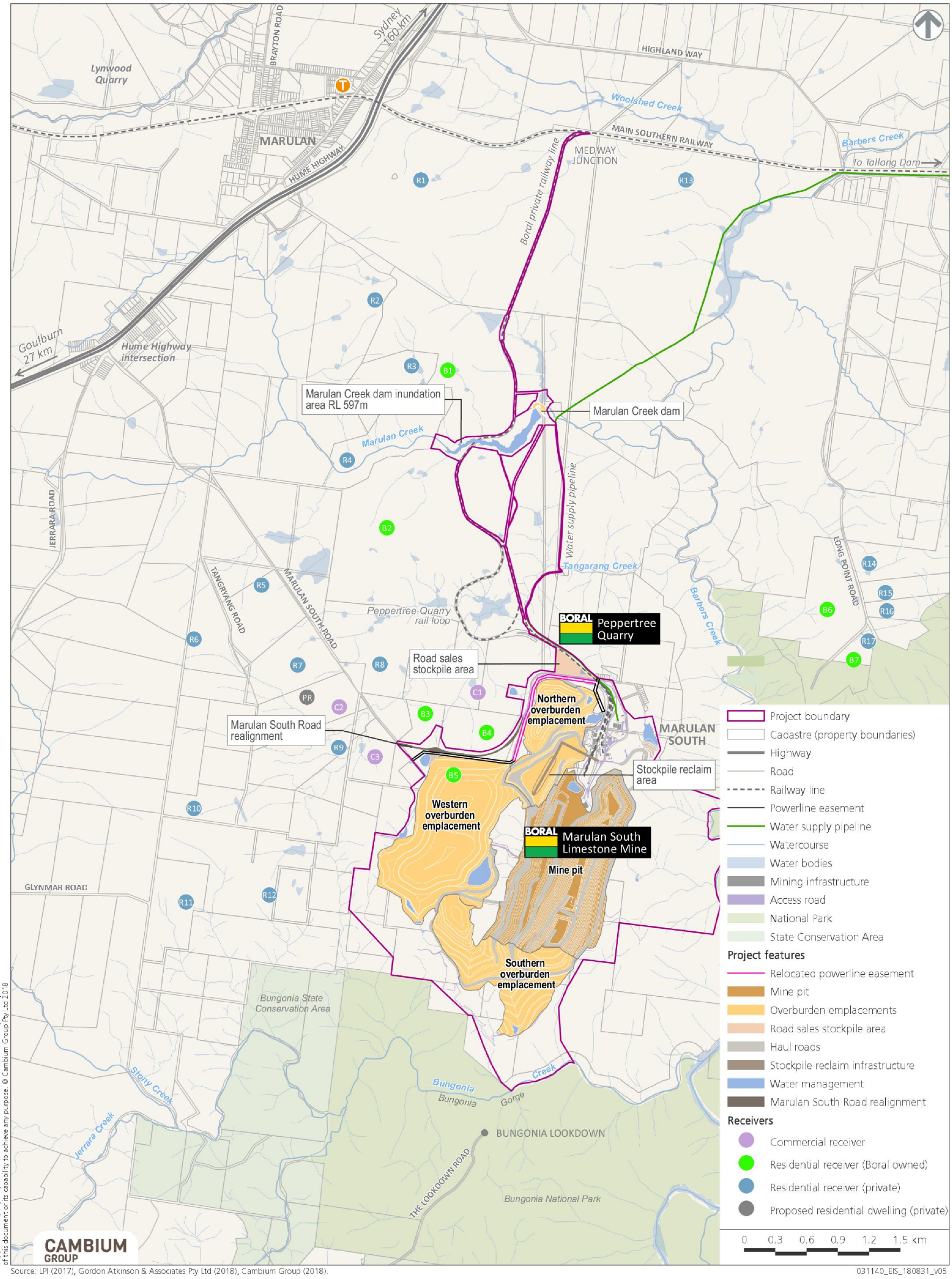
Figure
The Project

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



Drawn by: PR Project Manager: MR Project Number: 2155 Date: 11/26/2018

The Project

Marulan South Limestone Mine Continued Operations

FIGURE 3

niche Environment and Heritage

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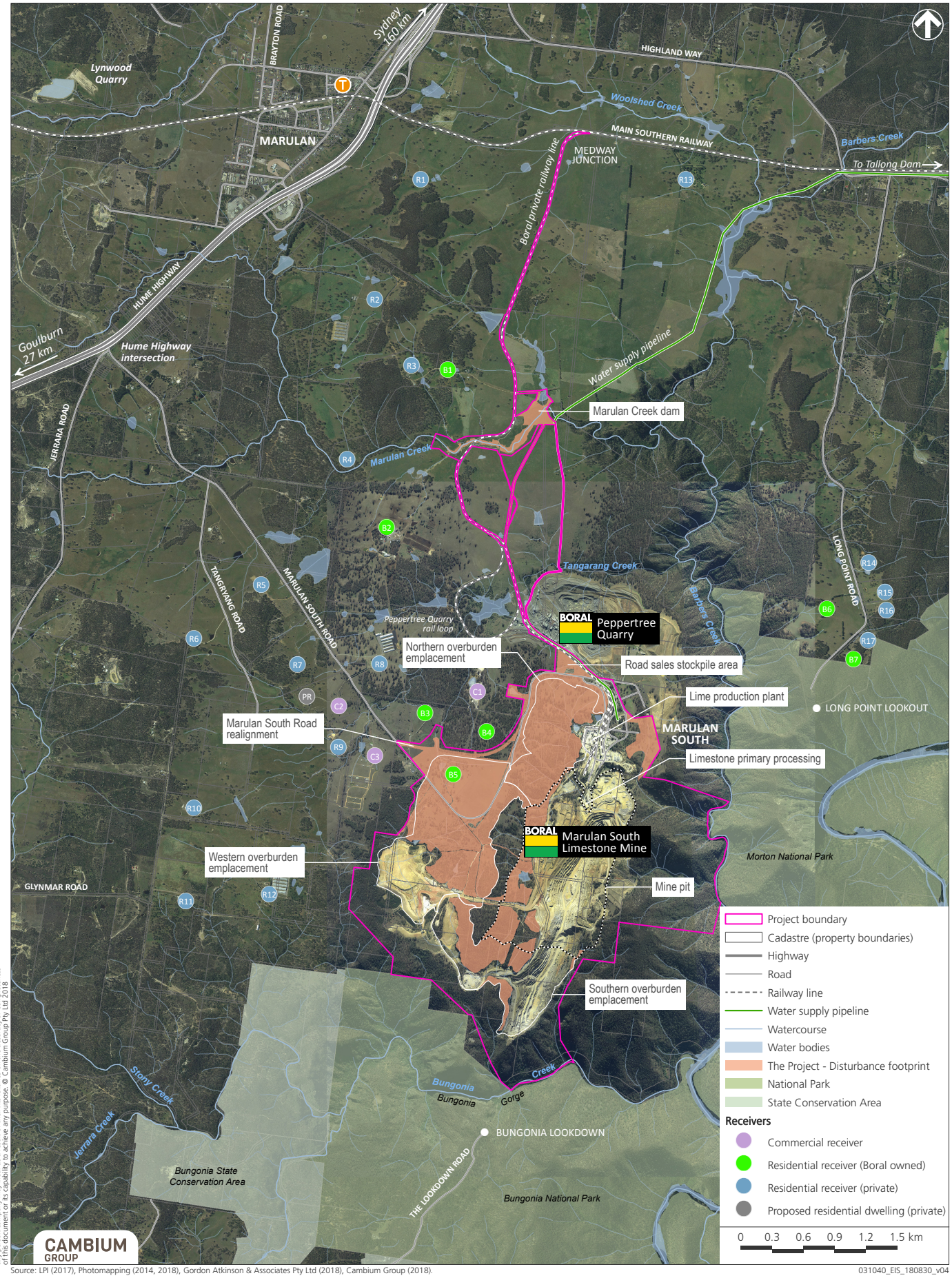
The Project - Disturbance footprint

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



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The Project Disturbance Footprint

Marulan South Limestone Mine Continued Operations

FIGURE 4

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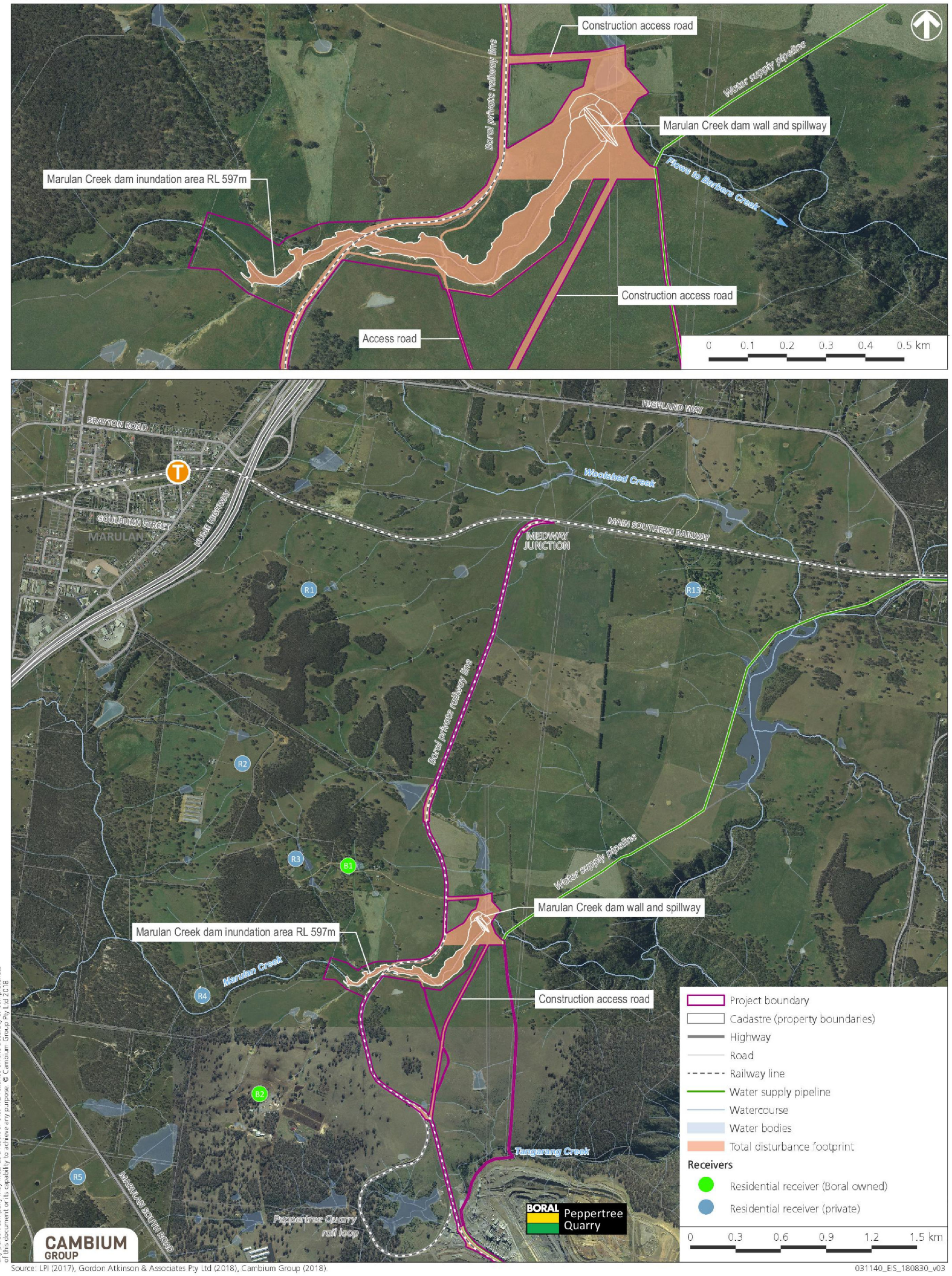
Marulan Creek Dam - Disturbance footprint

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



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Marulan Creek Dam - Disturbance footprint

Marulan South Limestone Mine Continued Operations

FIGURE 5

niche Environment and Heritage

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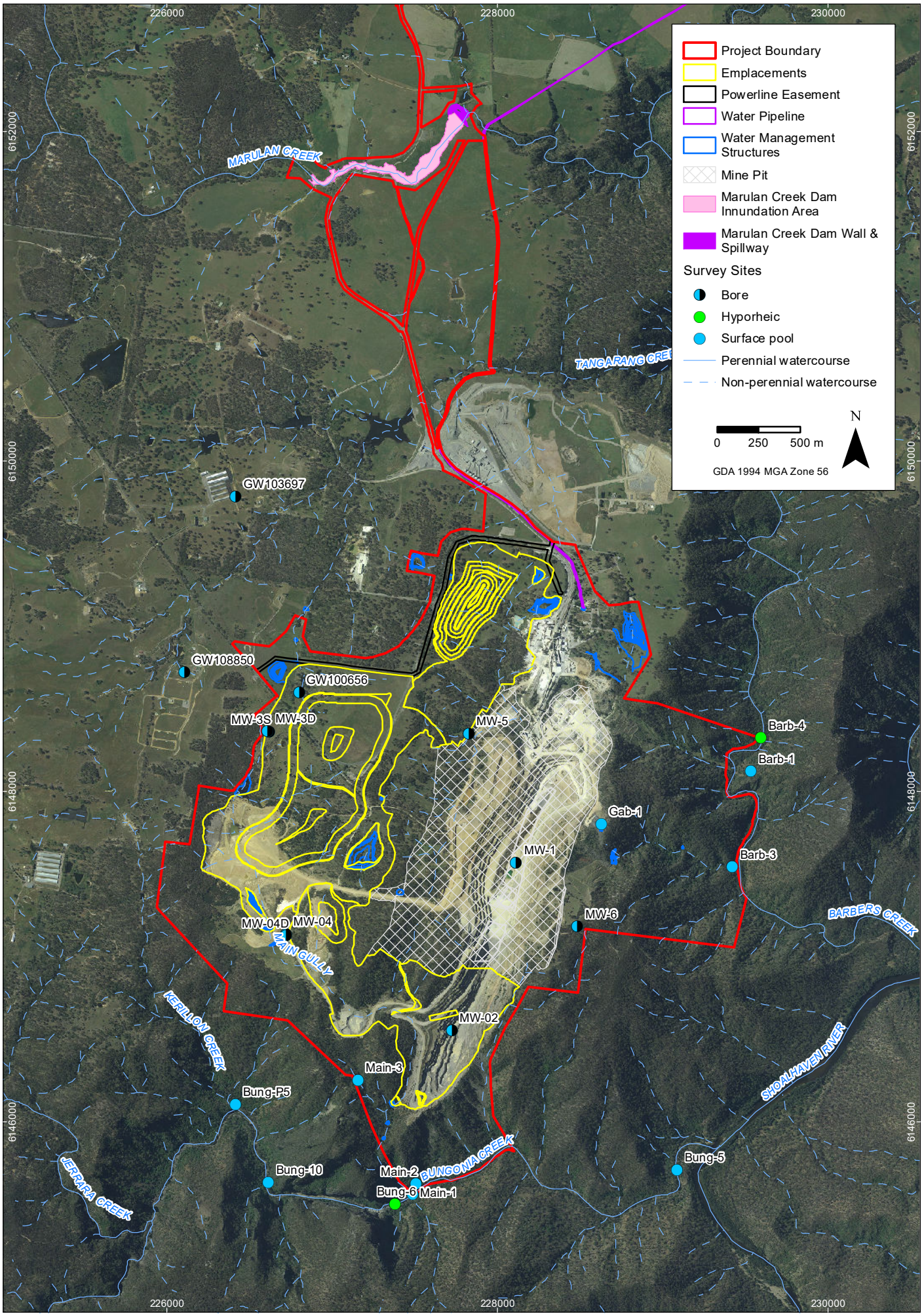

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Location of survey sites

Marulan South Limestone Quarry EIS Stygofauna and GDE Asssessment

FIGURE 6

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Stygofauna\2155_Figure_6_Stygo.mxd

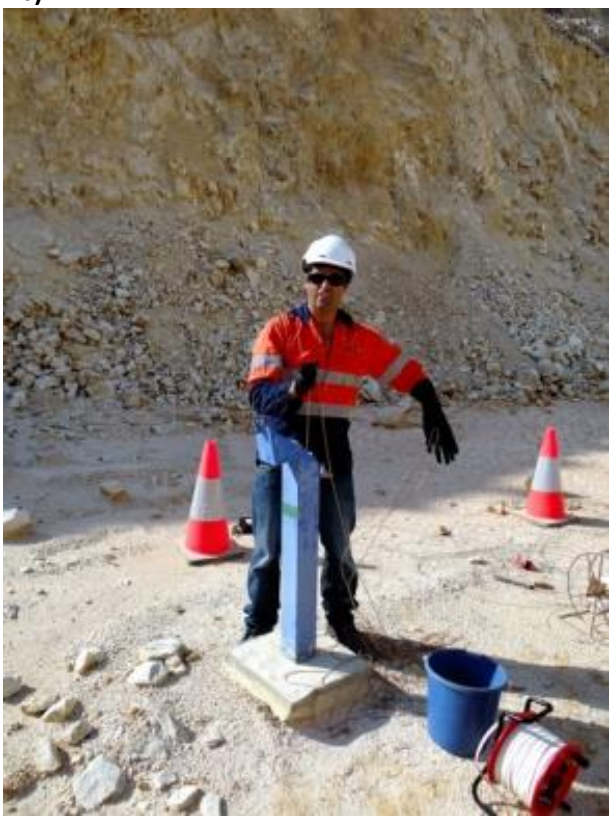
Imagery: (c) Boral 2014-11-02

Plates

1a)



1b)



1c)



1d)



Plate 1 Bore sites used in baseline survey. 1a) MW1 location; 1b) MW01; 1c) MW02; 1d) MW03S.

2a)



2b)



2c)



2d)



Plate 2 Bore sites used in baseline survey. 2a) MW04S; 2b) MW04D; 2c) MW05; 2d) MW06.

3a)



3b)



3c)



Plate 3 Bore sites used in baseline survey. 3a) GW103697; 3b) GW100656; 3c) GW108850.

4a)



4b)



4c)



4d)

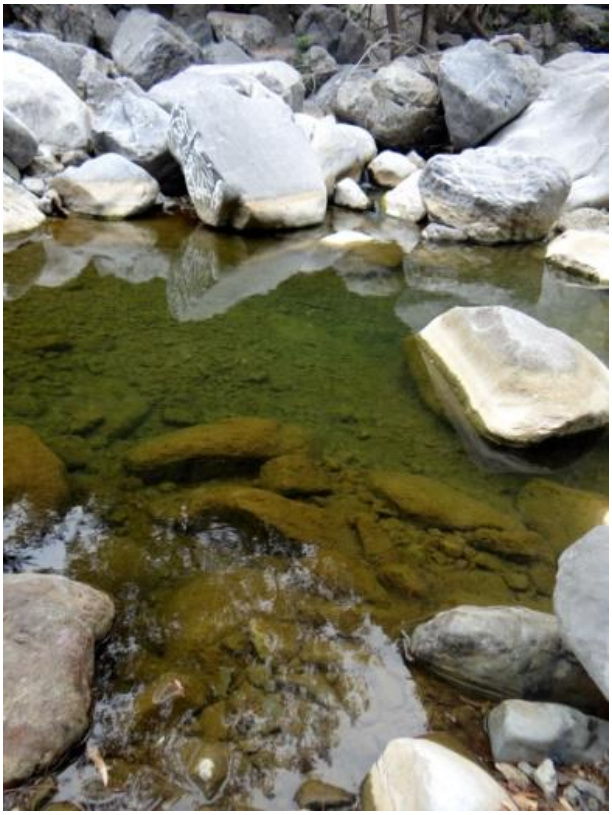


Plate 4 Barbers Creek sites used in baseline survey. 4a) Barbers Creek lower; 4b) Barbers Creek upper; 4c) Gabion Baskets Stream, lower, Barbers Creek; 4d) Gabion Baskets Stream pool, lower, Barbers Creek.

5a)



5b)



5c)



5d)



Plate 5 Bungonia Creek sites used in baseline survey. a) Bungonia Creek Lower; b) Bungonia Ck, u/s Main Gully; c) Bungonia Creek Upper, Priority 5; d) Bungonia Creek Upper

6a)



6b)



6c)



6d)



Plate 6 Bungonia Creek sites used in baseline survey. a) Spring at base of Red Track b) Spring uphill on Red Track; c) Fishbone fern community on cliff in Bungonia Ck gorge; d) Fishbone fern community on cliff in Bungonia Ck gorge.

7a)



7b)



7c)



7d)



Plate 7 Main Gully sites used in baseline survey. 7a) Riparian pool d/s Main Gully, Bungonia Ck; 7b) Main Gully, Bungonia Ck; 7c) Main Gully, spring head in upper section; 7d) Main Gully, spring head stream in upper section.

Appendix 1: Species list

Phylum	Class	Order	Family	Subfamily	*Genus/species*	Habitus	MW6	MW1	MW02	MW3S	MW3D	MW04S	MW04D	MW5	Steve William Ordasi	Poultry/turkey Farm	Fot Pyrotechnics	Barbers Creek lower	Barders Creek upper	Gabion Baskets Stream, lower	Gabion Baskets stream, Upper	Bungonia Creek Lower	Bungonia Ck, u/s Main Gully	Bungonia Creek Upper, Priority 5	Bungonia Creek Upper, hyporheic	Red Track springt	Riparian pool d/s Main Gully, Bungonia Ck	Main Gully, Bungonia Ck	Main Gully, spring head in upper section
Arachnida	Mesostigmata	Undetermined	Undetermined	Undetermined	*Undetermined*	Edaphobites														*							*		
Annelida	Oligochaeta	Tubificida	Enchytraeidae	Undetermined	*Unidentified*	Stygooxene												*	*	*		*	*				*		
Mollusca	Gastropoda	Bassomatophora	Ancylidae	Undetermined	*Ferressia petterdi*	Stygooxene															*		*	*					
Mollusca	Gastropoda	Bassomatophora	Glacidorbidae	Undetermined	*Glacidorbus sp.*	Stygooxene												*									*		
Mollusca	Gastropoda	Bassomatophora	Physiae	Undetermined	*Haitia acuta*	Stygooxene												*	*	*	*	*	*				*		
Mollusca	Gastropoda	Bassomatophora	Lymnaeidae	Undetermined	*Austropeplea tormentosa*	Stygooxene												*	*	*	*						*		
Mollusca	Gastropoda	Bassomatophora	Lymnaeidae	Undetermined	*Pygmanisus sp.*	Stygooxene																				*			
Mollusca	Gastropoda	Neotaenioglossa	Hydrobiidae	Undetermined	*Austropyrgus bungoniensis*	Stygooxene												*	*	*	*		*	*		*	*		*
Mollusca	Gastropoda	Neotaenioglossa	Hydrobiidae	Undetermined	*Posticobia sp.*	Stygooxene												*						*		*			*
Arthropoda	Insecta	Collembola	Isotomidae	*Folsomotoma c.f.*	*sp.*	Edaphobites											*												
Arthropoda	Insecta	Coleoptera	Elmidae	Undetermined	*Kingolus flavopliatus c.f.*	Stygooxene												*	*	*		*							
Arthropoda	Insecta	Coleoptera	Scirtidae	Undetermined	*Scirtes sp.*	Stygooxene												*	*	*		*		*			*	*	
Arthropoda	Insecta	Coleoptera	Dytiscidae	Undetermined	*Platynectes sp.*	Stygooxene												*	*	*	*		*	*			*		
Arthropoda	Insecta	Coleoptera	Dytiscidae	Undetermined	*Necterosome sp.*	Stygooxene												*		*									
Arthropoda	Insecta	Coleoptera	Dytiscidae	Undetermined	*Sternopriscus sp.*	Stygooxene														*					*				
Arthropoda	Insecta	Coleoptera	Hydrophilidae	Undetermined	*Berosus sp.*	Stygooxene												*			*				*		*		
Arthropoda	Insecta	Coleoptera	Hydrophilidae	Undetermined	*Enochrus sp.*	Stygooxene												*					*						
Arthropoda	Insecta	Coleoptera	Psephenidae	Undetermined	*Sclerocyphon maculatus*	Stygooxene																	*						
Arthropoda	Insecta	Diptera	Athericidae	Undetermined	*sp.*	Stygooxene																					*		*
Arthropoda	Insecta	Diptera	Ceratopogonidae	Undetermined	*Bezzia sp.*	Stygooxene												*	*	*		*			*		*		
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		Stygooxene																		*			*	*	*
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladinae	*Paralimnophyes*	Stygooxene												*		*				*			*		*
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Nilotanypus c.f*	Stygooxene												*	*	*	*	*	*				*	*	
Arthropoda	Insecta	Diptera	Simuliidae	Undetermined	*Simulium sp.*	Stygooxene																	*						
Arthropoda	Insecta	Diptera	Tabanidae	Undetermined	*Tabanus sp.*	Stygooxene												*					*	*			*	*	
Arthropoda	Insecta	Diptera	Tipulidae	Undetermined	*sp.*	Stygooxene													*			*	*		*			*	
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	Undetermined	*Atalophlebia sp.*	Stygooxene												*	*	*	*	*	*				*		
Arthropoda	Insecta	Ephemeroptera	Bartidae	Undetermined	*Bungona sp.*	Stygooxene															*		*						
Arthropoda	Insecta	Ephemeroptera	Caenidae	Undetermined	*Tasmanocoenis*	Stygooxene												*											
Arthropoda	Insecta	Hemiptera	Microvelidae	Undetermined	*Microvela sp.*	Stygooxene												*		*					*				
Arthropoda	Insecta	Megaloptera	Corydalidae	Undetermined	*Archichauliodes guttiferus*	Stygooxene																			*				
Arthropoda	Insecta	Odonata	Aeshnidae	Undetermined	*Austroaeschna subapicalis*	Stygooxene												*						*				*	
Arthropoda	Insecta	Odonata	Corduliideae	Undetermined	*Eusynthemis virgula*	Stygooxene																		*					
Arthropoda	Insecta	Odonata	Gomphidae	Undetermined	*Hemigomphus sp.*	Stygooxene														*							*		
Arthropoda	Insecta	Odonata	Libellulidae	Undetermined	*Diplocodes haematodes*	Stygooxene												*											
Arthropoda	Insecta	Odonata	Megapodagrionidae	Undetermined	*Austroargiolostes icteromelas*	Stygooxene															*				*			*	
Arthopoda	Insecta	Psocoptera	Trogiomorpha	Undetermined	*Not determined*	Edaphobites											*												
Arthropoda	Insecta	Trichoptera	Calamoceratidae	Undetermined	*Anisocentropus sp.*	Stygooxene															*								
Arthropoda	Insecta	Trichoptera	Helicopsychidae	Undetermined	*Helichopsyche sp*	Stygooxene												*			*			*	*			*	
Arthropoda	Insecta	Trichoptera	Leptoceridae	Undetermined	*Oecetis sp.*	Stygooxene												*										*	
Arthropoda	Insecta	Trichoptera	Leptoceridae	Undetermined	*Notalina spira*	Stygooxene												*		*									
Arthropoda	Insecta	Trichoptera	Leptoceridae	Undetermined	*Triplectides sp.*	Stygooxene												*		*	*				*				
Arthropoda	Insecta	Trichoptera	Hydrobiosidae	Undetermined	*Apsilochorema sp.*	Stygooxene																		*					
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Undetermined	*Hellyethira sp.*	Stygooxene												*			*			*					
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Undetermined	*Hydroptila sp.*	Stygooxene															*				*				
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Undetermined	*Oxyethira sp.*	Stygooxene																		*					
Arthropoda	Insecta	Trichoptera	Tasimiidae	Undetermined	*Tasimia sp.*	Stygooxene																		*					
Arthropoda	Crustacea	Decapoda	Atyidae	Undetermined	*Paratya australiensis*	Stygooxene												*		*		*					*		
Arthropoda	Crustacea	Syncarida	Parabathynellidae	Undetermined	*N.Sp*	Stygobites										*													
Arthropoda	Maxillopoda	Cyclopoida	Cyclopidae	Undetermined	*Mesocyclops sp.*	Stygooxene												*	*	*		*					*		
Arthropoda	Ostracoda	Myodocopida	Candonidae	Candoninae	*Candonopsis cf.*	Stygooxene												*	*	*							*		
Nematomorpha	Not assigned	Gordioidea	Gordiidae	Undetermined	*Gordius sp.*	Stygooxene													*	*									
Platyhelminthes	Turbellaria	Tricladida	Dugesiidae	Undetermined	*Unidentified*	Stygooxene												*	*	*	*	*	*	*					
				Total No. species	*53*		DNS	0	0	0	0	0	0	0	0	1	2	30	15	23	16	11	23	13	3	3	20	9	5

DNS = did not sample

Appendix 2: Risk assessments

Bore MW1

Locality	**Bore MW1**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype				X	
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of water table level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.			
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.	No detectable change from natural seasonal variation.				
Degree of groundwater salinity.	No detectable change				

	from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).			Major change/alternation of aquifer structure resulting in a permanent change in GDE habitat		
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No		
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)			< 30		
Patch size % of GDE relative to original/historic extent			< 30%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		

Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**6**	**3**	**8**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore MW2

Locality	**Bore MW2**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype				X	
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any			

		dependent habitat type.*			
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.	No detectable change from natural seasonal variation.				
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).			Major change/alternation of aquifer structure resulting in a permanent change in GDE habitat**		
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**

Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE			No		
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)			< 30		
Patch size % of GDE relative to original/historic extent			< 30%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			

TOTAL NUMBER OF ATTRIBUTES	**6**	**3**	**8**		
OVERALL VALUE			**Low**		
COMMENTS					
Locality	**Bore MW1**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype				X	
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of water table level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*			
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.	No detectable change from natural seasonal variation.				

Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).			Major change/alternation of aquifer structure resulting in a permanent change in GDE habitat**		
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No		
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)			< 30		
Patch size % of GDE relative to original/historic extent			< 30%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		

Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**6**	**3**	**8**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore MW3

Locality	**Bore MW3**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype				X	
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of water table level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to			

		part of any dependent habitat type.*			
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.	No detectable change from natural seasonal variation.				
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).			Major change/alternation of aquifer structure resulting in a permanent change in GDE habitat**		
BIODIVERSITY					

Rarity within catchment/groundwater source	High	Moderate	Low	Unknown	Comments
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No		
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)			< 30		
Patch size % of GDE relative to original/historic extent			< 30%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification,		Fractured Rock/semi-consolidated aquifer connected to			

biodegradation relating to aquifer structure and porosity		terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**6**	**3**	**8**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore MW4

Locality	**Bore MW4**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype				X	
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*			
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.	No detectable change				

	from natural seasonal variation.				
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).			Major change/alternation of aquifer structure resulting in a permanent change in GDE habitat**		
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No		
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)			< 30		
Patch size % of GDE relative to original/historic extent			< 30%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**

Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**6**	**3**	**8**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore MW5

Locality	**Bore MW5**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype				X	
AQUIFER					

Water quantity parameters	High	Moderate	Low	Unknown	Comments
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*			
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alkalinity runoff or acidification of groundwater source.			Permanent exposure of high alkalinity with likely runoff into dependent ecosystems.		
Degree of nutrient load.	No detectable change from natural seasonal variation.				
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand			Major change/alternation of aquifer structure resulting in a		

and gravel extraction, compaction of aquifer, etc).			permanent change in GDE habitat**		
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No		
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)			< 30		
Patch size % of GDE relative to original/historic extent			< 30%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			

Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**5**	**3**	**9**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore GW103697

Locality	**Bore GW103697**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*	Fluctuation in groundwater levels resulting in permanent loss of any dependent habitat type. *		
Alteration to direction of hydraulic gradients	No detectable change from natural				

	seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.				X	
Degree of groundwater salinity.			Permanent increase in salinity to dependent ecosystem.		
Degree of bioaccumulation i.e. heavy metal contamination				X	
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.					
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)				X	
Patch size % of GDE relative to original/historic extent				X	
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**

Diversity of groundwater dependent native flora and fauna species within a GDE.					None
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity			Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity			Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**6**	**1**	**7**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore GW100656

Locality	**Bore GW100656**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in				

	GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*	Fluctuation in groundwater levels resulting in permanent loss of any dependent habitat type. *		
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.				X	
Degree of groundwater salinity.			Permanent increase in salinity to dependent ecosystem.		
Degree of bioaccumulation i.e. heavy metal contamination				X	
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered					

species, population or ecological community within GDE.					
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)				X	
Patch size % of GDE relative to original/historic extent				X	
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.			Presence of one species or less than 50% of species relative to reference sites		
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity			Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity			Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**6**	**1**	**7**		
OVERALL VALUE			**Low**		
COMMENTS					

Bore GW108850

Locality	Bore GW108850				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*	Fluctuation in groundwater levels resulting in permanent loss of any dependent habitat type. *		
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.				X	
Degree of groundwater salinity.			Permanent increase in salinity to		

			dependent ecosystem.		
Degree of bioaccumulation i.e. heavy metal contamination				X	
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.					
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)				X	
Patch size % of GDE relative to original/historic extent				X	
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.					Only soil invertebrates observed. Not considered groundwater obligate species.
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical			Occurs only within the State		

features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)					
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity			Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity			Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**6**	**1**	**7**		
OVERALL VALUE			**Low**		
COMMENTS					

Barbers Creek Lower

Locality	**Barbers Creek Lower**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	

Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					

Rarity within catchment/groundwater source	High	Moderate	Low	Unknown	Comments
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		

		and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Barbers Creek Upper

Locality	**Barbers Creek Upper**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural				

	seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered	Yes				

species, population or ecological community within GDE.					
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing,		Fractured Rock/semi-consolidated	Consolidated aquifer connected		

nitrification/denitrification, biodegradation relating to aquifer structure and porosity		aquifer connected to terrestrial and aquatic ecosystems.	to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Gabion Basket Creek Lower

Locality	**Gabion Basket Creek Lower**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural				

	seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				

Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		

OVERALL VALUE			**High**		
COMMENTS					

Gabion Basket Creek Upper

Locality	**Gabion Basket Creek Upper**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change				

	from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					

Diversity within catchment/groundwater source	High	Moderate	Low	Unknown	Comments
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Bungonia Creek Lower

Locality	Bungonia Creek Lower

GDE ENVIRONMENT	High	Moderate	Low	Unknown	Comments
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load	Permanent increase in nutrient load to		

		to dependent ecosystems.	dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80%				

	number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Bungonia Creek Upstream

Locality	**Bungonia Creek Upstream**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of		

			one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from				

	natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				

SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	High	Moderate	Low	Unknown	Comments
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Bungonia Creek Priority area 5

Locality	Bungonia Creek Priority area 5				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical				

	structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change				

	from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		

Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Bungonia Creek Upper

Locality	**Bungonia Creek Upper**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				

AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of water table level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**

Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		

Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Red Track off Bungonia Creek

Locality	**Red Track off Bungonia Creek**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.	Yes				
Presence of exotic flora or fauna within GDE	None exist				
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.	No detectable change from natural				

	seasonal variation.				
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.	No detectable change from natural seasonal variation.				
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand	No detectable change in				

and gravel extraction, compaction of aquifer, etc).	aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.		Presence of 2-4 species or 80-50% of species relative to reference sites			
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity			

		to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**12**	**4**			
OVERALL VALUE			**High**		
COMMENTS					

Riparian Pool, Main Gully Creek

Locality	**Riparian Pool, Main Gully Creek**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural				

	seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered	Yes				

species, population or ecological community within GDE.					
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing,		Fractured Rock/semi-consolidated	Consolidated aquifer connected		

nitrification/denitrification, biodegradation relating to aquifer structure and porosity		aquifer connected to terrestrial and aquatic ecosystems.	to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Main Gully Lower

Locality	**Main Gully Lower**				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE		Exotic species in small numbers			
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.	No detectable change from natural seasonal variation.				
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions				X	

Water quality parameters	High	Moderate	Low	Unknown	Comments
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.			
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).				X	
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No		
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No		
Patch size rank of GDE relative to other patches of the same					

GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)			Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.			
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.			
TOTAL NUMBER OF ATTRIBUTES	**7**	**4**	**5**		
OVERALL VALUE			**High**		
COMMENTS					

Main Gully Upper

Locality	Main Gully Upper				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural				

	seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load to dependent ecosystems.	Permanent increase in nutrient load to dependent ecosystems.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					

Diversity within catchment/groundwater source	High	Moderate	Low	Unknown	Comments
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80% number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

Locality	Main Gully Upper				
GDE ENVIRONMENT	**High**	**Moderate**	**Low**	**Unknown**	**Comments**

GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No		
Presence of exotic flora or fauna within GDE			Exotic species in large populations of one or more species.		
Removal or alteration of GDE type or subtype	No detectable change in physical structure, species composition or size in GDE type or subtype.				
AQUIFER					
Water quantity parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.				X	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.				
Alteration of base flow conditions	No detectable change from natural seasonal variation.				
Water quality parameters	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.				
Degree of nutrient load.		Temporary increase in nutrient load	Permanent increase in nutrient load to dependent ecosystems.		

		to dependent ecosystems.			
Degree of groundwater salinity.	No detectable change from natural seasonal variation.				
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.				
Aquifer structure	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc).	No detectable change in aquifer structure				
BIODIVERSITY					
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.	Yes				
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***	Yes				
Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate)					
Patch size % of GDE relative to original/historic extent					
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Diversity of groundwater dependent native flora and fauna species within a GDE.	Presence of 5 or more species or >80%				

	number of species relative to a reference site				
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**	**Unknown**	**Comments**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.		
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc)		Occurs only within the catchment	Occurs only within the State		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity		Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems.	Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity		Fractured Rock/semi-consolidated aquifer connected to terrestrial and aquatic ecosystems.	Consolidated aquifer connected to terrestrial and aquatic ecosystems		
TOTAL NUMBER OF ATTRIBUTES	**10**	**4**	**7**		
OVERALL VALUE			**High**		
COMMENTS					

All sites

Locality	**All sites**			
Water Quantity Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**

What will be the risk of a change in groundwater levels/pressure on GDEs?			No change to aquifer water levels or pressure.	
What will be the risk of a change in the timing or magnitude of groundwater level fluctuations on GDEs?			No change in timing of water level fluctuations.	
What will be the risk of changing base flow conditions on GDEs?			No change in direction of flow.	
Water Quality Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**
What is the risk of changing the chemical conditions of the groundwater source?			Negligible change (<5%)	
What is the risk on the groundwater source by a change in the freshwater/salt water interface?			No change or not applicable	
What is the likelihood of a change in beneficial use (BU) of the groundwater source?			Negligible change for identified triggers (<5%)	
Aquifer Integrity Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**
What is the risk of damage to the geologic structure?	Permanent destruction of the aquifer matrix. Major cracking/fracturing of the bedrock/stream bed leading complete dewatering of the GDE			

Biological Integrity Asset	High	Moderate	Low	Insufficient data or unknown
What is the risk of alterations to the number of native species within the groundwater dependent communities (fauna and flora)?			No reduction in No. of species.	
What is the risk of alterations to the species composition of the groundwater dependent communities (fauna and flora)?			No change in species composition.	
What is the risk of increasing the presence of exotic flora or fauna?			None exist.	
What is the risk of removing or altering a GDE subtype habitat (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction)?			No removal or alteration of habitat.	
Risk Valuation	**1**	**0**	**10**	
Risk	**There is a low risk of impact from the proposed activity.**			

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Appendix N

Aboriginal cultural heritage assessment

VOLUME 5

Appendix M	Stygofauna and groundwater dependent ecosystem assessment
Appendix N	Aboriginal cultural heritage assessment





Marulan South Limestone Mine Continued Operations Project

Aboriginal cultural heritage assessment | including the results of an archaeological survey and test excavation

Prepared for Boral Cement Limited
November 2018









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Marulan South Limestone Mine Continued Operations Project

Aboriginal cultural heritage assessment | including the results of an archaeological survey and test excavation

Prepared for Boral Cement Limited | 29 November 2018

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Marulan South Limestone Mine Continued Operations Project

Final

Report J14107RP1 | Prepared for Boral Cement Limited | 29 November 2018

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Position	Senior Archaeologist	Position	Senior Archaeologist	Position	Heritage Services Manager
Signature		Signature		Signature	
Date	25 March 2016	Date	29 November 2018	Date	29 November 2018

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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Executive Summary

EMM Consulting Pty Limited Pty Limited (EMM) was commissioned by Boral Cement Limited to prepare an Aboriginal cultural heritage assessment (ACHA) to accompany the development application for the Marulan South Limestone Mine Continued Operations Project.

Approval for the Project is being sought under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). An environmental impact statement (EIS) is a requirement of the approval processes. This Aboriginal cultural heritage assessment (ACHA) forms part of the EIS. It documents the methodology and results of the assessment, the measures taken to avoid and minimise impacts and the additional mitigation and management measures proposed.

This ACHA has been prepared in accordance with the Secretary's Environmental Assessment Requirements for the project and leading practice guidelines. In summary, the ACHA has involved:

- background research of the study area's environmental, archaeological and ethno-historical context;
- Aboriginal consultation in accordance with the *Aboriginal Consultation Requirements for Proponents 2010* (DECCW 2010c);
- an archaeological survey and test excavation; and
- an assessment of archaeological (scientific) and socio-cultural and historic values (significance to the Aboriginal community), impact assessment and management recommendations for the identified Aboriginal cultural heritage values using the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011).

Nineteen Aboriginal parties registered their interest in the project and are referred to as registered Aboriginal parties (RAPs). RAPs were offered to provide cultural information about the study, invited to participate in two consultation meetings, and provided with draft assessment and fieldwork methods for review.

One cultural site (non-statutory) was identified during the consultation process. This site has been assessed in a separate report and will not be impacted by the Project (Appendix G – Waters Consultancy 2017). A total of 57 Aboriginal sites were identified during the Project, which includes 40 sites identified during the survey and identified 17 during the test excavation. An additional 18 sites were identified in the vicinity of the Project site and were incorporated into the Project impact assessment and management measures. Thus a total of 75 recorded Aboriginal sites have been considered in this assessment.

Each identified site was assessed for archaeological significance. There is a total of:

- one site of high significance (MSL 046);
- 11 sites of moderate significance; and
- 63 sites of low significance.

Out of a total of 75 Aboriginal sites, 49 will be impacted to some degree by the Project, leaving 25 sites not impacted and one site previously M1 (BCSC1)/BCSC 1 removed as part of approved mining activities. A total of 39 sites will be totally lost and 10 sites totally disturbed.

Management and mitigation measures were developed in response to the proposed impacts. The level of management proposed is directly proportionate to the archaeological significance of each site and the nature of the impact. A summary of the management measures across the Project site is shown in Table E.1. All management measures, including unexpected finds protocols, will be developed during the preparation of an Aboriginal heritage management plan (AHMP) subsequent to Project approval.

Table E.1.1 Management summary

Row Labels	Artefact scatter	Isolated find	Subsurface artefact deposit	Total
Avoidance	1	7	2	10
Avoidance and protection	8	6		14
Collection	25	10		35
Salvage excavation			5	5
Unmitigated impacts			10	10
None (site removed)	1			1
Total	**35**	**23**	**17**	**75**

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1 Introduction

1.1 Overview

Boral Cement Limited (Boral) owns and operates the Marulan South Limestone Mine (the mine). It is a long standing open cut mine that has produced up to 3.38 million tonnes 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.

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 and continuing use rights.

Due to changes between the *Mining Act 1992* and the *Environmental Planning & Assessment Act 1979* (EP&A Act), when mining moves beyond the area covered by the current Mining Operations Plan, a development consent under the EP&A Act will need to be in place.

An Environmental Impact Statement has been prepared by Element Environment Pty Ltd on behalf of Boral for submission to the Department of Planning and Environment to satisfy the provisions of Part 4 of the EP&A Act. Boral is seeking approval for continued operations at the site through a development application for a State Significant Development including a 30 year mine plan, associated overburden emplacement areas and a mine water supply dam (hereafter referred to as 'the Project').

EMM Consulting Pty Limited (EMM) was engaged by Boral to prepare an Aboriginal cultural heritage assessment (ACHA) to accompany the Environmental Impact Statement for the Project. The ACHA documents methods and results, and the initiatives built into the project design to avoid and minimise impacts to Aboriginal cultural heritage values. Additionally, it proposes mitigation and management measures to address residual impacts for sites that are unable to be avoided.

1.2 Site location

The mine is located in Marulan South, 10 kilometres (km) southeast of Marulan village and 35 km east of Goulburn, within the Goulburn Mulwaree Local Government Area (LGA) in the Southern Tablelands of NSW (Figure 1.1). Access is via Marulan South Road, which connects the mine and Boral's Peppertree Hard Rock Quarry (Peppertree Quarry) with the Hume Highway approximately 9 km to the northwest (Figure 1.2). Boral's private rail line connects the mine and Peppertree Quarry with the Main Southern Railway approximately 6 km to the north (Figure 1.2).

1.3 Existing operations

The Marulan South Limestone Mine is sited on a high grade limestone resource. Subject to market demand the mine has typically produced 3 to 3.3 million tonnes of limestone and 120,000 to 200,000 tonnes 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. Material 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, west of the open cut pits.

The current operations are 24 hour, 7 days per week with personnel employed on a series of 8, 10 and 12 hour shifts to cover the different operational aspects of the mine. Blasting is restricted to daylight hours and on weekdays, excluding public holidays.

1.4 The proposed project

1.4.1 Mining operations

Boral proposes to continue mining limestone from the mine at a rate of up to 4 million tonnes per annum (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 tonnes per annum (tpa).

The proposed 30 year mine plan accesses approximately 120 million tonnes 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 part of the South Pit, leaving the remainder of the South Pit for overburden emplacement and a visual barrier (Figure 1.3).

In addition to mining approximately 5 million tonnes of shale, the extraction of the limestone requires the removal of approximately 108 million tonnes of overburden over the 30 year period. This material will be emplaced within existing and proposed overburden emplacement areas (Figure 1.3).

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 propose to increase production of manufactured sand to approximately 1 million tpa.

Boral's adjoining 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 million tonnes of overburden from the mine after the removal of accessible limestone , Boral proposes to emplace up to 15 million tonnes of overburden from Peppertree Quarry within the Northern Overburden Emplacement (Figure 1.3).

1.4.2 Associated infrastructure

i Processing

The existing facilities for processing limestone will continue to be utilised to produce a series of graded and blended limestone products that are despatched from site for use primarily in cement manufacture, steel making, commercial and agricultural applications.

Limestone processing facilities (Figure 1.3) 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.

Kiln stone grade limestone will also continue 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.

Processing infrastructure and the reclaim and stockpile area at the northern end of the North Pit will be relocated during the life of the 30 year pit to enable full development of the mine plan. The timing and location of this is presented in the EIS.

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.

ii Water supply

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 water supply dam on Marulan Creek (Figures 1.3 and 1.4). This dam would be located on Boral owned land north of Peppertree Quarry and utilises Boral's adjoining Tallong water pipeline to transfer water to the mine. This dam would require the purchase of water entitlements.

Mine water demand will also be supplemented by Tallong Weir via the Tallong water pipeline.

iii Rail

No changes are proposed to the existing rail infrastructure. A 1.2 km long passing line was constructed at Medway Junction during construction of the Peppertree Quarry, which will also be used by the mine to enhance access to the Main Southern Railway.

iv Road

Road access from the mine to the Hume Highway is via Marulan South Road. The proposed Western Overburden Emplacement extends northwards over Marulan South Road. Boral propose to realign a section of Marulan South Road, to accommodate the northern portion of the proposed Western Overburden Emplacement (Figure 1.3).

All public roads within 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 will be de-proclaimed.

v Power

Power supply to the mine is via a high voltage power line that commences at 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 proposed Northern Overburden Emplacement (Figure 1.3).

1.5 Study area

The study area for the Project comprises the area within the Project site (Figure 1.1 to Figure 1.4). This includes areas around Marulan Creek in the north and areas to the west of the current mine pit. The Project site has been divided into two sections for ease of reference; the main Project site and Marulan Creek Dam.

1.6 Planning context

This report has been prepared to fulfil the Secretary's environmental assessment requirements (SEARs) for Aboriginal heritage under Part 4 Division 4 of the *Environmental Planning and Assessment Act, 1979* (EP&A Act). The SEARS and EMM's responsive approach are presented in Table 1.1.

Table 1.1 SEARs

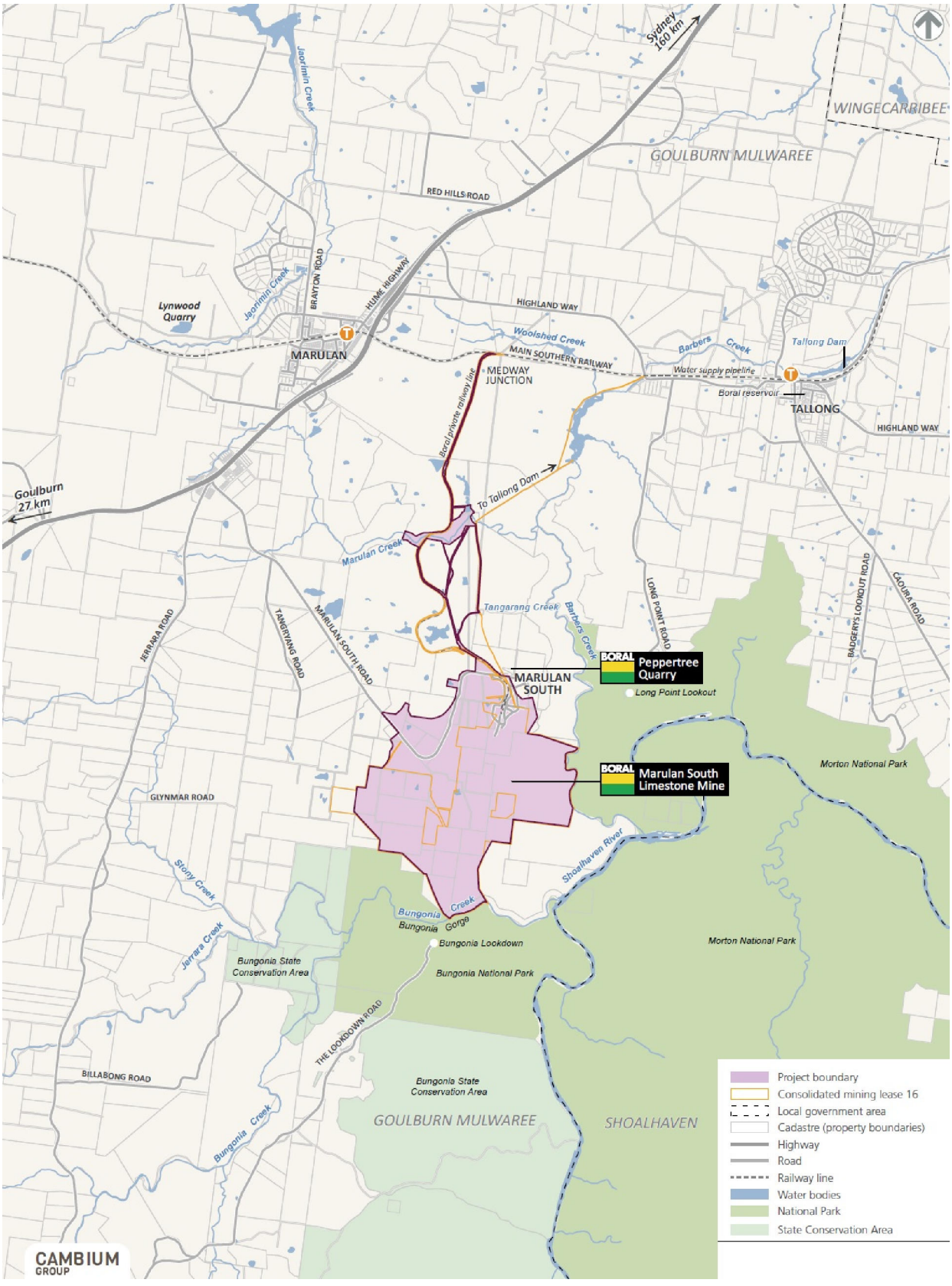
Aboriginal heritage	Relevant report section
SEARs requirements	
An Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must:	This report
Demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; and	Section 2
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 11
Make use of the following documents:	
Draft guidelines for Aboriginal cultural heritage assessment and community consultation (DEC 2005);	This report

Table 1.1 SEARs

Aboriginal heritage	Relevant report section
Aboriginal cultural heritage consultation requirements for proponents (DECCW 2010); and	This report
The Burra Charter (The Australian ICOMOS charter for places of cultural significance) (ICOMOS 2013).	This report
Office of Environment and Heritage (OEH) requirements	
The EIS must identify and describe the tangible and intangible Aboriginal cultural heritage values that exist across the whole area that will be affected by the Project and document these in the EIS. This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided by the *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (DECCW 2011) and consultation with OEH regional officers.	Sections 3 – 9
Where Aboriginal cultural heritage values are identified, consultation with Aboriginal people must be undertaken and documented in accordance with the *Aboriginal Cultural Heritage consultation requirements for proponents 2010* (DECCW) The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the EIS.	Section 2
Impacts on Aboriginal cultural heritage values are to be assessed and documented in the EIS. The EIS must: Demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the EIS must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH.	Sections 10 and 11
The assessment of Aboriginal cultural heritage values must include a surface survey undertaken by a qualified archaeologist in conjunction with Registered Aboriginal Parties. The result of the surface survey is to inform the need for targeted test excavation to better assess the integrity, extent, distribution, nature and overall significance of the archaeological record. The results of surface surveys and test excavations are to be documented in the EIS.	Sections 6, 7 and 8 Appendix G for cultural site report Appendices C, D and E
Consultation with Aboriginal people must be undertaken and documented in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010 (DECCW).	Section 2 and Appendix A Appendix G for cultural site report
OEH notes that section 13.3 of the Preliminary Environmental Assessment (dated April 2015) refers to consultation will be undertaken in accordance with the Interim Community Consultation Requirements for Applicants (DEC 2005). OEH advises that the 2010 Aboriginal Cultural Heritage Consultation Requirements for Proponents, as stated in section 1.2 of these requirements, have now replaced the Interim Community Consultation Requirements for Applicants.	Section 2 and Appendix A

Table 1.1 SEARs

Aboriginal heritage	Relevant report section
Impacts on Aboriginal cultural heritage values are to be assessed and documented in the EIS. The EIS must: a) Demonstrate attempts to avoid impact upon Aboriginal cultural heritage values and identify any conservation outcomes; b) Where impacts are unavoidable, outline measures proposed to mitigate impacts; c) Outline procedures to be followed if Aboriginal objects are found at any stage of the life of the project to formulate appropriate measures to manage unforeseen impacts; and d) Outline procedures to be followed in the event Aboriginal burials or skeletal material is uncovered during construction to formulate appropriate measures to manage the impacts to this material.	Sections 10 and 11
Any Aboriginal objects recorded as part of the assessment must be document and notified to OEH. Copies of the relevant Archaeological report and Aboriginal cultural heritage assessment report must also be forwarded to OEH.	Appendix B



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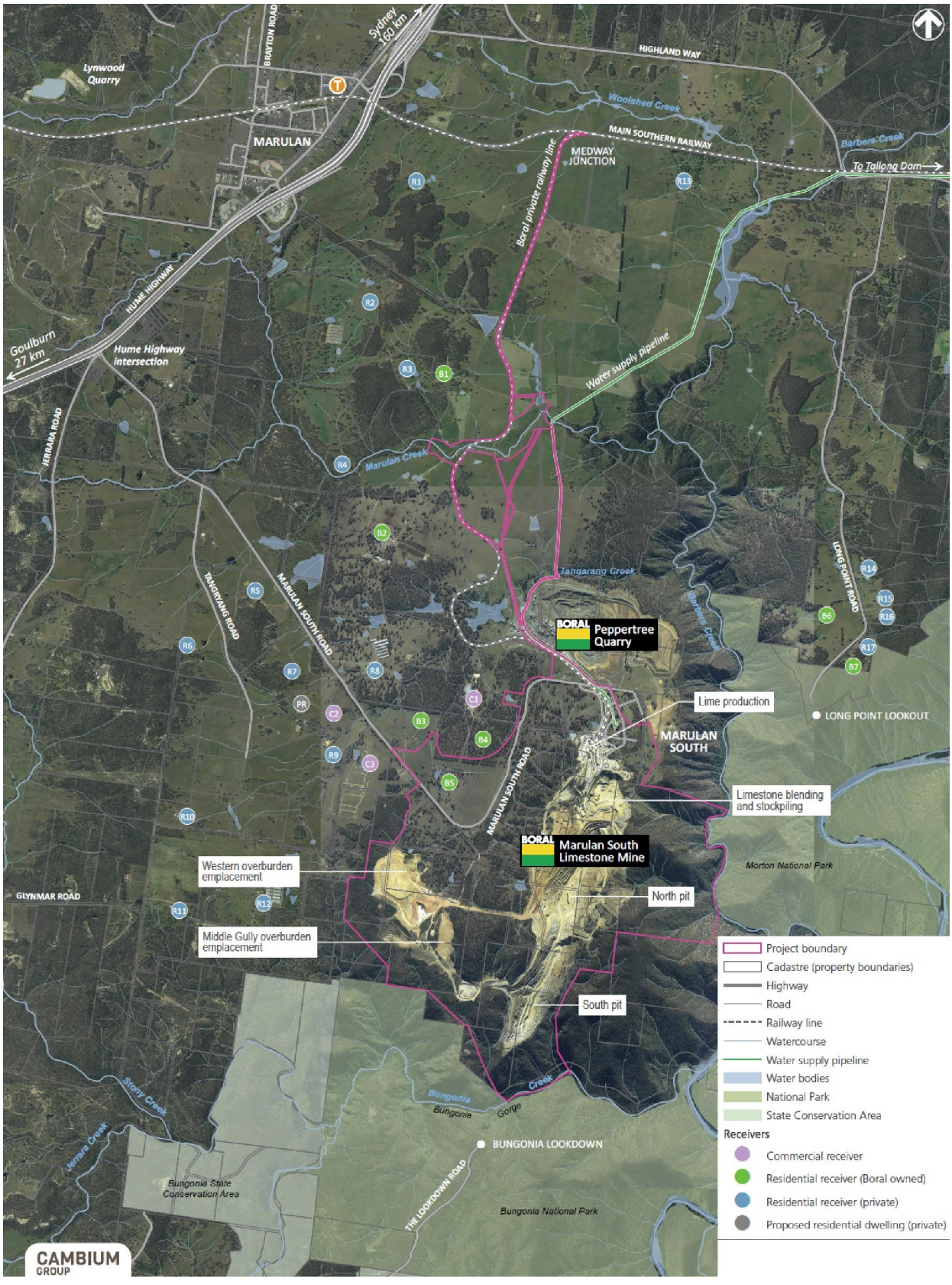
Source: Cambium Group Pty Ltd (2018)

Regional context



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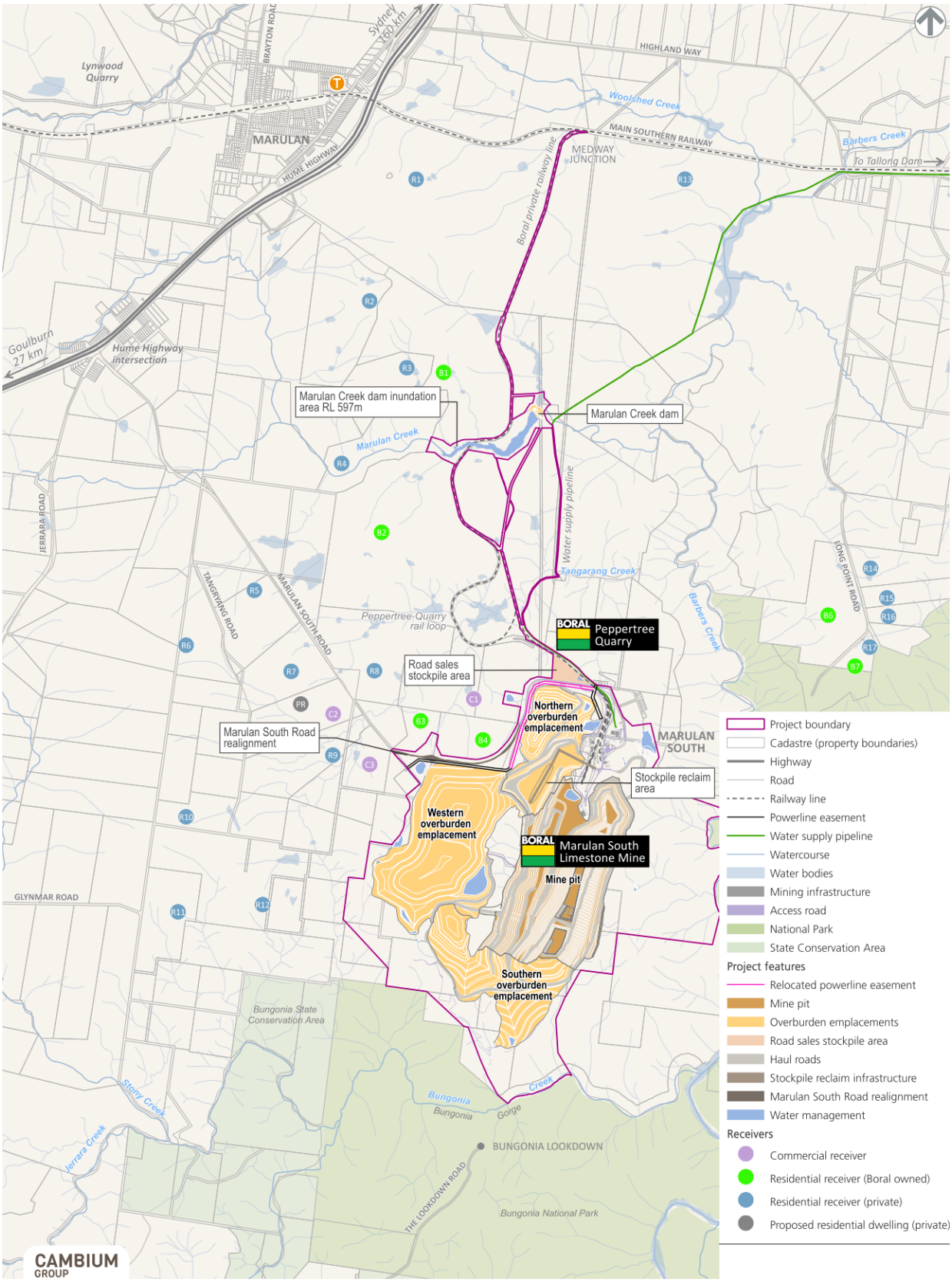
Source: Cambium Group Pty Ltd (2018)

Local context



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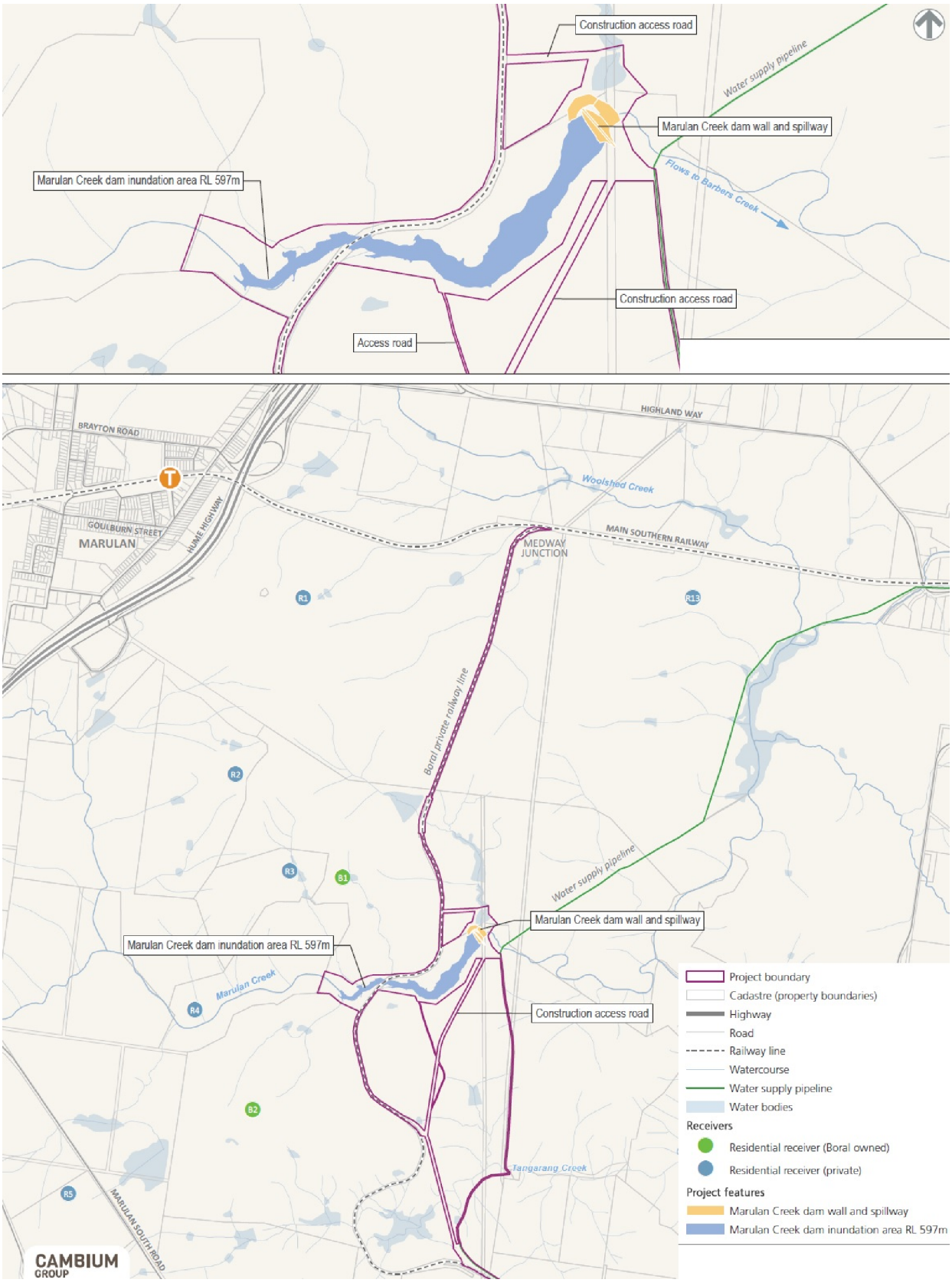

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Source: Cambium Group Pty Ltd (2018)

The project MCD v02

1.7 Objectives of this assessment

The aim of this ACHA was to assess the Aboriginal cultural heritage values within the Project site in accordance with the SEARs. It was prepared as a technical study appended to the EIS for the Project.

The objectives of the assessment were to:

- identify Aboriginal cultural heritage values relevant to the Project site which may entail:
  - Aboriginal objects and sites;
  - Aboriginal socio-cultural values which might not be related to Aboriginal objects;
  - areas of archaeological sensitivity;
- assess the significance of Aboriginal objects, sites and places identified in the course of archaeological investigations and through Aboriginal community consultation;
- assess the impact of the Project on the identified Aboriginal heritage values; and
- identify appropriate management measures for potentially impacted Aboriginal heritage values in response to the assessed significance of those values and potential impacts.

1.8 Authorship

This report was written by EMM Archaeologist Rebecca Newell (BA hons Archaeology) who prepared the assessment up until the draft ACHA was firstly presented to registered Aboriginal parties (RAPs) in November 2015. Since that time, it has been updated by EMM Heritage Services Manager, Pamela Kottaras(BA hons Archaeology) in 2016 and has been reviewed and revised by EMM Senior Archaeologist Ryan Desic in 2018 (BA hons Archaeology). The report has also been reviewed by Neville Hattingh (Element Environment), Les Longhurst (Boral) and Rod Wallace (Boral).

1.9 Acknowledgments

The following are acknowledged in the preparation of this report:

- Pamela Kottaras and Ryan Desic (EMM) test excavation trench supervisors;
- Pamela Chauvel excavation assistance, artefact cataloguing and preparation of artefact analysis report sections;
- Irek Golka; archaeological excavation and field surveying (GIS); and
- Nikolas Svede, archaeological excavation.

2 Aboriginal consultation

2.1 Consultation process

2.1.1 Statutory basis

The SEARs have stipulated the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010) as the guiding consultation document for the Project. In accordance with the DECCW 2010 guidelines, 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.

The guidelines referred to above explicitly exclude employment on archaeological fieldwork from the definition of 'consultation'.

Details of consultation are provided in Appendix A.

2.2 Stage 1 – identification of registered Aboriginal parties

2.2.1 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:

- The Office of Environment and Heritage (OEH) South East Region;
- Pejar Local Aboriginal Land Council (PLALC);
- Goulburn Mulwaree Shire Council;
- South East Local Land Service (replacing the Catchment Management Authority);
- National Native Title Tribunal;
- the office of the Registrar of Aboriginal Owners; and
- NTSCorp.

Responses were received from all agencies and are included in Appendix A.

2.2.2 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. No responses to the public notice were received.

2.2.3 Aboriginal group invitation to register

Letters via post and email were sent 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.

2.3 Registered Aboriginal parties

Table 2.1 provides information on the Aboriginal parties who registered an interest in being consulted for the Project. A total of 19 groups registered for the Project.

Table 2.1 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
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

2.4 Stages 2 and 3 – presentation of information and request for cultural information

2.4.1 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 the Project and method information.

2.4.2 Consultation meeting 1

A meeting was held on 25 March 2015 at Boral's Marulan South Limestone Mine office attended by EMM, Boral and RAPs. The meeting included the presentation of Project information, survey strategy and the possibility of test excavation for the Project. A presentation was made and colour hardcopies provided to all attendees (Appendix A). Attendees included:

- Rebecca Newell, Ryan Desic (EMM);
- Rod Wallace, Les Longhurst, Vince Scarcella, Sharon Makin (Boral);
- A. Bond (Badu);
- Walter Bell, Karen Denny (Buru Ngunawal Aboriginal Corporation);
- Steve Johnson (Corroboree Aboriginal Corporation);
- Kieran McNally (Gundungurra Aboriginal Heritage Association Inc);
- Keith Nye (Gunyuu);
- Kayleen Busk, Peter Cole (Koomurri Ngunawal Aboriginal Corporation);
- Shaun Caroll (Merrigarn Aboriginal Corporation);
- Peter Falk (Mr Peter Falk Consultancy);
- Ryan Johnson (Murri Bidgee Mullangari Aboriginal Corporation);
- Tammy Muscat (Ngunawal Heritage Aboriginal Corporation);
- Aaron Broad, D. Patterson (Nundagurri);
- Justin Boney (Pejar LALC);
- Hike Tekowhai, Owen Carriage (Walbunja Aboriginal Corporation);
- Leeroy Bota (Wullung); and
- Dwayne M (Yerramurra).

2.4.3 Test excavation

After the completion of 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
- Mr Peter Falk Consultancy expressed their opposition to the use of a machine for excavation.

As a result of the comments on the method 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.

2.5 Stage 4 - review of draft Aboriginal cultural heritage assessment

2.5.1 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. A four week time frame for review was issued with the draft assessment report. 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 implemented 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 stipulating a 28 day review timeframe.

2.5.2 Consultation meeting 2

A meeting to discuss and review the draft ACHA was held at the Marulan South Limestone 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).

A project update on the survey and test excavation methodology and results was presented, followed by an outline of the proposed management strategies. Kate Waters, who was engaged to conduct an assessment of a cultural site identified by one of the RAPs during survey, 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 will then involve examining the whole cultural landscape in order to contextualise and understand the site under investigation. She will also look at documentary and other evidence.

Other issues raised by the RAPs at the meeting are included in Table 2.2.

2.5.3 Response to comments

The issues raised in response to the draft report are provided in the RAP letters and in response letters from EMM in Appendix A. Requests or concerns raised in response to correspondence from RAPs and the manner in which those concerns are addressed are summarised in Table 2.2. 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.

Table 2.2 Summary of RAP responses to the draft report received at meeting 10 December 2015

Issue raised	Response
BNAC agrees with the management recommendations in the draft ACHA from a scientific archaeological viewpoint; however, have stressed concern that too much emphasis is placed on scientific archaeological values in heritage assessments to the detriment of cultural values.	Waters Consultancy (Cultural Heritage Specialist) (Appendix G 2017) was engaged to investigate an identified cultural site and to assess intangible heritage which has provided context for the cultural landscape and its values.
CAC has no additional comments or request in relation to the draft ACHA.	Noted
KNAC/GNHAC considers the Marulan South Limestone Mine site to be one continuous site with Peppertree Quarry and therefore recommends that a monitoring plan similar to the one in place at Peppertree Quarry be instigated at the Marulan South Limestone Mine.	EMM acknowledges the importance of understanding cultural landscapes as a whole, and their intangible and spiritual importance. However, archaeologically, only Marulan Creek has high artefact densities similar to those found on the Peppertree Quarry site. Across the rest of the Marulan South Limestone Mine project area, the surface scatters are not reflective of subsurface deposits (which are of low density). Many of the proposed overburden emplacements are on areas where there is little archaeological evidence.

Table 2.2 Summary of RAP responses to the draft report received at meeting 10 December 2015

Issue raised	Response
NHAC believe the management measures are adequate but represent the minimum that should be done. They are pleased that sites will be preserved and agree with the salvage excavation that is proposed. However, they would like to see MSL048 added to the salvage excavation. They would also like monitoring of top soil stripping in high density PAD areas, especially around Marulan Creek, and cited Peppertree Quarry as an example of why this should happen.	The location of the test pit at MSL 048 will not be impacted by the project. However, it is acknowledged that the Project will still impact an area of high archaeological sensitivity nearby the sites MSL 045 and MSL 048. As such, the impacted portion of the nearby area of high archaeological sensitivity will represent salvage associated with MSL 045 and MSL 048. Overburden emplacements and haul roads will be located on areas that are away from areas of moderate to high archaeological sensitivity therefore monitoring and grader scrapes are not warranted. The exception to this is the area surrounding MSL 055 which is an area of moderate archaeological sensitivity which will be subject to controlled salvage excavation. In many areas there is very little topsoil and grader scrapes would not be justified. However, surface collection and salvage will be undertaken where needed. Topsoil stripping around Marulan Creek is also not warranted. The appropriate sites subject to direct impacts will be archaeologically salvaged. The areas that are in the dam inundation area do not require ground disturbance, and therefore topsoil stripping would introduce greater impacts when compared to the impact of water inundation.
Tyrone Bell (Thunderstone) requested that education opportunities be considered. He suggested workshop packages to interpret culture and stressed the importance of implementing initiatives to include the next generation.	Boral have expressed their willingness for this to be developed in the future.
Tyron Bell (Thunderstone) proposed grader scrapes and monitoring of affected areas.	Overburden emplacements and haul roads will be located on areas that are not archaeologically sensitive therefore monitoring and grader scrapes are not warranted. In many areas there is very little topsoil (less than 10%) and grader scrapes would not result in information that could contribute to the archaeological record, nor is it anticipated that a high number of Aboriginal objects would be retrieved. However, surface collection and salvage will be undertaken where needed.
Glen Freeman (KNAC/GNHAC) said that the Marulan South Limestone Mine is on Ngunawal and Gundungurra country. EMM has a duty of care to the traditional owners and he expressed his concern that representatives from other groups have been involved in the project. Consequently, he is reluctant to share cultural knowledge because he does not want it appropriated by other groups.	The relevant requirements stipulate that all who register must be consulted. Please refer to the *Aboriginal cultural heritage consultation requirements for proponents* 2010, Part 6 *National Parks and Wildlife Act* 1974.

2.5.4 Written responses to draft report

Table 2.3 Summary of RAP written responses to the draft report

Issue raised	Response
BNAC reiterated issues raised at the previous meeting. BNAC agrees with the management recommendations in the draft ACHA from a scientific archaeological viewpoint; however, have stressed concern that too much emphasis is placed on scientific archaeological values in heritage assessments to the detriment of cultural values. BNAC stressed the importance of cultural understanding and that more validity should be given to the evidence of spiritual/cultural connection to place provided by Aboriginal people.	Waters Consultancy P/L (Cultural Heritage Specialist) was engaged to investigate an identified cultural site and to assess intangible heritage which will help provide context for the cultural landscape (Appendix G).
CAC confirmed that the group has no additional comments or request in relation to the draft ACHA.	Noted
KNAC/GNHAC reiterated issues raised at the previous meeting that the group considers the Marulan South Limestone Mine site to be one continuous site with Peppertree Quarry and therefore recommends that a monitoring plan similar to the one in place at Peppertree Quarry be instigated at the Marulan South Limestone Mine.	EMM acknowledges the importance of understanding cultural landscapes as a whole, and their intangible and spiritual importance. However, archaeologically, only Marulan Creek has high artefact densities similar to Peppertree Quarry and that across the rest of the Marulan South Limestone Mine project area, the surface scatters are not reflective of subsurface deposits (which are of low density). Many of the proposed overburden emplacements are on areas where there is little archaeological evidence.
NHAC reiterated that the group believes the management measures are adequate but represent the minimum that should be done. They are pleased that sites will be preserved and agree with the salvage excavation that is proposed. However, they would like to see MSL048 added to the salvage excavation. They would also like monitoring of top soil stripping in high density PAD areas, especially around Marulan Creek, and cited Peppertree Quarry as an example of why this should happen.	MSL048 will not be impacted by the project so there is no need to conduct a salvage excavation for this site. Overburden emplacements and haul roads will be located on areas that are not archaeologically sensitive therefore monitoring and grader scrapes are not warranted. In many areas there is very little topsoil (less than 10%) and grader scrapes would not be justified. However, surface collection and salvage will be undertaken where needed.

2.5.5 Consultation through project redesign

During the revision of the mine plan for the Project, the RAPs were kept informed of its continuation through 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 being pursued for the assessment.

In February 2018, RAPs were notified about Project changes relating to the assessment, whereby approval for overburden emplacement in the Northern Overburden Emplacement and Road Sales Stockpile Area needed to be brought forward due to timing delays for the project SSD application. As such, part of the Project area was integrated into the nearby Peppertree Quarry site boundary for emplacement activities to be approved under Modification 5 to the quarry's existing project approval. Further information about Peppertree Quarry Modification 5 is provided in Section 10.8 of this report.

3 Environmental background

3.1 Landscape overview

The study area is located in the Southern Tablelands of NSW - a plateau surrounded by steep gorges and valleys. Prominent landforms in the vicinity are the Barbers Creek Gorge to the east and Bungonia Creek Gorge to the south.

The Project site is characterised by undulating terrain with areas of high relief in the east. The area is located near a number of different topographic locations, from the very steep hills of the Barbers and Bungonia Gorges with chasms and escarpment, to the undulating low hills of the Southern Tablelands. This creates a dynamic landscape with a variety of geological material, flora and fauna.

3.2 Topography

3.2.1 Landscape

The local landscape has considerable topographic variations and this is evidenced in the Project site. Landscape topography and hydrology is presented in Figure 3.1.

The Project site is characterised by undulating hills and the large flat plateau that the town of Marulan South was situated on; this is contrasted by the steeply inclined rugged gorges associated with the Morton National Park, Bungonia National Park and the Bungonia State Conservation Area. This terrain would have acted as a barrier to pedestrian access routes to the south and east (Gojak 2006).

The main Project site represents a transition from rolling hills to the north into steep hills with deeply incised drainage channels that form to the south in the proposed northern, western and southern emplacement areas.

The area of Marulan Creek Dam is characterised by rolling hills and areas of plateau. Marulan Creek is gently incised. This area would have been suitable for long term camping and habitation, with many resources available.

3.2.2 Drainage

The main watercourses near the Project site include the Shoalhaven River approximately 3 km to the south-east which runs in a north-easterly direction. From the Shoalhaven River the tributaries of Barbers Creek and Bungonia Creek are located approximately 0.8 km east and 0.4 km south of the Project site respectively. Main Gully is a tributary of Bungonia Creek and is located on the southern edge of the Project site. Tangarang Creek is located 3 km to the north-west of the main Project site. A dam has been constructed on this creek to supply water to the Peppertree Quarry project. Dams and ponds have been built on the Project site and surrounding areas over the last 50 to 100 years changing the landscape to a small degree but would not have been a water source for Aboriginal people in the past.

The main Project site is dominated by a series of unnamed ephemeral watercourses and drainage lines which run in a west to east direction. These ephemeral drainage lines divide multiple gentle to steep spur landforms. Prior to mining, these watercourses would have drained to Barbers Creek to the east and Bungonia Creek to the south, but are now intercepted by the mine pit. A series of unnamed ephemeral watercourses are also located in the north-western extent of the Project site. They drain northwards into Tangarang Creek, which is a tributary of Barbers Creek.

The proposed dam is located on Marulan Creek to the north of the main Project site and Peppertree Quarry. It is a fourth order l stream of similar size to Tangarang Creek and joins Barbers Creek in the east.

3.3 Geology

The Project site is in the Lachlan Geosynclinal Province; also known as the Lachlan Fold Belt, which contains the Marulan limestone deposit. Early geologists identified the conglomerate sandstone that characterises the Project site including the limestone at Marulan South (*Sydney Morning Herald* 1852 p.2). The Lachlan Fold Belt is a complex sequence of volcanic and metamorphic layers dipping very steeply to the west in some areas it is almost vertical (AGEC 2018, p.11).

The southern areas of the Project site is characterised by the Silurian-Devonian geology formation known as the Bungonia Limestone Group. The Bungonia Limestone Group includes interbedded fossiliferous shale, sandstone, limestone and siltstone. This geological unit was formed by a reef complex, later folded and faulted by crustal collisions, and levelled by substantial erosion. About 65 Million years ago the area was again uplifted, giving way to a rejuvenated river system, and resulting in the landscape of today (Crawford 2015, p.19). The Lookdown Limestone Formation is the highest grade limestone on the Project site and is the subject of mining (AGEC 2018, p.12).

The northern areas of the Project site, including Marulan Creek are characterised by Devonian granodiorite, known as the Glenrock Granodiorite intrusion. Stone material which would have been suitable for the production of stone tools includes quartz, feldspar and tuff and areas of these stone types are located in the north approximately 3 km from the Project site. Cherts are known to outcrop along the Wollondilly River approximately 25 km from the Project site. The survey identified outcrops of naturally occurring silcrete along Marulan Creek and the underlying geology is siliceous. The geological landscape of the Project site will have provided suitable raw material for stone tool manufacture, as much of the underlying geology is comprised of siliceous material.

3.4 Soils

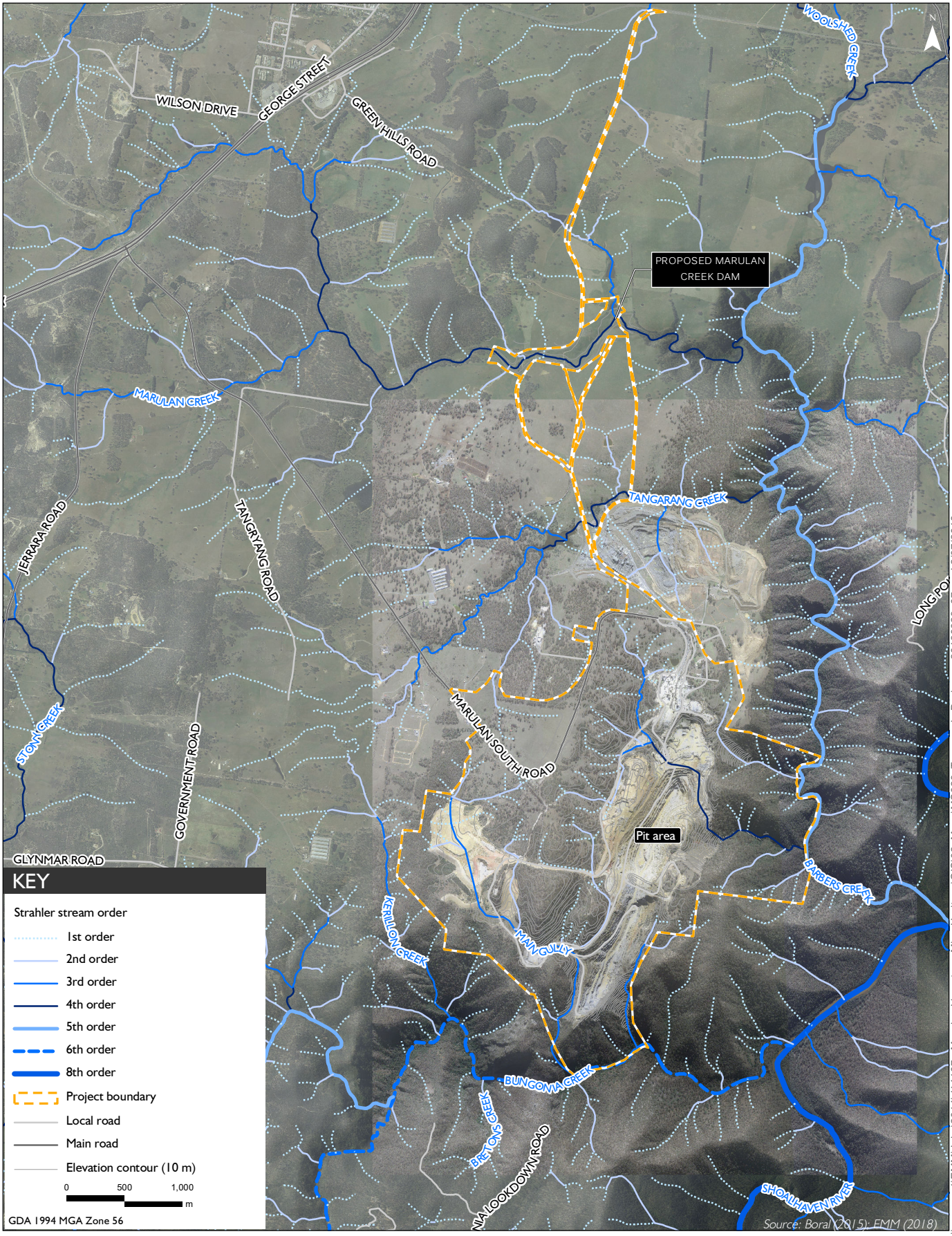
Generally the soil profile is duplex with a thin, poorly structured loamy sand topsoil A horizon and a clayey B horizon. It is usually weakly pedal with pH range of 4.5 – 10. Extensive land clearing has exposed the topsoils to high levels of erosion (LAMAC Management 2018). A detailed soil assessment has been completed for the Project site (LAMAC Management 2018). It identified six soil landscape units in the Project site using the Australian soil classification system:

- Sodosols (red/brown): a soil type located in the northern areas of the Project site on mid to upper gently undulating slopes. The A1 horizon is dark grey loam with an A2 profile of yellowish brown sandy loam overlying olive brown heavy clay.

- Kurosols (brown): a soil type located in the southern areas of the Project site on flats and in drainage depressions. The A1 is a dark greyish brown sandy loam with an A2 profile of yellowish brown sandy clay loam. The B2 profile is yellowish brown medium clay.

- Tenosols (brown orthic/bleached orthic): a soil type located in the centre of the Project site on ridge crests, upper slopes and steep slopes. It consists of a thin A1 profile of dark brown sandy loam overlying a B2 profile of yellowish brown heavy clay.

- Tenosols/Rudosols (steep slopes): a soil type located in the south-west, south and east of the Project site on steep to precipitous slopes and ridgelines. The profile contains shallow stony sideslope soils.



EMM

Topography and drainage

Marulan South Limestone Mine Continued Operations Project

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Figure 3.1

- Rudosols (alluvial): a soil type located in the eastern and southern areas of the Project site in stream channels and adjacent terraces. The profile contains shallow loose alluvial sands and gravels.

- Disturbed land and anthroposols: a soil profile located in the central and south-west areas of the Project site. It consists of disturbed land including the pit infrastructure and overburden emplacements.

The soil and landscape assessment identified a shallow topsoil resource across the Project site with many areas experiencing less than 10 cm of topsoil (LAMAC Management 2018). It also identified elevated pH levels across the Project site. The soil landscape surrounding the Project site would have provided suitable raw material for stone tool manufacture, as much of the underlying geology is comprised of siliceous material.

3.4.1 Vegetation

The majority of the Project site has been cleared for past agricultural land uses. Vegetation consists of open cultivated paddocks with scatters of eucalyptus trees or open woodland. The flora typical to the areas consists of grassy open eucalypt woodlands and pasture. Dominant tree species include Blakely's Red Gum (*Eucalyptus blakelyi)* white stringybark (*Eucalyptus globoidea*), yellow stringybark (*E. muelleriana*), woollybutt (*E.longifolia*), coast grey box (*E. bosistoana*) and silvertop ash (*E. sieberi*) (Niche 2018, Appendix 3).

Typically the project site contained a midstorey of *Acacia parramattensis*, which depending on disturbance was sparse to dense in areas, in particular toward the south of the Western Overburden Emplacement and Southern Overburden Emplacement. The shrub layer consisted of *Cassinia aculeata, Lissanthe strigosa* and *Olearia viscidula*. The ground layer consisted *of Einadia hastata Austrodanthonia racemosa, Microlaena stipoides, Bothriochloa macra, Acaena novae-zelandiae, Lomandra filiformis subsp. coriacea, Thysanotus patersonii, Anisopogon avenaceus, Poa sieberiana, Austrostipa scabra*, and *Aristida ramose* (Niche 2018, Appendix 3).

Areas around Marulan Creek dam were cleared of native trees and shrubs and contained exotic pasture grasses (Niche 2018, Appendix 3).

3.4.2 Fauna

Faunal resources in the Project site include kangaroo, wallaby, wombat, reptiles and birds. In addition, the remains of turtles and crayfish have been noted near the watercourses.

3.4.3 Climate

The nearest Bureau of Meteorology (BoM) weather station to the Project site is Goulburn Airport Automatic Weather Station which is located 25 km west-south-west of the Project site (BoM 2014). The Marulan South Limestone Mine and the adjacent Peppertree Quarry each operate an automatic weather station and this data has been used to characterise the climate as 'temperate without a dry season and warm summers' (Todoroski Air Sciences 2018, p.12).

The rainfall long term annual average is 694.2 mm/year (AGEC 2018, p.11). June is the wettest month of the year with an average of 58.6 mm over 7.3 days (Todoroski Air Sciences 2018, p.12). The mean maximum temperature in the hottest month of the year; January is 27.8°C and the coldest month of the year; July has a mean minimum of 0.3°C.

Wind direction is variably throughout the seasons and the time of day. Generally winds are from the west or north-west with the strongest winds originating from the west (Todoroski Air Sciences 2018, p.13).

3.5 Land use and disturbance

The topography of the main Project site has been disturbed by the construction of the mine, which involves substantial vegetation clearing and earthworks. The mine is built into the landscape with an open cut extraction as well as overburden emplacement areas and the installation of mine infrastructure, tracks and power easements. The largest area of flat ground was modified to create the town of Marulan South. A number of historical European quarry sites have been identified during the course of the historic heritage assessment.

Prior to this disturbance, the area was characterised by agricultural and animal grazing which is still present in the areas surrounding the Project site.

Creeks to the north and south have been dammed since the 1950s. The former town of Marulan South is located immediately north of the pit area, with some community buildings associated with the old town, now used by the mine for administration purposes, workshops and storage.

The area of Marulan Creek dam is used for grazing. Some areas of Marulan Creek have been disturbed by the establishment of infrastructure including Boral's private railway line, the Tallong water pipeline and farm access roads.

4 Aboriginal heritage background

4.1 Ethno-history

4.1.1 Historic overview

European explorers first visited the Southern Tablelands as early as 1798 when John Wilson was sent to the area by Governor Hunter (Chisholm 2006). His reason for exploring the area was to dispel the myth that convicts would be able to walk to China (Higginbotham 2009, p.21). He ascended Mt Towrang and viewed the Goulburn Plains before returning home.

Major towns included Marulan, which was established first in 1834 and then moved approximately 2 km to the north-west in 1868 when the Great South Railway Line was constructed. Other towns established in the area included Bungonia (1836), Tallong (1869) and Wingello (1871). The town of Marulan South was created in the mid-twentieth century to service the Marulan South Limestone Mine. Marulan South became a community hub for the miners and their families and a well known place in the local district. The town was closed in 1998 when the decision was made to move the residents rather than complete additional repairs and upgrades, particularly for sewerage treatment. People's houses were transported to Marulan as part of the closure.

Stock and cattle stations were established in the 1820s throughout the Goulburn plains and the wool industry dominated the area during the 1800s (Firth 1983). Pastoralists set up stations run by the convict labour force. The wealthiest pastoralists ran their stations from Sydney or the Cumberland Plain sending sons or overseers to run the day to day operations (Higginbotham 2009, p.27).

With the exception of the Marulan South Limestone Mine and Peppertree Quarry, the area is predominantly used for cattle and sheep grazing, along with poultry farming and other commercial operations. Tourism to the Southern Highlands has increased as the improvements to the Hume Highway connected the area to Sydney. The former Mulwaree Shire was amalgamated into the Goulburn Mulwaree local government area (LGA) in 2005.

4.1.2 Local population

Information about the socio-cultural structure of Aboriginal society prior to European contact largely comes from ethno-historic accounts made by Europeans. These accounts and observations were made after massive social disruption due to disease and displacement. As a result, this information is often contentious, particularly in relation to language area boundaries.

Information on the practices of Aboriginal people has been lost due to settlement and interactions with European settlers but certain generalisations can be made from early colonial records and subsequent research. Aboriginal people moved in small family groups (Smith 1992), which belonged to clans all of which were united by language and cultural affinities with ties to specific territories.

The Project site is located on the boundary of four Aboriginal groups (based on Tindale 1974) comprising the Gandangara, Ngunawal, Wodi Wodi and Wandandian.

4.1.3 Living arrangements

Generally Aboriginal people lived in family based clan groups of between 30 and 50 people in a defined area. Each group would have been mobile for at least part of the year and comprised of various ages males and females with approximately four to eight pairs of husband and wives. Most men were considered to have only one wife; although Govett (1836) notes that the chiefs of each tribe were able to have two wives. Historical records have noted large gatherings of people took place in Goulburn in the early 1800s (Smith 1992).

There is evidence of the construction of covered sleeping areas known as gunyahs- shelters made of bark or bushes laid against supporting trees or poles (Bluett 1927, p.11 and Govett 1836, p.19).

Louisa Atkinson, botanist, journalist and fiction author, writing in 1863 of her life in the Southern Highlands in the 1830s and 1840s describes the appearance and construction techniques of gunyas:

> Their dwellings were of a description most readily constructed, soon dilapidated, and forsaken without regret. Sometimes a sheet of bark supported on end in an inclined position by a small pole, at others, a few branches place round a triangle, formed by partially severing a sapling so as to bend both ends to the ground, and supported in the middle by a sloping forked stick, were the materials almost always employed; but occasionally these were rendered more comfortable, and impervious to wind and rain, by being built over with grass (Lawson 1989, p. 46).

This description though saturated with values very different to those of the original inhabitants, accords with early photographs and drawings of gunyas. Timber and bark were also used to make tools and weapons adhered with resin from plants. Local and imported stones including quartz and silcrete were used to make a variety of tools.

4.1.4 Burial customs and ceremony

Burial in the region appeared to occur in a number of ways. Individuals could be interred in the ground in a shallow grave covered by stone, rocks or cobbles. Positioning of the burial may have been associated with ownership of areas (ERM 2012). Other reports of burial included placing the corpse in a hollow tree or in a sitting position in the ground (Gillespie 1988, p.2).

Writing for the *Sydney Mail* in 1863, Atkinson describes a burial near Berrima:

> The mode of interment is to confine the hands around the knees, drawing them up to the chest; a shallow grave is then dug, the corpse placed in it, and built over with earth - the stems of the trees in the vicinity being carved with simple devices (Lawson 1989, p.51).

Atkinson also notes that the dead are buried with all their possessions and the items that they used during their illness (Lawson 1989, p.51).

As a result of its location at the centre of a number of different geographic areas, it has been hypothesised (ERM 2012, p.26) that the Marulan and Marulan South area may have been suitable for large or regular ceremonial and tribal meetings.

4.1.5 Tools and weapons

Kangaroo and possum skins were used for cloaks and covering as well as wrapping tools for travel. Wood was used to create many tools including canoes, spears, boomerangs, clubs and containers.

The bark of stringy bark trees were used for making shelters and rope. Hearths were constructed using wood and stone to provide warmth and for cooking.

The category of tools which survives best for archaeological investigation are made of stone. These were widely used in axes and spears, as grinding and cooking implements. The geology of the region provided stone for tool manufacture including quartz pebbles and, silcrete cobbles eroding from some creeks. Material may have also been imported from the surrounding region through trade.

4.1.6 Food

Aboriginal people subsisted on plant foods, aquatic life from the surrounding waterways and ate a variety of animal life such as possum, kangaroo, snakes and lizards. Migrating Bogong moths were part of the food supply during the summer months and may have been the basis for large tribal gatherings during these months (Matthews 2007).

4.1.7 Summary

The Project site is in a landscape that would have been conducive to human occupation and exploitation as it provided an abundance of fresh water, plant and animal resources. These resources would have been available for groups of people as they travelled through or if they stopped temporarily.

4.2 Aboriginal Heritage Information Management System search

An Aboriginal Heritage Information Management System (AHIMS) search was completed on 1 September 2014 for an area of 10 km by 10 km and covering the Project site (Figure 4.1). The search covered a large enough area so as to adequately characterise the local archaeological record. A wide variety of Aboriginal site types were identified. Sites were distributed across multiple landforms but clustered near watercourses. A total of 112 Aboriginal sites were identified within the search area (Figure 4.1, Figure 4.2 and Table 4.1). The AHIMS search results are contained in Appendix B.

The AHIMS search was updated on 20 February 2018 to account for Project delays due to the revision of the mine plan which has taken over twelve months to complete. The search results revealed that the site cards EMM submitted as part of the ACHA were registered. These sites are presented in Chapter 6 of this report rather than in this section in order to present the ACHA results in clear chronological order.

A diverse range of site types occur, 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 are also present, with one rock shelter with art identified.

Table 4.1 AHIMS registered sites in the search area 2014

Site type	Number of sites	Percentage
Isolated find	49	44%
Open camp site	54	48%
Quarry	1	1%
Shelter with art	1	1%
Modified tree	5	4%
Stone arrangement	1	1%
Burial (stone arrangement)	1	1%
Total	**112**	**100%**

Out of the 112 Aboriginal sites identified, 19 were recorded within or directly adjacent to the Project site and are summarised in Table 4.2.

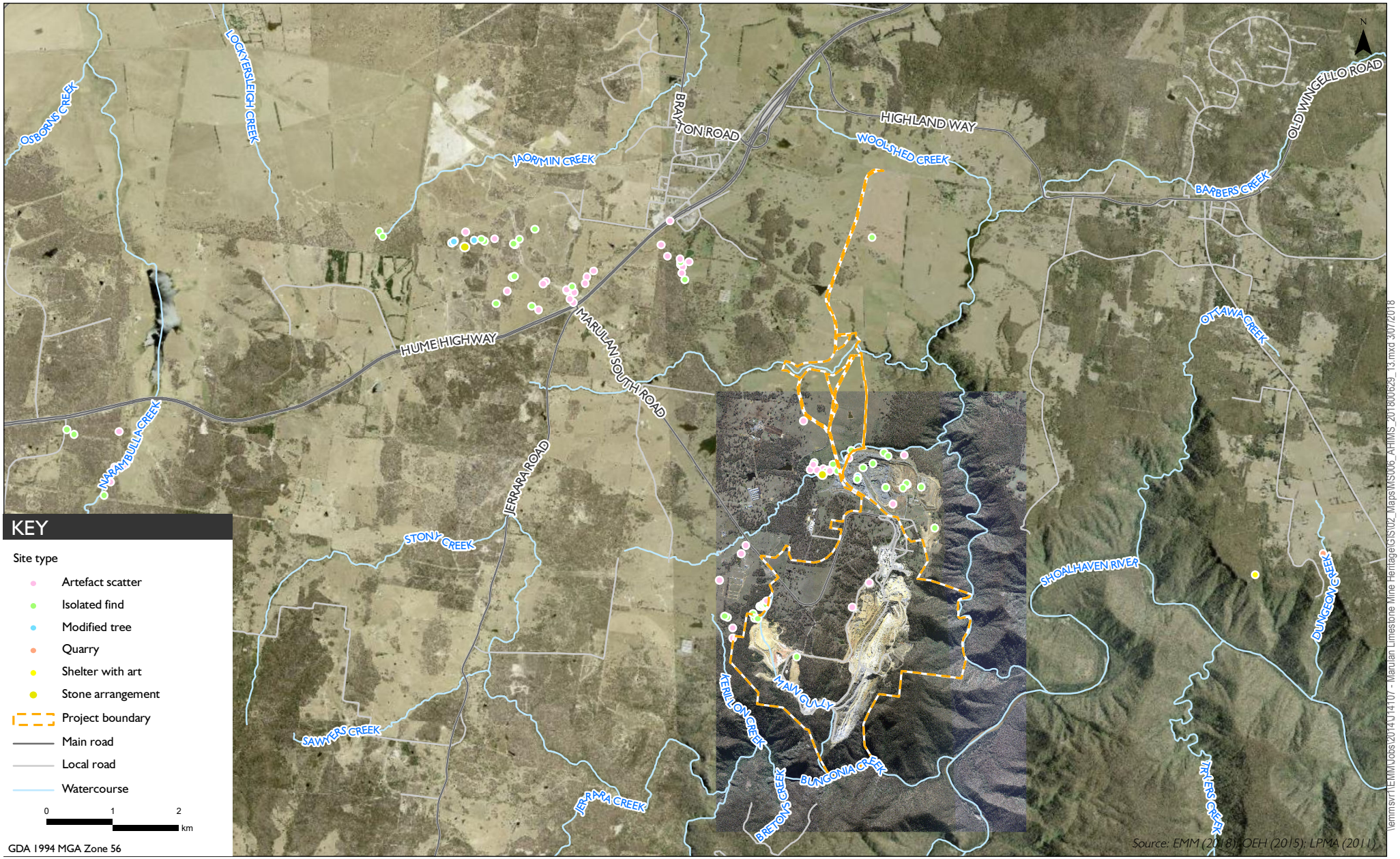
Table 4.2 AHIMS registered sites within the vicinity of the Project site 2014

AHIMS site number/Site name	Summary	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 of the same but with different AHIMS coordinates. Notwithstanding, the site has been destroyed.	Inside Project Boundary
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, is the same site. It was considered to have no archaeological potential as the area was subject to sever disturbance from mining. Artefacts were collected prior to impact from mining activities. This site has been destroyed	Inside Project Boundary
52-4-0246: M2	Three silcrete flakes	Inside Project Boundary
52-4-0276: BCSC IF11	A grey green quartzite flake located in a woodland area.	Inside Project Boundary
52-4-0271: BCSC IF3	A red silcrete flake piece located in a woodland area on a mid-slope landscape.	Inside Project Boundary
52-4-0272: BCSC IF4	A grey silcrete flake located in woodland on a gentle north facing slope.	West of Project Boundary
52-4-0270: BCSC IF2	A single red brown silcrete flake located in the woodland area of the mine at the base of an eroded slope.	West of Project Boundary
52-4-0274: BCSC IF8	One red silcrete core located in the woodland area, located near some historic ruins.	West of Project Boundary
52-4-0273: BCSC IF7	One grey brown red silcrete flake located in woodland.	West of Project Boundary
52-4-0279: BCSC IF9	A grey silcrete flake located in a cleared area.	West of Project Boundary
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 Boundary
52-4-0278: BCSC IF13	A white quartz flake on an east facing lower slope.	West of Project Boundary
52-4-0277: BCSC IF12	A red brown silcrete flake piece on a lower slope facing east.	West of Project Boundary
52-4-0279: BCSC IF14	A grey green quartzite flake located at the base of a slope facing east.	West of Project Boundary
52-4-0268: BCSC AS3	Two artefacts; a silcrete flake and a quartz flake located on an eastern facing lower slope.	West of Project Boundary
52-4-0267: BCSC AS2	A scatter of two flakes located at the base of a woodland area on an east facing lower slope.	West of Project Boundary
52-4-0266: BCSC AS1	A scatter of seven artefacts including silcrete and quartz flakes and cores. The site is located on an east facing lower slope.	West of Project Boundary
52-4-0263: BCSC IF1	One grey silcrete core located along an eastern ridgeline in the mid-west gully area of the mine. South of a mine access road which connects to the western mine area. It was not located in situ but among eroded soil and shale rock.	Inside Project Boundary
BCSC AS 5: 52-4-0574	A scatter of ten artefacts located on a lower slope facing east.	West of Project Boundary

As noted in Table 4.2, two of the nineteen Aboriginal sites identified within or directly adjacent to the Project site (M1 (BCSC1) and BCSC 1)) have been removed as part of previous archaeological salvage programs (RPS HSO 2008). The areas containing these sites have been disturbed as part of approved mining activities.

The site cards for the two sites have been reviewed and the location coordinates and information for both sites is the same (despite the different locations being recorded on the AHIMS search table and presented on Figure 4.1). It appears that they are actually one large site, all of which was salvaged. Additionally, while both sites have been salvaged neither site card has been updated with this information. The site cards are contained in Appendix B.

The remaining 17 Aboriginal sites remain valid and are consistent with the general pattern of Aboriginal sites in the region and include open artefact scatters and isolated finds of silcrete, chert and quartz. Two archaeological sites identified in the Project site appear not to have been previously registered on AHIMS (BCSC IF1 and BCSC AS5). Site cards have been prepared for these sites and are in Appendix B**.** Two valid and previously recorded sites (M2 and BCSCIF1) are within the disturbance footprint. The remaining 15 archaeological sites are located outside of the Project site to the immediate west and will not be impacted by the Project, however they have been considered in the assessment due to their proximity to the Project site.



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AHIMS search results prior to this assessment (2014)

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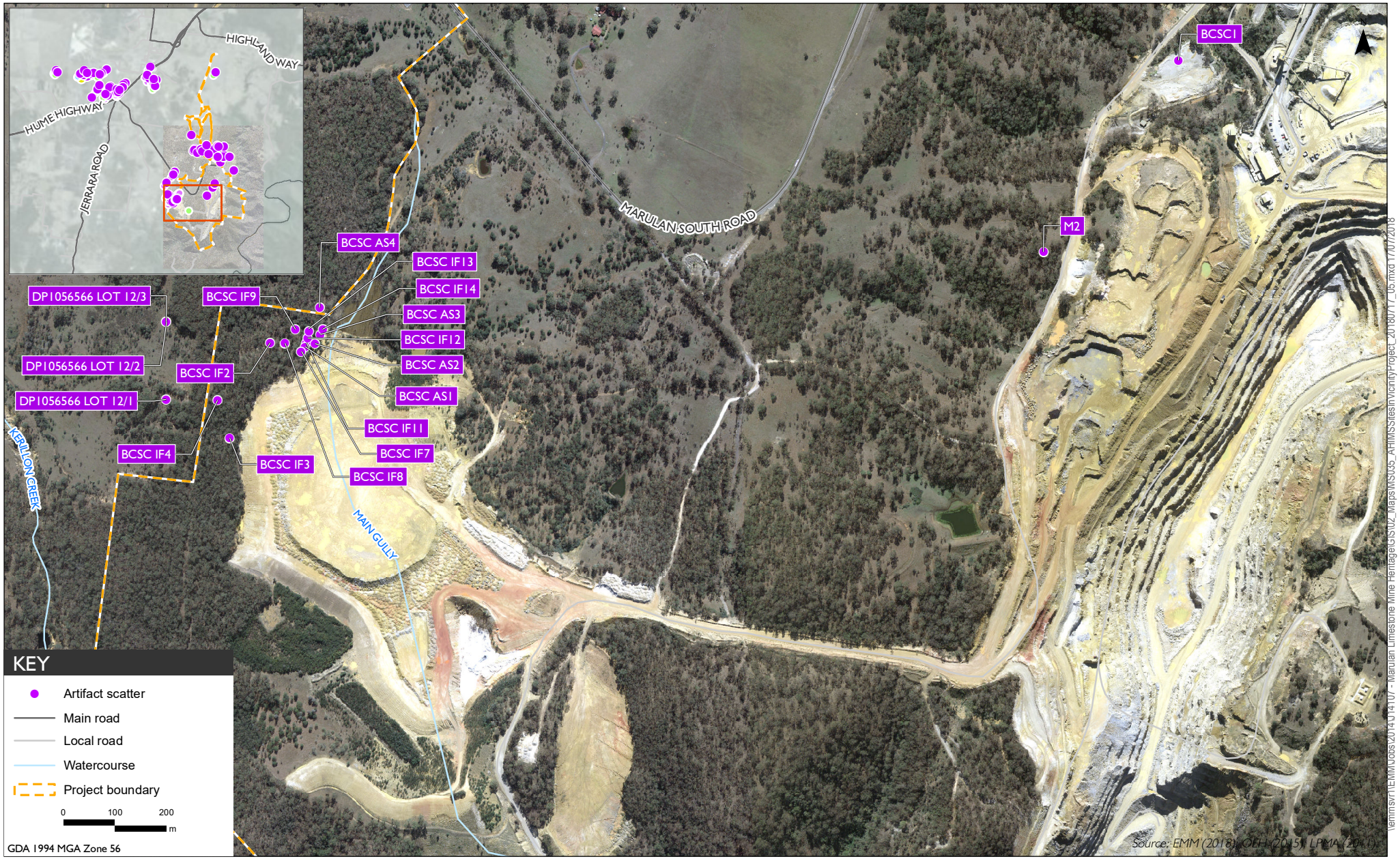
Figure 4.1



AHIMS sites in the vicinity of the Project site (2014)

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Figure 4.2

4.3 Regional archaeological context

Archaeological investigations have been undertaken around the Project site over the last 20 years. The following section presents a summary of those archaeological investigations which have occurred in the Southern Highlands and Southern Tablelands region.

Lance and Koettig 1986, *An Aboriginal Resource Planning Study for the City of Goulburn*, report by ANUTECH to Goulburn City Council.

Lance and Koettig undertook a large scale investigation aimed at identifying land use patterns in the Marulan region as part of a regional study for the City of Goulburn. The results of the investigation predicted that stone artefacts scatters would be found within 50 to 100 m of water. They also hypothesised that the largest and most dense artefact scatters would be found at the junctions of creeks and rivers with site size and frequency decreasing with the increased distance from water.

Haglund 1986, *Archaeological Survey of Areas within Bungonia State Recreation Area likely to be Affected by Present and Future Recreational Activities and Associated Development,* report to Bungonia State Recreation Area Trust.

This report details an investigation of areas of potential archaeological sensitivity within the Bungonia National Park approximately 10 km south of the Project site. In total 15 sites were identified with artefacts consisting of flakes, cores and blades made of silcrete, quartz and indurated mudstone. From these sites Haglund hypothesises that artefact numbers and their distribution indicated that sites were repeatedly used by small groups. The sites were also described as containing large amounts of flaked debris and reject material.

Williams, 2004, *An archaeological survey of a proposed pyrotechnics facility Lots 11 and 12 DP 1056566, Marulan South*, near Marulan NSW.

Williams completed a survey and assessment of an 80 ha area approximately 3 km north-west of the Project site. In total eight archaeological sites were identified comprising six artefact scatters and two isolated finds. These sites were mostly found in areas of exposure near permanent drainage lines, ridge crests and simple slopes.

Australian Archaeological Survey Consultants 2007, *Proposed hard rock quarry Marulan NSW: Preliminary archaeological assessment for Readymix Holdings*.

Australian Archaeological Survey Consultants completed a survey and assessment of a proposed quarry and haul road located approximately 13 km north of the Project site. The field survey identified five Aboriginal sites including one isolated find and four artefact scatters of less than ten artefacts. The sites were identified on landscapes consisting of gently undulating slopes near semi-permanent to permanent water courses or on hill crests above watercourses.

Lynwood Quarry Project, Marulan (Umwelt 2005, 2006, 2007a, 2007, 2008a, 2008b, 2009, 2010, 2012).

The following summarises the investigations completed as part of the approvals for the Lynwood Quarry facility, located approximately 5 km north-west of the Project site. To date the investigations have included survey, test and salvage excavation and a detailed artefact analysis and excavation report is in production.

The survey area for this report was approximately 5 km north-west of the Project site. The first stage of survey involved sampling transects over the different landscapes in the Project site. The survey located 52 Aboriginal sites including 30 artefact scatters, 13 isolated finds and seven culturally modified trees and two stone arrangements. Several artefact scatters with more than 150 stone artefacts were recorded. Artefact material included silcrete, quartz and chert.

Umwelt also developed an identification system based on archaeological terrain units (ATUs). The ATUs take into account both the environmental and cultural context of the Lynwood Quarry project site and are used as part of the predictive model for surface and subsurface sites.

An additional survey was conducted for proposed transmission lines at the Lynwood Quarry area approximately 1 km south of the Project site. The survey identified 15 sites, eight of which were within the boundary of their project area. The sites generally consisted of artefact scatters with no more than ten artefacts. Dominant raw material included silcrete and quartz.

The results of the survey and impact assessment were used to inform three stages of test and salvage excavation:

- Stage 1 included three separate stages of excavation. Stage 1a consisted of the excavation of 20 power pole locations. Over 300 artefacts were identified including flakes, flaked pieces and cores. The dominant raw material type was quartz followed by quartzite, silcrete and chert. Stage 1b involved five additional testing sites and 110 test pits, which yielded a total of 52 artefacts. Stage 1c involved artefact analysis.

- Stage 2 consisted of four stages of investigation. Stage 2a included subsurface testing of known sites and Stage 2b tested the remaining ATUs in the development impact area. Stage 2c involved monitoring of the historic heritage investigations at Old Marulan Town and Stage 2d consisted of reporting and updates to AHIPs to ensure works were able to proceed.

- Stage 3 consisted of two stages of investigation. Stage 3a involved further subsurface salvage of ATUs and Potential Archaeological Deposits (PADs) and Stage 3b consisted of a final report incorporating the results of all stages (in production).

As a result of proposed modifications to the Lynwood Quarry facilities a survey and an assessment was completed of an additional 10 ha area located approximately 5 km to the north of the original project site. The assessment included survey and consultation with registered Aboriginal stakeholders. The survey did not identify any artefacts but three areas were identified as potential archaeological deposits. Additional impacts were also proposed in areas previously identified as containing Aboriginal sites and potential archaeological deposits. The recommendations for the project included retaining topsoil in the project areas and a variation to the existing AHIP #1100264 to allow additional construction elements. The variation to AHIP #1100264 included subsurface testing of areas of potential archaeological deposit.

The combined survey and excavation program at Lynwood Quarry identified 94 Aboriginal sites. Ten of these sites have been combined into one site (Joarimin Creek South). A total of 34 ATUs were identified with survey and testing identifying 29 with Aboriginal sites present. The preliminary analysis of the results of the survey and three stages of excavation have identified that:

- The largest numbers of known sites are within the Bindook Porphyry geological unit, on spur crest and gentle slope landforms.
- The entire area was used by Aboriginal people including for ceremonial purposes. All ATUs provided light background artefact scatter.
- Areas associated with ridge crests, saddles on ridge crests, saddles on spur crests and slopes of moderate gradient reflect transient use.
- Four areas have artefact numbers and densities which may reflect long term occupation including spur crests, parts of Joarimi Creek South and gentle slopes in association with a reliable water source.
- Silcrete and quartz were the dominant raw materials used and it was assessed that most of the stone used for tool manufacture was brought into the area.

Management of the identified sites included the creation of a cultural heritage management zone (CHMZ) to conserve 11 Aboriginal sites long term, with an additional 51 Aboriginal sites conserved *in situ* outside the project area. A total of 32 sites will be subject to partial or total impact by the project.

Peppertree Quarry Project, Marulan South (ERM 2006 and 2012 draft).

ERM was engaged by Boral to complete an Aboriginal heritage assessment conducted for the Environmental Assessment of the Peppertree Quarry. The assessment identified 11 sites within the quarry footprint and a proposed water storage dam along Tangarang Creek. The majority of artefacts identified were silcrete and quartz flakes and cores. A recommendation was made for salvage excavation in areas along Tangarang Creek.

Following project approval ERM undertook a large scale test and salvage excavation prior to the commencement of quarry activities. The following results are currently in draft.

The test excavation followed that of Umwelt (2007–2008) for the excavation of the Lynwood Quarry with landforms across the project area sampled along linear transects. A total of ten test transects covered six landforms within the Tangarang Creek Dam area and another three outside this area. Test pits were located at 5 m intervals along each transect. This resulted in the excavation of 103 test pits and a total of 2,089 artefacts recovered. Table 4.3 provides a summary of the artefacts uncovered in each of the ten test transects.

Table 4.3 Test transect results (from ERM 2012)

Transect No	Landform	Nº of test pits excavated	Nº of artefacts recovered	Open area excavation?
1	Moderate height hilltop	10	2	None
2 and 3	Low hilltop close to Tangarang Creek	17	315	Test pit 14 expanded into Trench 1 Test pit 10 expanded into Trench 2
4	Spur crest	11	228	Test pit 1 expanded into Trench 8
5	High hilltop	13	631	Test pit 4 expanded into Trench 3 Test pit 6 expanded into Trench 4 Test pit 7 expanded into Trench 5 Test pit 4 expanded into Trench 6 Test pit 13 expanded into Trench 7
6	Lower slope and associated elevated flat adjacent to Tangarang Creek	8	16	None
7	Elevated outer bank of Tangarang Creek on an alluvial fan	10	79	None
8	Inner bank of Tangarang Creek on an alluvial fan	9	0	None
9	Two high hilltops and the saddle in between	16	259	Test pit 15 expanded into Trench 9 Adjacent to test pit 15 expanded into Trench 10
10	High hilltop near railway line	5	95	None
Total		**99**	**1,625**	

The areas determined for salvage excavation were based on the results of the test transects. Ten open area trenches were expanded and salvaged. These ten trenches were divided into four hills as follows:

- Area 1 – (ERM "Trading Hill") – trenches 1 and 2;
- Area 2 – (ERM "Hearth Hill") trenches 3,4,5,6 and 7;
- Area 3 – (ERM "Spur Line") trench 8; and
- Area 4 – (ERM "Grinding Stone Hill") trenches 9 and 10.

A total of 122 m^2 of open excavation was undertaken in the project site from which 20,956 artefacts were uncovered during the salvage excavation. During the open area excavation a number of high density artefact concentrations, hearths and ovens and a human burial were also recorded. A summary of the information uncovered in the salvage excavation is shown in Table 4.4.

Table 4.4 Salvage excavation results (from ERM 2012)

Open Area	Trench N°	Landform	Area (m^2)	Artefacts recovered	Features identified
Area 1	1	Low hilltop close to Tangarang Creek	9	2,179	0
	2	Low hilltop close to Tangarang Creek	28	7,405	Two features – a tree root hole and a burial
Area 2	3		1	42	0
	4		18.5	1,540	A concentration of granite cooking stones were observed
	5		3.75	96	A hearth
	6		8	445	Two features – an oven and a feeder fire pit.
	7		3	419	0
Area 3	8		22.75	4,357	A possible gunyah post hole
Area 4	9		27	4,749	Up to three hearths, and a burnt tree root, cooking stones,
	10		1	59	Possible grinding stone
Total			122	21,336	

The results of the salvage excavation identified seven domiciliary areas, around high artefact concentrations, suggesting the varied and long term use of the area for camping and meeting. Flakes dominate the assemblage with backed artefacts, cores and retouched flakes also present. Seven types of raw material were present, dominated by silcrete, chert, quartz and quartzite. Chalcedony basalt and granite artefacts are present in low numbers.

The occupation pattern from the excavations showed evidence that preferred camping areas were shallow hill slopes and hill tops associated with Tangarang Creek. Long term and frequent habitation by a large group is suggested by the relatively high technological diversity of artefacts, volume of artefacts and the presence of non-transportable items such as grinding stones. There was also evidence of a lack of initial manufacture stages across the quarry site, and suggests that initial reduction of material may have occurred in another area. Thus the tools in the project area are the result of later stages of tool manufacture and tool maintenance (Hiscock 2001). It was also considered possible that the area was used as a trading or ceremonial location considering the size and type of artefacts recovered and the location of the project area at the boundaries of four Aboriginal clan groups.

Peppertree Quarry Project, ongoing salvage measures (Boral and EMM).

Subsequent to the salvage excavation program led by ERM in 2011, additional salvage measures have been ongoing at Peppertree Quarry under an approved Aboriginal Heritage Management Plan (AHMP) in consultation with the Aboriginal Management Committee (AMC). The excavation method includes construction topsoil monitoring and artefact collection by the AMC starting in 2011. In 2013 EMM were engaged to provide advice on how to approach archaeological salvage excavation if high density artefact scatters were identified during topsoil monitoring of the quarry pit footprint; within a 50 m radius of an identified site or 100 m of the first and second order streams feeding north into Tangarang Creek. A method was developed that included placing 1 m^2 test pits in areas where 10 artefacts or more were exposed from topsoil stripping in a 50 cm^2 area. If the test pits recovered over 50 artefacts, then surrounding pits were excavated. This method continued in all directions in the surrounding pits until less than 50 artefacts were recovered.

This method has resulted in the recovery of extensive artefact assemblages. As of June 2016, over 90,000 artefacts had been salvaged, over 50,000 of which were recovered from salvage excavation squares. Analysis and reporting for these results are yet to be completed, but the results of salvage excavation have been mapped as part of the Peppertree Quarry AHMP (Boral 2017). The preliminary results support previous excavations in that broad hill crests and spurs next to watercourses contain distinct artefact concentrations. Examples of these results are shown in Figures 4 to 11 of the Peppertree Quarry AHMP (Boral 2017).

AMBS 2012, *Goulburn Mulwaree LGA Aboriginal Heritage Study,* prepared for Goulburn Mulwaree Council.

This report provided a comprehensive historical and ethnographic study of the region. It identified areas of Aboriginal sensitivity within the Goulburn Mulwaree LGA for consideration during developments in the LGA. This study identified the area around South Marulan as an area of Aboriginal heritage significance.

4.4 Archaeological reports in the Project site

This section provides information on previous studies within the Project site.

ERM, 2006. Marulan South Continuation of Operations: Aboriginal Cultural Heritage Assessment, report for Blue Circle Southern Cement.

Environmental Resource Management (ERM) was commissioned by Blue Circle Southern Cement (BCSC) to complete an Aboriginal heritage assessment of an area to be impacted by continued mining operations. The three hectare area was located to the north-west of the existing mine. This area is located within the Project site.

The landform was considered to be a gently undulating limestone plateau. Three minor drainage lines were identified running east to west and feeding into the Bungonia Creek. The archaeological survey identified one Aboriginal site (BCSC 1). BCSC 1 was a artefact scatter of 38 artefacts located at the confluence of two drainage lines. The majority of the artefacts were uncovered within 20 m of the drainage lines.

ERM considered the Project site to have little archaeological potential due to severe disturbance from previous quarrying activities and bioturbation and the small amount of artefacts found in an area with large areas of good exposure and visibility. The recommendation for the site was a Section 90 (NWPS Act 1974) permit for surface salvage and that no further archaeological excavation was warranted.

RPS HSO 2008 Cultural Heritage S.90 Salvage, report prepared for Blue Circle Southern Cement.

RPS Harper Somers O'Sullivan (RPS HSO) undertook the salvage of site BCSC 1 identified by ERM (2006) and described above. The salvage was undertaken due to the impact to the site which would occur through the continuation of mining.

A total of 91 artefacts were collected from BCSC 1 which was 53 more than identified in the original site investigation. It was noted as being in a highly disturbed area with visible impacts from both natural and human events. Alluvial disturbance was also indicated through the presence of flattened grass and debris. The majority of the collected artefacts were located within 50 m of drainage lines, with the exception of one artefact scatter which was located approximately 100 m from the drainage line. It was considered that no further contextual data could be attached to the collected assemblage. Site BCSC1 was considered to be of low archaeological significance and the majority of artefacts considered to be disturbed and displaced. No further investigation was undertaken.

RPS HSO, 2009, Cultural Heritage Assessment Marulan South Limestone Mine, report prepared for Blue Circle Southern Cement.

RPS HSO conducted an Aboriginal heritage assessment for a review of environmental factors to support the continued mine operations within CML 16. It included survey and assessment. The survey uncovered a total of 16 Aboriginal sites including 11 isolated finds and 5 artefact scatters. The majority of these sites were located on lower slope landform units adjacent to a water source. Two artefacts were located outside the boundaries of impact areas and were not impacted by the project. An additional area on the western side of their project site was unable to be surveyed due to the steep terrain.

Recommendations for the sites impacted by the project included redesign of the overburden emplacement areas to protect the identified archaeological resource, however if this was not feasible a salvage program was recommended for all Aboriginal sites within the impact area. The 16 sites identified remain *in situ* adjacent to the western edge of the Project site. They will not be impacted by the Project.

5 Predictive model of site location

5.1 Overview

This section summarises the archaeological and environmental background the region presented in the previous chapters and presents its implications for archaeology in the Project site with reference to its landscape context.

5.2 Synthesis of background information

The surface geology of the area provides stone for use in the manufacture of stone tools including quartz, feldspar and tuff. Chert outcrops are also known to occur along the Wollondilly River approximately 25 km to the north-west. Silcrete outcrops were evident along Marulan Creek.

The temperate climate was suitable for Aboriginal occupation of the area. The environment of the Project site would have provided a variety of resources for exploitation by Aboriginal people including plants and animals for food and adequate water supplies in the nearby creeks and rivers. Vegetation in the Project site would also have provided wood and an abundance of stone for making tools was also available with which to fashion implements and shelters.

Pleistocene occupation of south eastern New South Wales is evidenced at sites such as Burrill Lake Shelter (Lampert 1971), Bass Point open site (Bowdler 1979), Lake George (Jones 1989; Singh et.al. 1981a; Singh et.al. 1981b; Wright 1986) and Birrigai Shelter (Flood et.al. 1987; Jones 1989). The earliest dated site (circa (c.) 20,000 BP) in the region is Burrill Lake Shelter, a coastal site situated approximately 85 km to the south-east of the Project site (in a straight line). Pleistocene sites in the region are, however, rare, with the majority of Aboriginal sites dated to the Holocene. The apparent disparity between the numbers of Pleistocene and Holocene sites is attributed to taphonomic processes, population increase, changing sea levels, resource availability associated with climate change, and technological change (Boot 2002; TEC 2006).

Aboriginal objects identified on the ground surface may indicate the presence of subsurface archaeological deposits depending on landform type and level of post-depositional ground disturbance. Post depositional factors such as land clearing, cattle grazing and mining activities may have disturbed stone artefacts. Disturbance would have resulted in the displacement of Aboriginal objects within the soil but would not fully diminish their archaeological and cultural value. Erosion also has the potential to more significantly displace Aboriginal objects through sheet wash and gully erosion, particularly on slopes and narrow, cleared crests near incised drainage lines in the main Project site. Other portions of the Project site, such as the broad, level to gently inclined spur near Marulan Creek have experienced minimal disturbance apart from clearing and artefacts uncovered in these contexts are likely to have higher archaeological integrity.

The results from the regional and local studies have indicated that the most common Aboriginal site types are open artefact scatters and isolated finds. These sites are usually found in relation to water with site size and frequency dependant on the distance to the water source. The majority of large sites are located along major creeks or at the confluences of minor creeks and drainage lines. Sites decrease in size and frequency as the distance from water increases. Sparse sites may exist on ridgelines and may represent evidence of the travelling routes used across the wider Southern Tablelands landscape.

Artefact density covers a considerable range from isolated finds to sites of up to one hundred artefacts. Generally, artefact density for surface sites is between two and twenty artefacts. Artefact density during excavations is also variable but tends to be over 50 artefacts per metre squared. These results suggest that in certain areas the surface artefact scatter is indicative of a large subsurface assemblage. This has been the case for the extensive excavations at the Peppertree and Lynwood quarries. Artefacts are generally made out of silcrete, chert or quartz with smaller number of mudstone and other materials.

However, the opposite is also possible depending on the soils. Skeletal soils tend to have most artefacts exposed on the surface with little or none below the surface. Culturally modified trees have been identified on all landform types but are limited to areas where remnant native vegetation of suitable age remains (typically over 100 years). Other site types such as axe grinding grooves and rock shelters are rare because the local valley floors do not have suitable rock outcrops. Shell middens, which may be found near the sea and suitable rivers further inland, are also rare due to the local environment, which did not contain amounts of molluscs large enough to create shell midden deposits.

Archaeological potential across the Project site is highest in areas close to reliable watercourses, particularly on gentle elevations. The archaeological excavations in the region have shown that these areas are likely to contain high densities of subsurface artefacts.

5.3 Site specific predictions

Table 5.1 presents a discussion of each predicted site type for the Project site and if it is likely to occur. Factors which may affect the occurrence of site types are also discussed. The predictive model is based on the environmental and archaeological information presented in Sections 3 and 4.

Table 5.1 Site type and distribution

Site type	Discussion for the Project site
Culturally modified trees	Generally, culturally modified trees are located in areas that contain trees over 100 years old as this is a sufficient age for traditional scarring to have occurred. Modified tress will generally not be located where vegetation is less than 100 years old but may occur. Modified trees have been identified in the region. Historically, vegetation clearing and mining has occurred in the Project site and this indicates that modified trees will be rare or non-existent in the Project site.
Rock shelters	Rock shelters occur in areas with suitable geological formation processes and outcrops of rock. Rock shelters where habitation occurs are generally located as close to watercourses as possible. One rock shelter with art has been found in the region but rock shelters are not predicted to occur as the landscape does not have suitable rock outcrops or overhangs.
Grinding grooves	Grinding grooves are most likely to occur in areas where rock outcropping exists and usually near running water; however occurrences of grinding grooves in areas away from running water have been recorded in other regions. No grinding grooves have been found in the region at this stage. The likelihood of this site type being found in the Project site is low as rock outcrops are rare and most that do exist have been inspected. The outcropping granite is generally too coarse to have been used for stone tool manufacture or food preparation.

Table 5.1 Site type and distribution

Site type	Discussion for the Project site
Open camp sites	The most common site type recorded in the region is 'open camp'. Artefacts can range from two to over 100 and may also provide further information through excavation. Artefact scatters are most usually found adjacent to watercourses, or on rises overlooking watercourses, particularly the confluence of creeks. There is a high possibility that open camp sites will be present in the Project site as it contains areas of flat and gently undulating ground as well as a number of ephemeral watercourses.
Isolated finds	Isolated finds are indicative of the random loss, deliberate discard or abandonment of artefact and can also represent the remains of dispersed and disturbed artefact scatters. Isolated finds are the second most common site type in the region and are found in all landform types and throughout the region. There is high potential that isolated finds may occur in the Project site.
Quarry	A quarry is an area of suitable stone material for use in the manufacture of stone tools, often with artefacts in the early stages of reduction. One silcrete quarry area has been identified in the region. There is a low potential for a quarry to be identified in the Project site as it is unlikely that an area of suitable stone for a quarry to exist. The limestone and granite geology of the area was not used for the production of stone tools.
Stone arrangement	A stone arrangement is found at places where Aboriginal people have positioned stones deliberately to form shapes or patterns, and can include large circular or linear arrangements, piles of stones, rock markers or more elaborate groupings that can depict animals or other designs. Stone arrangements are often an indicator of a significant cultural site. Aboriginal people also use stone arrangements for other purposes, such as for fish traps. One stone arrangement has been identified in the region. There is a low potential for stone arrangements to be present in the Project site due to disturbance from historic land clearing and mining activities.
Midden	A midden is a rubbish dump, generally comprising shell and stone artefacts, due to their preservation qualities. Middens have also known to exist near freshwater rivers and streams and in association with burials. No middens have been identified in the region. There is a low potential for middens to be present in the Project site due to disturbance from historic land clearing and mining activities.

5.4 Summary

Based on the landscape factors, AHIMS search and previous archaeological investigations detailed above the following predictions can be made about Aboriginal sites in this area:

- artefacts may be present as part of open camp sites or as isolated finds;
- due to the geology of the Project site rock shelters and art sites are not likely to be present;
- 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 in the Project site.

6 Archaeological survey

6.1 Overview

Field survey was conducted over one week from the 13 – 17 April 2015. The survey included EMM archaeologists and field representatives of the RAPs. A list of stakeholders who participated in the field survey is included in Appendix C.

The primary aims of the survey were to:

- identify Aboriginal sites or potential Aboriginal places with the assistance of Aboriginal knowledge holders; and
- characterise the landscape to aid predictions of surface and sub-surface archaeological potential.

6.2 Survey strategy

The survey strategy was developed to respond to the predicted archaeological sensitivity across the Project site, which resulted in:

- a focus on the land adjacent to reliable watercourses such as both sides of Marulan Creek and the eastern side of Main Gully;
- a focus on the hill spurs and crests in the main Project site which are frequently separated by deeply incised drainage channels causing steep side slopes; and
- gathering a representative sample of the relatively flat and undulating land that occasionally intersect with the headwaters of first order streams such as west of Marulan South Road near the proposed road realignment (Transects 31 to 43) and the haul road to Marulan Creek (Transects 1 and 2), and south of Peppertree Quarry (Transects 10 to 12). These areas were predicted to have lower archaeological sensitivity to the land next to reliable watercourses and hill spurs and crests.

Although the survey aimed to cover the entire geographic extent of the disturbance footprints, a full coverage survey (a survey that covers the entire ground surface of the disturbance footprints) was not adopted because of the following factors:

- a large portion of the disturbance footprint has been disturbed by existing mining activities;
- a large portion of the main Project site is characterised by steep to very steep spur slopes and side slopes and deeply incised drainage channels that would have been hazardous to walk and for these reasons were also unlikely to feature Aboriginal sites; and
- large portions of the relatively flat and undulating land away from watercourses are currently thickly grassed and used for grazing. This means that ground exposures are rare and extensive survey of such areas would have been ineffective.

6.3 Survey method

6.3.1 General fieldwork method

The archaeological survey and data collection methods followed Section 2.2 of the Code which sets out best practice recording methods. The survey of the surface infrastructure area comprised pedestrian field transects across defined landform elements. The survey team varied between eight to nine people each day who inspected the ground surface of each transect while spaced within a 50 m wide corridor where possible (typically spaced between five and six metres apart).

These methods were considered to be suitable as a large portion of the surveyed area was grassed, and exposures were easily identified at this spacing.

The survey team targeted ground exposures such as vehicle and cattle tracks, eroded scalds and stream banks, all which provided good ground surface visibility for identifying Aboriginal objects. However, ground surface visibility was hindered in thickly grassed grazing paddocks and forested areas with gravelly surfaces and leaf litter.

The survey team inspected all mature trees within the transect paths. All outcropping rock was inspected for grinding grooves, rock pools or engravings.

6.3.2 Landform division for sampling

Survey transects were recorded using the *Australian Soil and Land Survey Field Book* (CSIRO 2009) as a guide. The Project area and surrounds were divided into 71 survey transects made up of the following landform class types:

- hill slope;
- ridgeline;
- spur;
- undulating plain; and
- watercourse (including stream banks, stream channels and the land up to 50 m of water courses).

6.3.3 Survey limitations

EMM acknowledge that there is vegetation of varying densities within the disturbance footprint, particularly in the main Project site. Although it was established that this vegetation is largely the result of regrowth after historical clearing, it is unknown if mature trees outside the survey transects remain. Subsequently, although predicted to be rare, further mature trees of sufficient age to have been carved or scarred could remain in the disturbance footprint. As such, any further mature trees with potential Aboriginal scarring or carving will be managed under the discovery of new Aboriginal sites protocol set out in Section 11.3.11.

6.4 Identification and recording of Aboriginal sites

6.4.1 Site and survey recording

Archaeological site recording was completed in accordance with the Code, using a hand-held non-differential GPS unit (GDA94 Zone 56). Site locations were checked using ArcGIS software. Survey transects were accurately mapped by downloading tracks recorded on GPS.

Representative photographs of both the survey transects and site features were taken throughout the survey.

6.4.2 Open artefact sites

Open stone artefact sites were defined by the presence of one (isolated find) or more (artefact scatter) Aboriginal objects on the ground surface. The boundaries of a site are limited to the spatial extent of the visible Aboriginal objects. Sites were recorded by marking each artefact location or each cluster of artefacts within a 5 m radius as a separate waypoint in the GPS. Site boundaries were allocated by drawing a line around the cluster waypoints for each site using ArcGIS software. Stone artefacts more than 50 m apart were recorded as separate sites although this technique may not reflect the subsurface character between the 50 m distances. The 50 m rule is an arbitrary distinction and is mainly used as a tool for the consistency of results and for comparison with Aboriginal sites beyond the Project area.

6.4.3 Potential archaeological deposits (PADs)

A 'site' does not include the assumed extent of subsurface archaeological deposits. PADs are technically separate to sites as they are defined as the predicted extent of subsurface Aboriginal objects in a particular area. PADs are not technically Aboriginal sites until Aboriginal objects are identified, typically through archaeological excavation. PADs can also be associated with artefact scatters that are likely to have eroded out of a more extensive subsurface deposit.

Although it was predicted that certain landforms were associated with PAD, this assessment avoided the demarcation of areas of PAD during survey. This approach was used primarily because an archaeological test excavation strategy was developed to test all landforms across the disturbance footprints and therefore it was considered inaccurate to demarcate PAD areas during survey, although areas of interest were noted for future test excavation.

More substantive predictions for archaeological potential were developed subsequent to the survey and test excavation and are presented as areas of archaeological sensitivity in Section 8.1.

6.4.4 Modified trees

Modified trees (either carved or scarred) can be difficult to identify. Scars commonly occur on trees through natural processes such a branch tears, insect damage, storm and fire damage and faunal damage. Scars also can occur from mechanical damage from vehicles or farming equipment. However, Aboriginal people were recorded using bark and cambium for canoes, containers, shelters and implements amongst other uses. The possible scar trees recorded during the survey were assessed against the publication *Aboriginal scarred trees in New South Wales: a field manual* (DEC 2005). Furthermore, a scar tree specialist (to be confirmed) was engaged to determine the status of one tree identified during the survey (MSL 037).

6.5 Survey coverage results

6.5.1 Rationale

The aim of recording and analysing survey coverage data is to determine the effectiveness of the survey. It is evaluated for its effectiveness in identifying the distribution of Aboriginal objects across the landscape, taking into account the potential for archaeological deposits. The percentage of the ground surface exposed in each landform and the visible ground surface within exposures (as ground exposures are often obscured by vegetation, gravels, etc) influences the survey results. 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. Overall, calculation of effective survey coverage is used to estimate not only how much area was physically surveyed, but also how favourable the survey conditions were for the identification of Aboriginal sites.

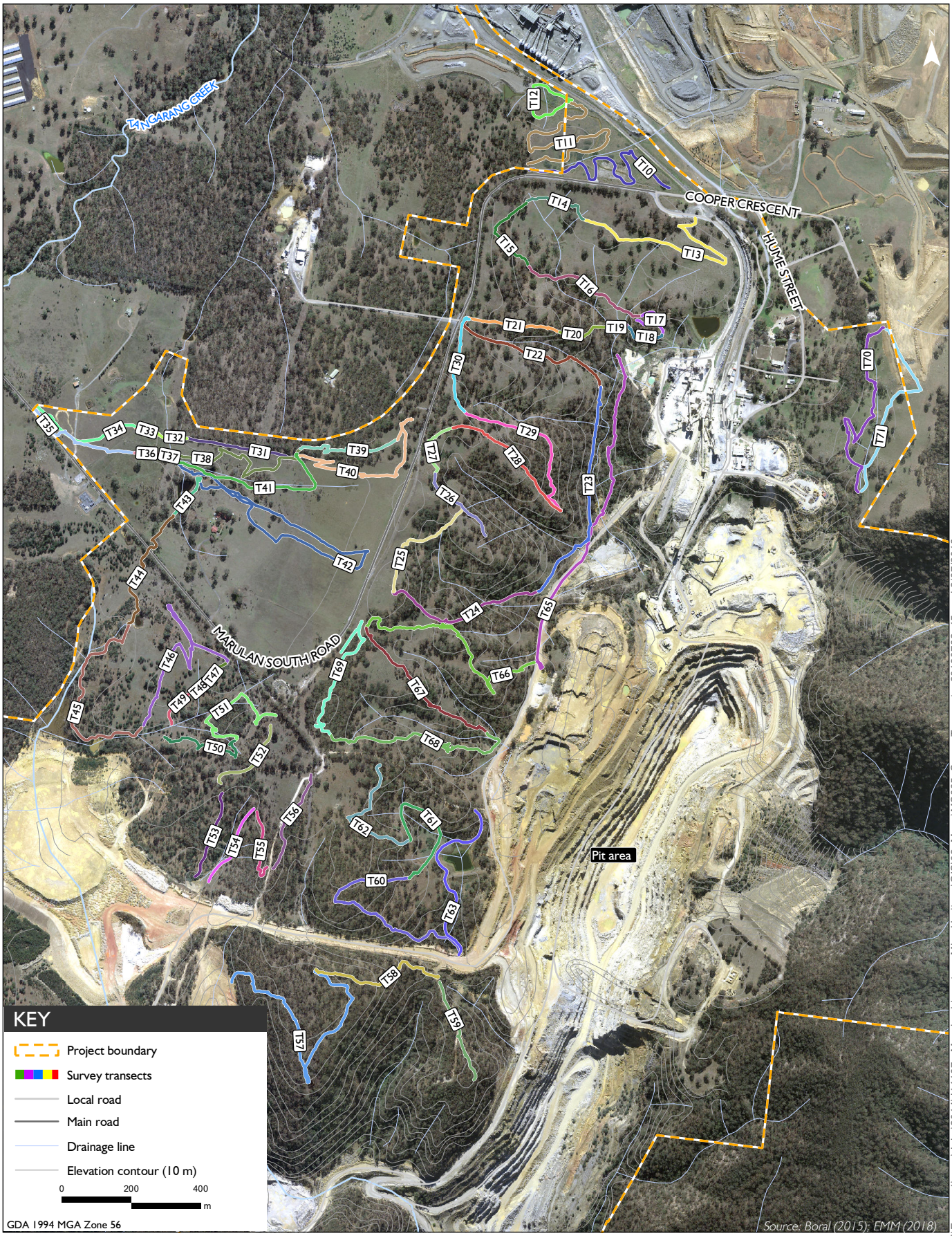
A total of 71 transects were walked covering an area of 51 km (Appendix D and Figures 6.1 and 6.2). The figures illustrate the survey transects logged by the GPS. However, the survey track data represents only where the archaeologist walked and does not represent the broader transect covered by the survey team of between eight and nine people.

Effective survey coverage is summarised in Table 6.1. Plate 6.1 to 6.14 provide some examples of the landscapes encountered across the surveyed area.

Table 6.1 Summary of effective survey coverage

Landform	Length (m)	Area (sq m)	Area available for detection (sq m)	Effective coverage (%)
Hill slope	2,541	128,328	11,879.84	9.2
Undulating plain	6,217	310,850	51,220.5	16.5
Ridgeline	9,262	423,220	43,396.8	10.2
Watercourse	24,397.5	1,203,482	244,041.66	20.2
Spur	8,076	395,380	36,753.05	9.3
Total	**50,493.5**	**2,461,260**	**387,291.85**	**15.7**

Table 6.1 shows that effective survey coverage was roughly between 10% and 20% in each landform and was 15.7% overall. Visibility was constrained in grazing paddocks through the growth of grass. Transects through paddocks were targeted at those areas with exposure, but otherwise were limited to areas of visibility resulting from vehicle track or cattle tread exposures.

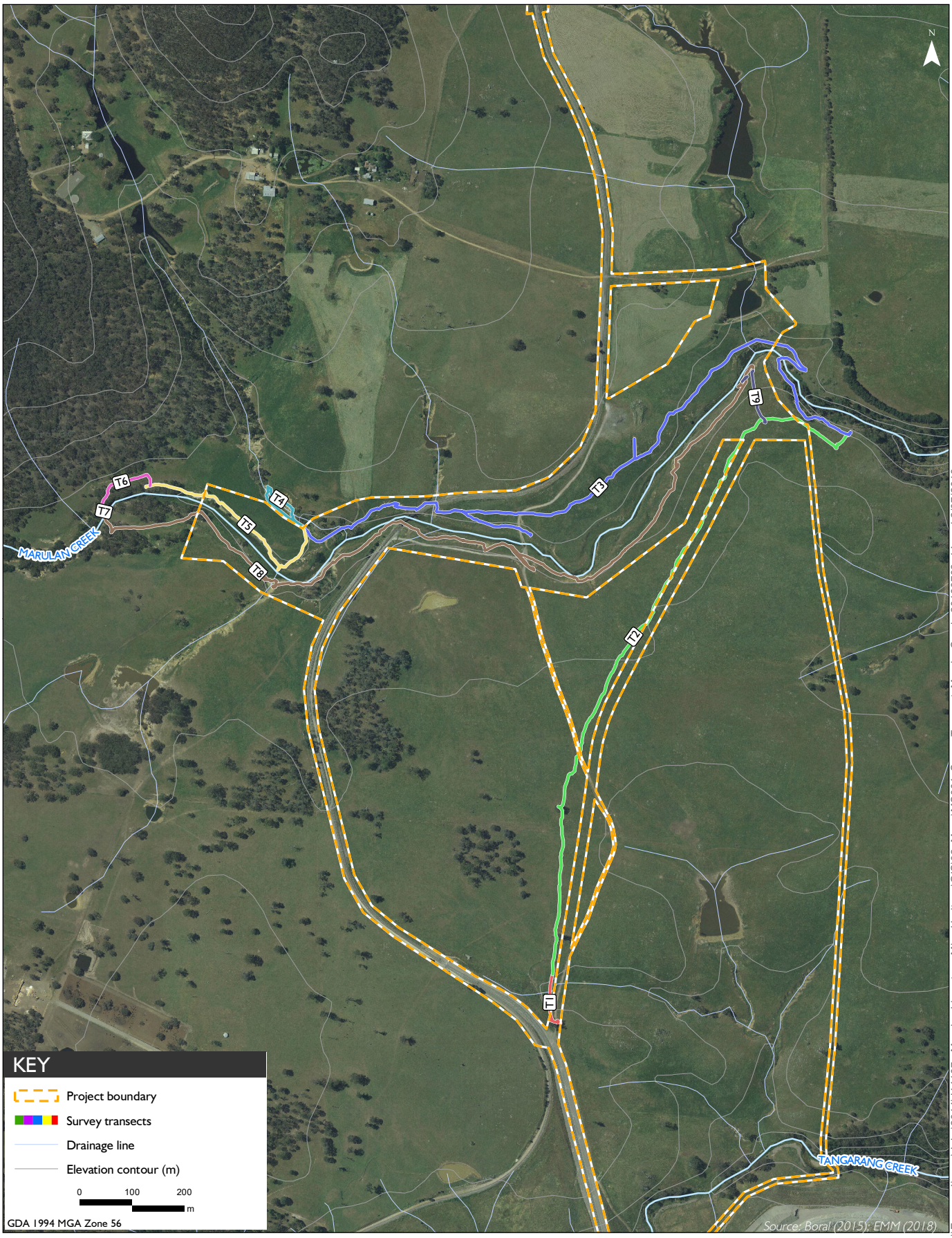


Survey transects at main Project site

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 6.1



Survey transects at Marulan Creek

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 6.2

Disturbance across the Project site was variable with the main Project site showing high levels of disturbance from earthmoving and mining activities. The majority of the Project site was cleared grassed paddocks, a result of historical vegetation clearance, which may have displaced Aboriginal objects within the soil matrix without fully diminishing their archaeological and/or cultural value.

The survey also identified differences in visibility and exposure between certain landscapes of the Project site; namely the landscape of Marulan Creek Dam and the landscapes of the Western, Southern and Northern Overburden Emplacements.

At the Marulan Creek Dam area, vegetation consisted of pasture grasses and visibility was low. As explored in the predictive model, reliable watercourses such as Marulan Creek are highly likely to contain evidence of past Aboriginal activity. The lack of visibility and exposure in this area may have resulted in fewer Aboriginal objects being identified than are actually present. Thus in this case, the effective coverage may be less reliable for areas around Marulan Creek Dam.

In contrast, the hill slopes, spurs and ridgelines in the landscapes associated with the Western, Southern and Northern Overburden Emplacements higher levels of exposure and visibility. These areas were also characterised by watercourses that were less reliable than Marulan Creek; the area of Marulan Creek Dam. Vegetation in the overburden emplacements contained sparse eucalypt woodlands and mossy vegetation in contrast to Marulan Creek Dam, which was characterised by pasture grasses. It may also suggest that effective coverage in these areas is more reliable as visibility and exposure were higher.

The contrasting results from the whole Project site illustrate the importance of placing the effective survey coverage results within their landscape context. To test the predictive model and the results of the survey including effective coverage, a test excavation was considered appropriate.

During the survey a possible cultural site was identified by a member of the survey party. A cultural heritage specialist was engaged to assess the place and concluded, in consultation with the knowledge holders, that it is a cultural site. The investigation into the significance and values associated with the cultural site are included in a report, which includes an impact assessment and suggested management measures. This report is attached as Appendix G, although it contains restricted information.



Plate 6.1 Transect 1 showing thick grass ground coverage across an undulating plain (view north)



Plate 6.2 **Transect 3: view from the northern side of Marulan Creek facing south. Note the broad, thickly grassed spur overlooking the creek (red arrow).**



Plate 6.3 **Transect 3 showing granite outcropping on Marulan Creek as it flows east towards a gorge (view west)**



Plate 6.4 Transect 8 on a gentle slope leading towards Marulan Creek (creek shown by red arrow). View north-east



Plate 6.5 Transect 10 undulating plain with low visibility adjacent to Peppertree Quarry (view east)

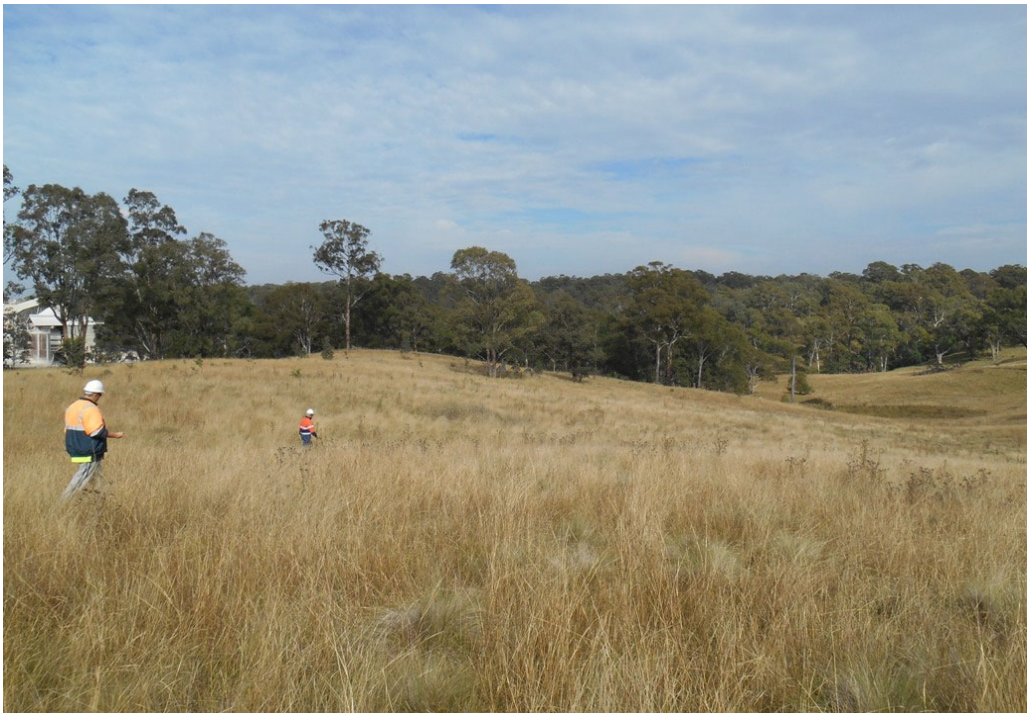


Plate 6.6 **Transect 13 on a rolling hill spur facing south towards a landscape of steeper slopes (Lime Plant to the far left)**



Plate 6.7 **Transect 16 showing a prominent spur crest bordering on steep slopes and incised gullies to the south (view west). Northern Overburden Emplacement area.**



Plate 6.8 **Transect 20 following the lower portion of a spur (view east)**



Plate 6.9 **Transect 25: photo taken from a spur crest showing steep side slopes and incised gullies that were largely avoided during the survey (Northern Overburden Emplacement area)**



Plate 6.10 **Transect 28 following the top of a spur line along an existing electricity transmission easement.**



Plate 6.11 **Transect 23: another example of a densely vegetated, steep gully between spurs (facing west). Northern Overburden Emplacement area.**



Plate 6.12 Transect 42 west of Marulan South Road showing thickly grassed undulating plain



Plate 6.13 Transect 46 showing areas of high ground visibility along low rolling hills south of Marulan South Road (view north) in Western Overburden Emplacement area.



Plate 6.14 Transect 57 following a very narrow, stony spur crest with limited visibility (view south)

6.6 Aboriginal site results: survey

6.6.1 Sites and landform associations

The survey team recorded 41 new sites during the survey. The site types and their frequencies are listed in Table 6.2 and are shown on Figures 6.3 and 6.4. All but one of these comprised stone artefacts, with 68% of sites being artefact scatters, 29% isolated finds and one scarred tree (MSL 037). MSL 037 was originally recorded during the survey at the request of an Aboriginal site officer, but was noted to be possibly caused by natural damage. During revision of this ACHA, EMM Senior Archaeologists Ryan Desic and EMM Archaeologist Pamela Chauvel conducted a site visit on 20 Jun

e 2018 to determine if the scar on MSL 037 was of Aboriginal origin. 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 *Aboriginal scarred trees in New South Wales: a field manual* (DEC 2005). The tree has a series of elongated and irregularly shaped scars curving around the trunk of the tree (Plate 16.5 and 16.6). 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, the tree MSL 037 is hereafter referred to as 'not a scar tree'. EMM acknowledge that this site was incorrectly recorded on AHIMS (site ID #52-4-0551) and should be deregistered (refer section 11.2.9).



Plate 6.15 **Scar on tree recorded as MSL 037. Note the elongated and curving nature of the scar (starting at the red arrow) which is indicative of lightening damage.**



Plate 6.16 Primary scar shown on the left of the trunk at MSL 037 and another smaller irregular scar on the right side.

Plates 6.16 to 6.24 provide some examples of the sites recorded across the Project site. Summary descriptions for each site are provided in Appendix F.

Over half of the isolated finds and artefact scatters were recorded on watercourse landform types. Two thirds (n=15) of the sites identified on a watercourse are those that were recorded on the eroded stream banks of Marulan Creek. The remaining seven sites are associated with minor ephemeral tributaries of the drainage networks within the proposed emplacements.

Over one quarter (29%) of the sites were identified on a spur landform type. Interestingly, all of these sites are within the main Project site. These results are most probably the result of high ground surface visibility that characterised these often stony, sparsely vegetated and eroded areas. This contrasts with the area around Marulan Creek where although a prominent spur was surveyed adjacent to Marulan Creek (T9), the ground surface visibility was almost nil and no artefacts were identified.

Three sites were identified on prominent ridgelines that represent the highest elevations in the proposed emplacements (MSL 036, MSL 035 and MSL 025). The remaining three sites were identified on the gently to moderately inclined hill slopes that characterise the land to the north of the current western overburden emplacement area.

Table 6.2 Artefact frequencies and landform associations

Row Labels	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	

6.6.2 Site characteristics

A total of 236 surface artefacts were counted during the survey, 224 of which were from scatters and 12, isolated finds.

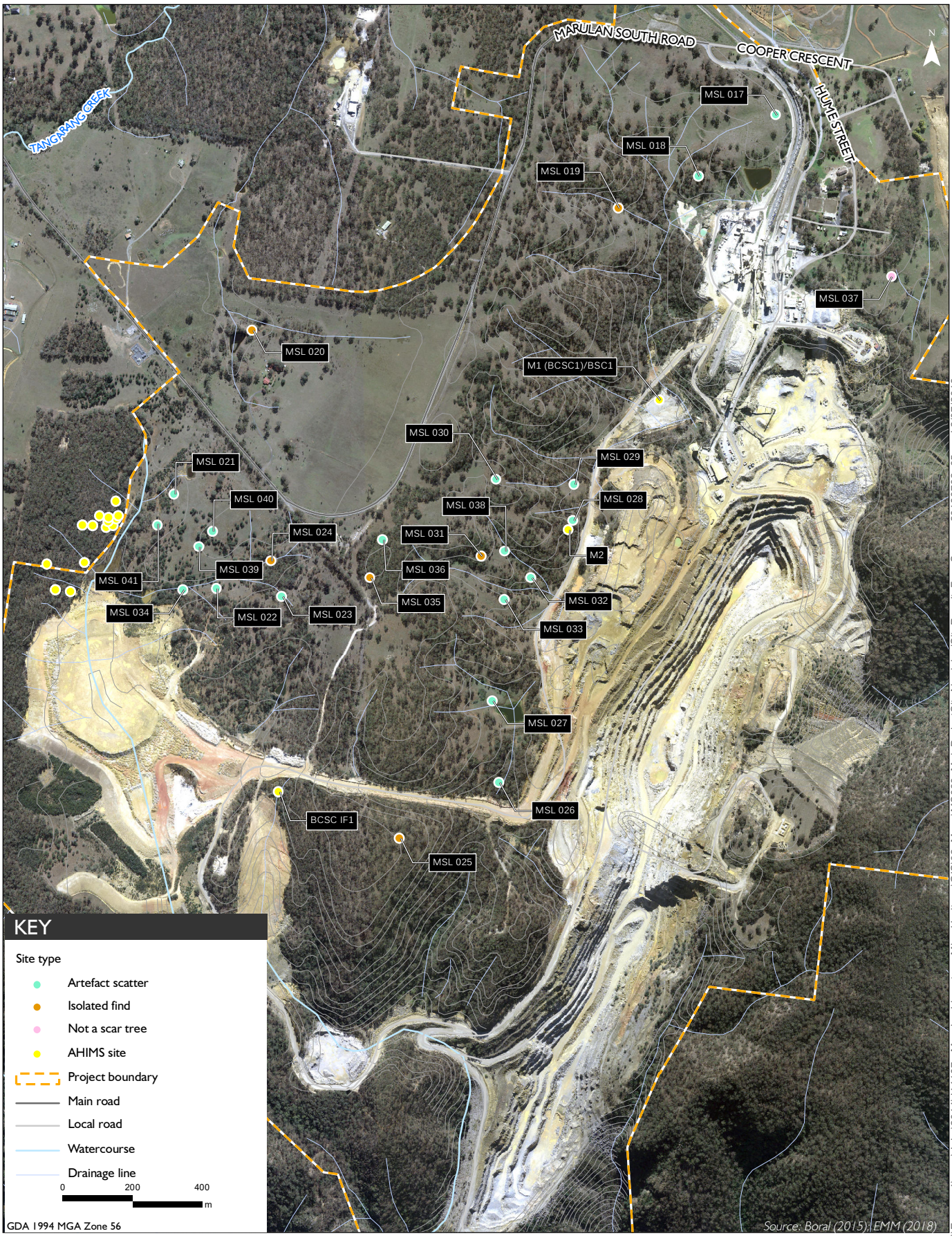
Artefact frequencies across the artefact scatters range from two to 30 artefacts. The average artefact frequency of the scatters is eight and the median 4.5. Most artefact scatters (five of the seven) with artefact frequencies over 10 were identified along watercourses. Only one of the 11 artefact scatters identified on spurs featured over 10 artefacts (MSL 030, n =30 artefacts).

A range of raw materials were recorded during the survey and comprised silcrete, quartz, chert, indurated mudstone (IMT), quartzite and chalcedony. Silcrete is the most widely distributed material, with 32 of the 40 artefact sites featuring silcrete. Fifteen sites contained silcrete only, but almost half of the sites (n=17) featured a mix of material types.

6.6.3 Discussion: survey results

As noted in the survey coverage results, ground surface exposure and visibility conditions have great influence on the detection of Aboriginal sites. The incidence of most sites and artefacts being recorded along watercourses, particularly Marulan Creek, is primarily because there were large tracts of eroded banks available for inspection. The land adjacent to Marulan Creek features the gentle slopes of undulating plains and occasional spur crests, however these are thickly grassed and no sites were identified during survey. Despite the lack of surface evidence, the spurs surveyed next to Marulan Creek were predicted to be archaeologically sensitive features, especially based on the outcomes of subsurface investigations at Peppertree Quarry.

Isolated artefact and artefact scatters were identified consistently along spurs within the main Project site. This largely attributed to the high ground surface visibility conditions in this area but it does not necessarily mean that significant subsurface deposits also exist, particularly because the drainage network in this area is ephemeral and that soils may be far more skeletal in this area when compared to Marulan Creek and the land surrounding Peppertree Quarry. Accordingly, further investigation through test excavation was implemented to better characterise the Project site (refer Chapter 7).



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Main Project site: Aboriginal site results from the survey

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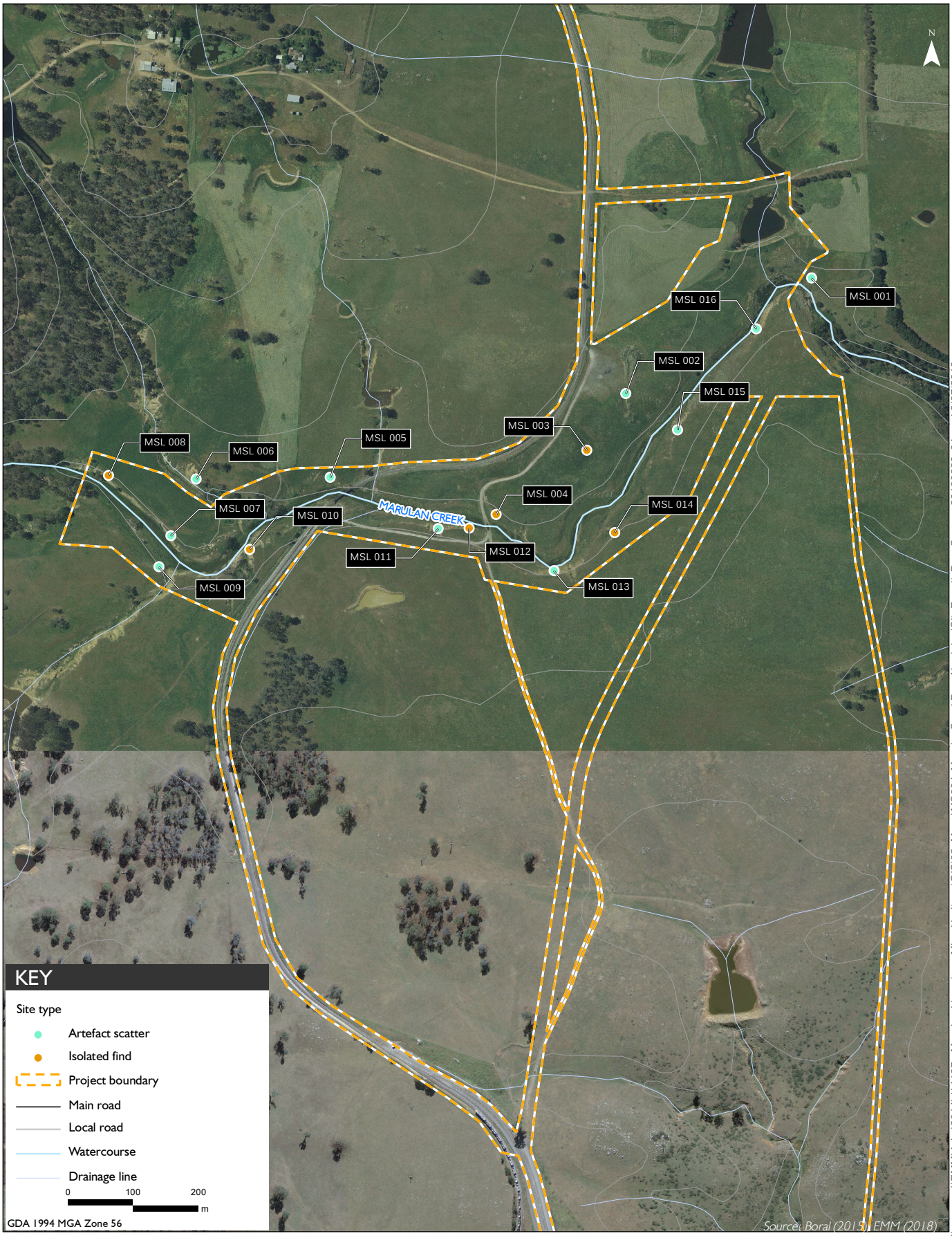
Figure 6.3



Marulan Creek dam: Aboriginal site results from the survey

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Figure 6.4



Plate 6.17 A group of silcrete artefacts identified as part of MSL 030



Plate 6.18 Site MSL 018 on a large spur crest exposure (view south-west)

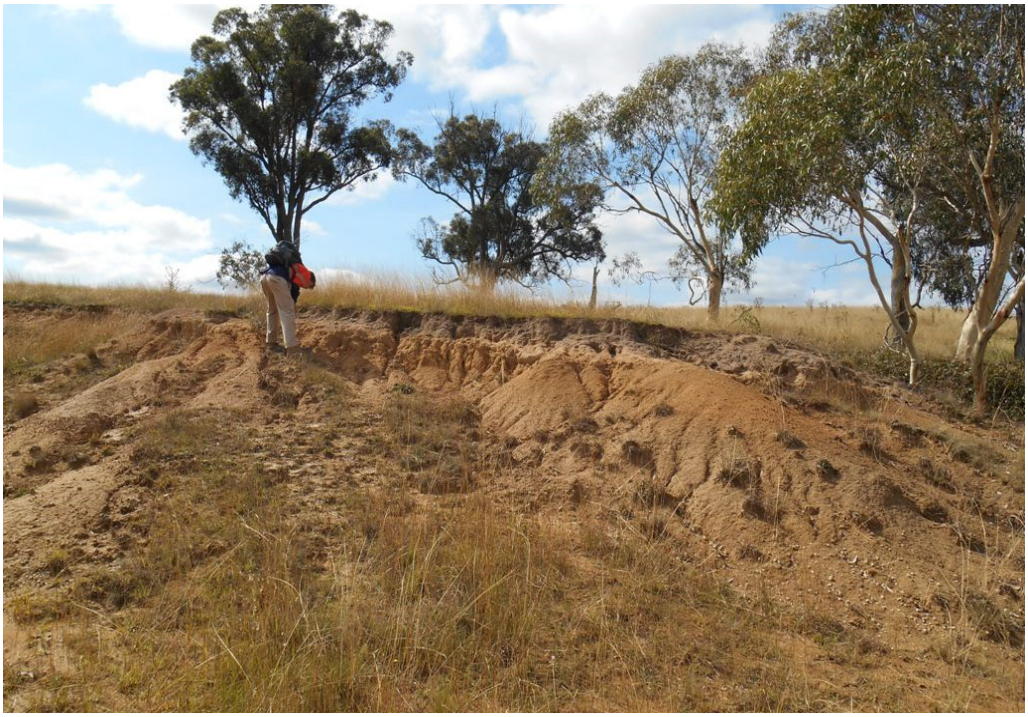


Plate 6.19 Site MSL 006 within a stream bank exposure of Marulan Creek



Plate 6.20 Silcrete artefacts scattered amongst natural gravels at MSL 006



Plate 6.21 Exposures and artefacts along Marulan Creek, part of MSL 016



Plate 6.22 A group of grey silcrete artefacts, site MSL041



Plate 6.23 Site MSL 022 identified along a large cleared hill slope next to a drainage depression (view north)



Plate 6.24 A group of silcrete artefacts and one quartz artefact (right) identified as part of MSL 022



Plate 6.25 Site MSL 30 on a broad spur crest facing east

7 Test excavation

7.1 Overview

The results from the background research and survey indicated that parts of the Project site had the potential to contain Aboriginal objects. While some Aboriginal sites were identified during the walking survey, it was also noted that visibility was particularly low on landscape features commonly associated with Aboriginal sites (such as the spur crests near Marulan Creek).

Low effective survey coverage and visibility limits the number of surface sites identified in sensitive landforms. 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.

A test excavation was conducted from 15 June 2015 to 1 July 2015. EMM archaeologists and RAPs participated in the fieldwork (see Appendix C for personnel and Appendix E for excavation data).

7.2 Test excavation strategy

The aims of the test excavation program were to:

- characterise the subsurface archaeological deposit across representative sample landforms spread across the geographical extent of the Project site;
- test the predictive model and survey results:
    - particularly to understand if areas with frequent surface artefacts generally indicate extensive subsurface deposits; or
    - if significant subsurface deposits are typically buried without surface artefact expressions; meaning that landscape analysis is a better guide to subsurface character than survey site results based on artefact expressions.

Some of the landscape types correlated with excavations planned for the soils and landscape assessment for the Project. The soil testing was required to complete a Soil Verification Certificate application for the Project which informed the soil and landscapes assessment. The soil testing required 3 m x 1 m test pits to be dug across the Project site. To minimise the overall disturbance footprint during the EIS, EMM incorporated the soil test pit layout and locations into the archaeological test excavation program. This approach allowed for all excavation to be completed in a controlled manner which was used to inform the archaeological investigation.

EMM discussed the suitability of this method with the OEH South East Region archaeologist in May 2015 during a teleconference. OEH supported the methodology on the basis that all soil test pit locations were excavated archaeologically until culturally sterile layers were encountered.

The locations of all test pits are shown in Figures 7.1 and 7.2. A total of 25 test pits were excavated across the landscapes of the Project site. The test pits were labelled with geographically non-consecutive numbers in the field and these have remained for analysis and reporting.

7.2.1 Fieldwork method

Each area chosen for archaeological excavation was divided into a 3 m by 1 m test pit. This approach was primarily used because the soil testing pits required these dimensions for the soils and landscapes assessment. Accordingly, all test excavation locations used the same sample size for consistency in the excavation method.

Each test pit was divided into North, Centre, and South 1 m by 1 m squares aligned on a north-south axis. Each 1 m by 1 m square was excavated and recorded separately, with artefacts placed in individual bags according to square and spit number. Test pits were divided into 1 m by 1 m squares to refine sample size and to allow comparison of artefact densities within the broader archaeological context.

Excavation was a combination of hand and machine methods. The first test pit in each landscape area was excavated by hand. Excavation then proceeded by machine excavator monitored by archaeologists. Sustained rain in the first week of fieldwork hampered the number of machine excavated test pits, resulting in the majority of all pits being excavated by hand.

Test pits were excavated in 10 cm spits to culturally sterile deposits. Each pit was also excavated by shovel to refine square boundaries and remove any remaining soil. All pits were backfilled.

Most of the excavated deposit was dry-sieved through nested sieve screens of 5 mm aperture mesh size. Where deposit was waterlogged, wet sieving was undertaken. After sieving, all artefacts were washed and bagged on site for future recording.

Standard archaeological excavation and recording methodologies were also implemented during field excavation. These included:

- photographic recording or all phases of work on site, including soil profiles and general photographs of the landscape;
- soil profile drawings of each test pit; and
- the recording of location, dimensions and characteristics of all test pits on standardised context recording sheets.

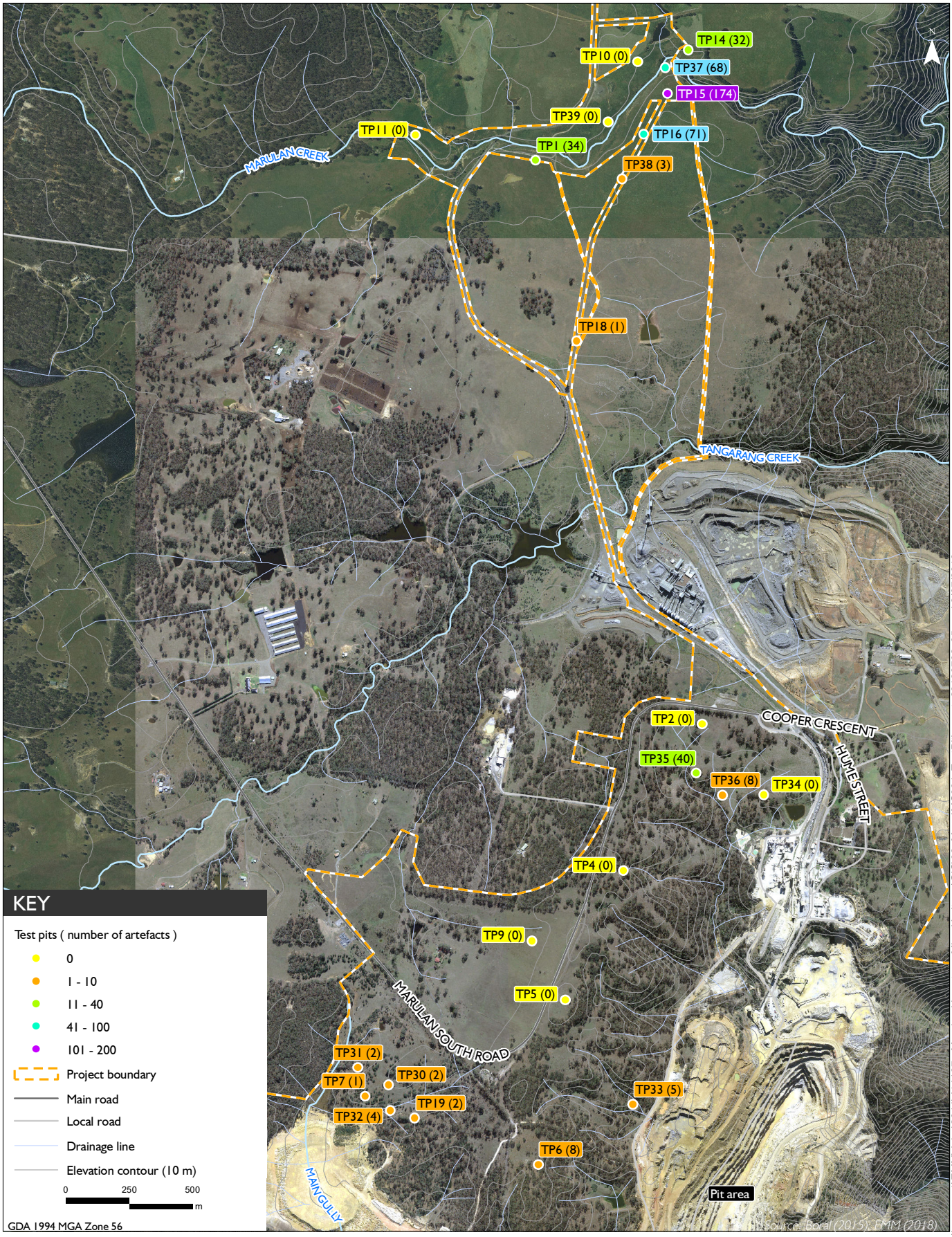
The method was designed to detect the presence of Aboriginal stone artefacts within the topsoil. The results will also assist in determining the focus areas of salvage excavation.

7.2.2 Aboriginal stone artefact recording and analysis

Stone artefact characteristics selected for recording were designed to contribute to a baseline description of the archaeology of the Project site. Aboriginal stone artefacts characteristics were identified as described in Section 6.2.3.

Basic artefact characteristics were a priority and include: artefact type, raw material type, length, weight, and implement type (where applicable). These variables sought to provide a general understanding of the local archaeology that may assist in future archaeological investigation and comparisons of the Project site and regionally.

Aboriginal stone artefacts were recorded using a Microsoft Access database. Subsequent analysis involved querying the database of its records and rationalising data using Microsoft Excel pivot charts and tables. These methods allowed statistical representations of the artefacts to assist in assessing their cultural and archaeological values.



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Test pit layout

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Figure 7.1

7.3 Results

7.3.1 Soils

The soils in the Project site were highly variable. This section provides a summary of the main soil types in the Project site. Further information on individual soil test pit profiles is in Appendix E.

Soils along Marulan Creek Dam were generally a homogenous dark brown sandy loam overlaying an orange-brown clay at depths varying from 30–80 cm. This included TP10, TP14, TP15, TP16, TP17, TP1, TP11, TP37 and TP39. An example of this soil type is shown in Plate 7.1. The depth of clay appeared to depend on the location of the pit within the flood and erosion areas of Marulan Creek. The deepest test pits (TP10 and TP37) were located close to the most dynamic portions of the creek with evidence of flooding and erosion clearly evident.

TP18 and TP9 were located on undulating plain landforms next to drainage depressions and had a similar soil profile to those test pits at Marulan Creek Dam. The soils in TP18 were silty sandy loam overlaying clay, though also evident were gravel inclusions of varying sizes. An example of this soil type is shown in Plate 7.2.

TP34, TP35 and TP36 were located on level to gently inclined landforms with areas tested including a ridge and spurs and slopes. An example of this soil type is shown in Plate 7.3. TP2, TP4, TP5 and TP6 were located on a ridgeline running through the middle of the main Project site. These test pits displayed a soil profile of sandy loam topsoil overlaying olive brown clay deposits. Again, the depth of test pits was variable and appeared to be linked to the degree of slope.

TP32 and TP33 were located on spurs adjacent to the current mining activities. The soils from these two pits highlighted the disturbance the area has experienced from mining activities and other construction with ceramics and plastic evident during excavation. The soils in these test pits were clayey silt overlying clay. Plate 7.4 provides an example of this soil type.

TP7, TP31, TP30 and TP19 were all located in an area of undulating landforms on various slopes and spurs adjacent to watercourses. The soil in these test pits was characterised by very shallow topsoils of between five and ten centimetres overlying a sandy loam with very high gravel content. Clay was usually uncovered at the base. It suggests that these areas have been subject to extensive erosion, possibly due to the landforms themselves but also likely due to the clearing of vegetation throughout this area. These areas had very low retention of artefact bearing soil deposits, despite artefacts being found on the surface. The range of test pits excavated in this area suggests this is a consistent soil and erosion pattern and that subsurface deposit are unlikely. Plates 7.5 and 7.6 provide an example of these skeletal soils.

Interestingly, these results offer strong correlation with the soils and landscape assessment, particularly the identification of shallow soils across a large section of the Project site with maximum topsoil depths of between 10 cm and 15 cm (Crawford 2018, p.42).



Plate 7.1 TP16, example of soil profiles near Marulan Creek Dam showing dark brown sandy loam overlaying clay horizon



Plate 7.2 TP18, example of a soil profile along an undulating plain, showing silty loam soil



Plate 7.3 **TP35, example of soil profiles on gentle spurs of the Project site showing brown sandy loam and clay horizon**

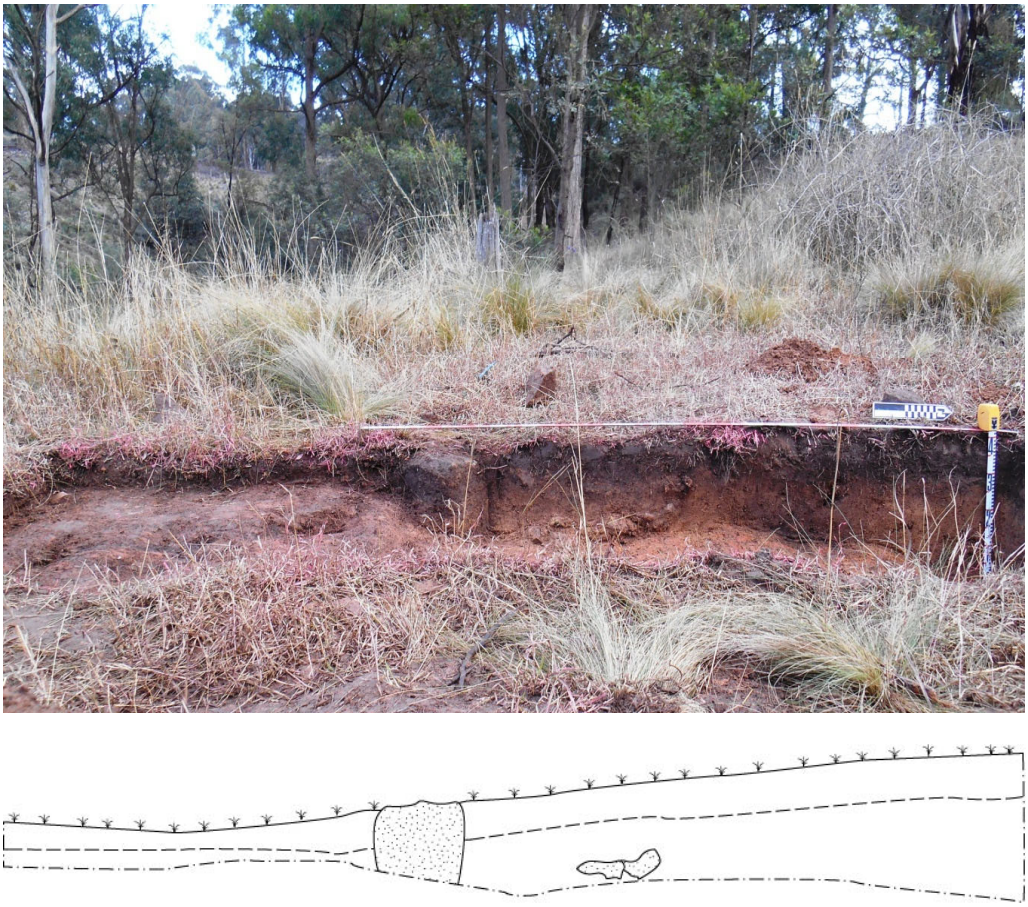


Plate 7.4 TP33, example of soil profiles on spurs near the current mining area showing clayey silt soil

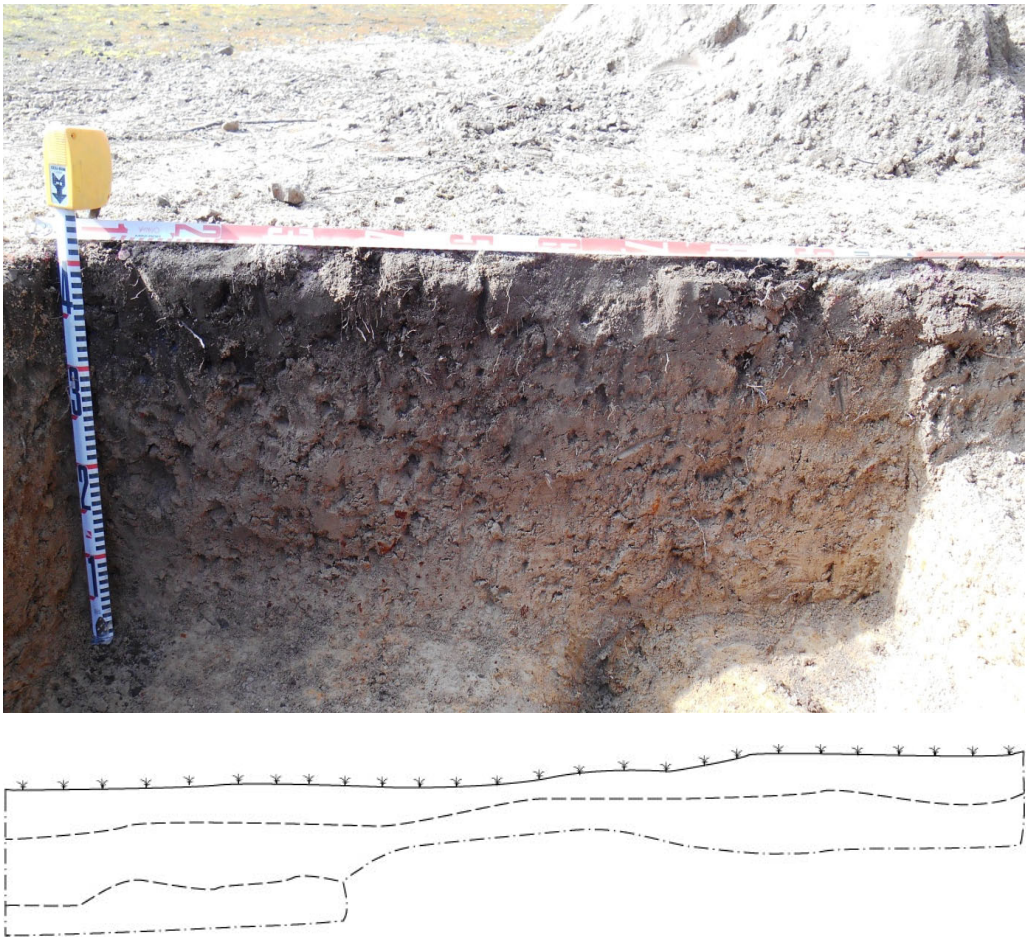


Plate 7.5 **TP32, example of soil profiles in the western Project site, showing shallow topsoil, and high gravel content**



Plate 7.6 TP19 showing extremely rocky and skeletal soils.

7.3.2 Artefact results

i Overview

A total of 539 artefacts were uncovered during the test excavation. Seventeen out of the 25 test pit locations contained artefacts. Each test pit that contained artefacts was attributed with a new site name, with the result that seventeen new sites were recorded and labelled consecutively from MSL 042 to MSL 058. These sites are labelled as “subsurface artefact deposits”.

Table 7.1 shows the test pits and the artefacts identified in each.

Table 7.1 Artefact frequency per 1 m x 1 m excavation unit

Test pit	Landform	Square	Artefact frequency	Total
TP1	Undulating plain	North	21	
		Centre	9	
		South	4	34
TP2	Ridge	North	-	
		Centre	-	
		South	-	0
TP4	Ridge	North	-	
		Centre	-	
		South	-	0
TP5	Ridge	North	-	
		Centre	-	
		South	-	0

Table 7.1 Artefact frequency per 1 m x 1 m excavation unit

Test pit	Landform	Square	Artefact frequency	Total
TP6	Spur	North	5	
		Centre	2	
		South	1	8
TP7	Spur	North	1	
		Centre	-	
		South	-	1
TP9	Hill slope	North	-	
		Centre	-	
		South	-	0
TP10	Drainage depression	North	-	
		Centre	-	
		South	-	0
TP11	Undulating plain	North	-	
		Centre	-	
		South	-	0
TP14	Spur	North	12	
		Centre	8	
		South	12	32
TP15	Spur	North	35	
		Centre	25	
		South	114	174
TP16	Spur	North	24	
		Centre	23	
		South	24	71
TP17	Spur	North	25	
		Centre	29	
		South	30	84
TP18	Undulating plain	North	-	
		Centre	1	
		South	-	1
TP19	Spur	North	-	
		Centre	-	
		South	2	2
TP30	Spur	North	-	
		Centre	-	
		South	2	2
TP31	Spur	North	-	
		Centre	1	
		South	1	2
TP32	Spur	North	1	
		Centre	-	
		South	3	4

Table 7.1 Artefact frequency per 1 m x 1 m excavation unit

Test pit	Landform	Square	Artefact frequency	Total
TP33	Spur	North	-	
		Centre	2	
		South	3	5
TP34	Spur	North	-	
		Centre	-	
		South	-	0
TP35	Spur	North	11	
		Centre	11	
		South	18	40
TP36	Spur	North	2	
		Centre	6	
		South	-	8
TP37	Spur	North	22	
		Centre	23	
		South	23	68
TP38	Undulating plain	North	1	
		Centre	1	
		South	1	3
TP39	Hill slope	North	-	
		Centre	-	
		South	-	0
Total				**539**

ii Frequency within test pits

As shown in Table 7.1 artefact frequencies varied throughout the test pits. Out of the 75 x 1 m^2 excavated a total of 51 contained artefacts. The average frequency per 1 m^2 is 7.3. The median frequency per 1 m^2 is 0, which does not accurately reflect those pits which had large numbers of artefacts. The median frequency was recalculated using only test pits with artefacts and the result was 10 artefacts per 1 $m^{2.}$ Notably, the pits with the highest frequencies were centred on broad spurs next to Marulan Creek (TP15; n=174, TP17; n=84 and TP 16; n=71). These results show the variability of artefacts across the Project site with many test pits containing nil artefacts and many others containing high numbers of artefacts.

Notably, 86% of the artefacts (n=466) were recovered from test pits near Marulan Creek despite less than half of the excavation effort being placed in that area. The average artefact frequency for test pits with artefacts near Marulan Creek is 22 artefacts per square metre. Notwithstanding, there is a distinct concentration of artefacts in one area which is on spur crests near Marulan Creek Dam (refer Figure 7.3).The remaining 73 artefacts were recovered from 10 out of 14 test pits within the main Project site. Over half of these were recovered from one location (TP35). Even with the considerable outlier in TP35, the artefact frequency for test pits with artefacts is 4 artefacts per square metre.

While there is no benchmark of what constitutes a high or low frequency value within a given region, an average of 22 artefacts per square metre near Marulan Creek is likely to be considered moderate whereas the average of four artefacts per square metre within the proposed emplacements is considered low. Notwithstanding, further expansion of the pits with the highest artefact frequencies would likely result in much higher averages in discrete locations. Excavations in the region generally record similar or smaller artefact frequencies (Umwelt 2012). The test excavation at Peppertree Quarry recorded frequencies of artefacts per transect (of 50 cm squared excavation unit) of between 0.8 and 210 with an average of 63.1 artefacts (ERM 2012, p.129). However, recent salvage excavation at Peppertree Quarry has identified considerable artefact concentrations on broad spur crests with artefact frequencies between 100–1,722 per square metre (Boral 2017). Based on this general discussion, Marulan Creek has a much lower average artefact frequency than certain areas of Peppertree Quarry, but further open area excavation of the spur crests conducted on a comparable scale to Peppertree Quarry would provide more reliable data for comparison.

Artefacts were found in the upper 30 cm of soil across the majority of the Project site. A total of 433 artefacts were uncovered in the top 30 cm of soil representing 80% of the assemblage. In the next 31 – 70 cm depth a total of 106 artefacts was uncovered representing 20% of the assemblage. The first 30 cm of soil correlates with the topsoil A horizon and artefacts were generally confined to this soil layer. However this was not consistent across the Project site with some areas yielding artefacts at depths of up to 60 cm, particularly near the creeks, where the results suggest alluvial deposits have created deeper artefact bearing profiles, either as buried topsoils or as redeposited artefacts. Excavations continued past the artefact bearing topsoil to clay.

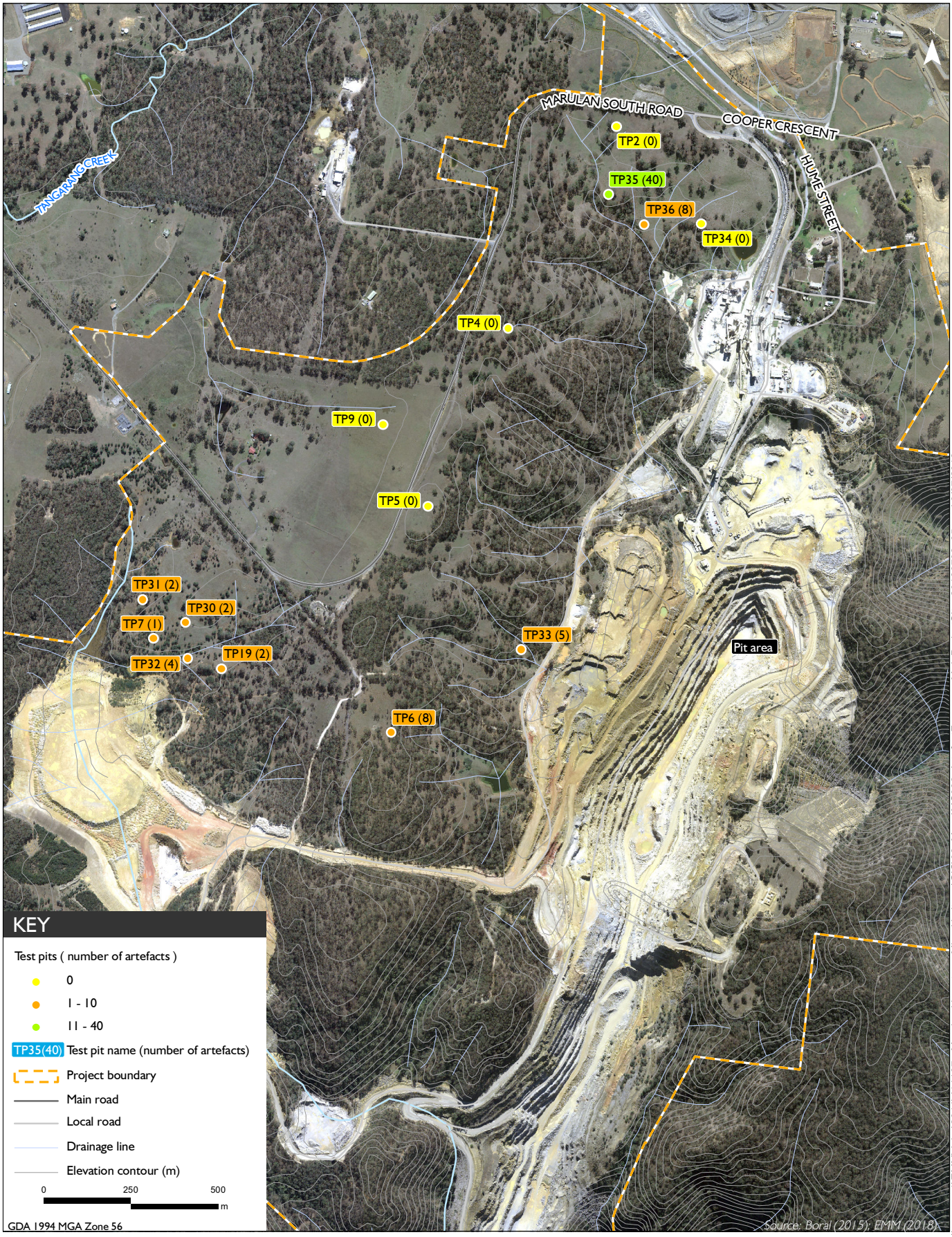
As noted in Section 7.3.1, soils across the Project site were highly variable with many areas experiencing very shallow soil profiles of 20 cm or less before reaching basal clay. The location of artefacts was directly linked to the amount of artefact bearing soil present across the Project site.

iii Distribution across Project landscape

As shown in Table 7.1 and Figure 7.3 artefact frequencies varied over the Project landscapes excavated. The highest artefact frequencies were found in test pits located along Marulan Creek. These areas accounted for over 80% of the total artefact assemblage. Marulan Creek appears to have been a focus of long term, sustained habitation, with frequent visitations to create a rich and varied artefact assemblage.

Localised differences in artefact frequencies were also evidenced at Marulan Creek. The largest concentrations of artefacts (TP15, TP16 and TP17) were located on broad spurs near bends, overlooking the creek. In contrast, TP10 and TP11 did not contain artefacts despite their proximity to the creek. It is likely that both TP10 and TP11 were too close to the creek or in the case of TP11, between Marulan Creek and a tributary. These areas would have been subject to flooding and would not have offered suitable camping spots. Both test pits were poorly drained and difficult to excavate due to their waterlogged state, further suggesting their location was too close to the creek for camping. The archaeological deposits in TP10 and TP11 may have also been disturbed by flooding throughout the lifespan of Marulan Creek. The banks of Marulan Creek have variable incision and terracing suggesting dynamic creek channel, flooding and resulting erosion. These events would have removed artefacts from their original location.

The largest group of artefacts in the main Project site were at TP35 which contained 40 artefacts. This test pit was located 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. Test pits in these steeper locations contained an artefact count of less than ten. Lower or nil densities of artefact were found in areas of the Project site that were away from reliable water, plain landscapes or in areas where drainage was poor and flooding was common.



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Artefact frequency in the main Project site

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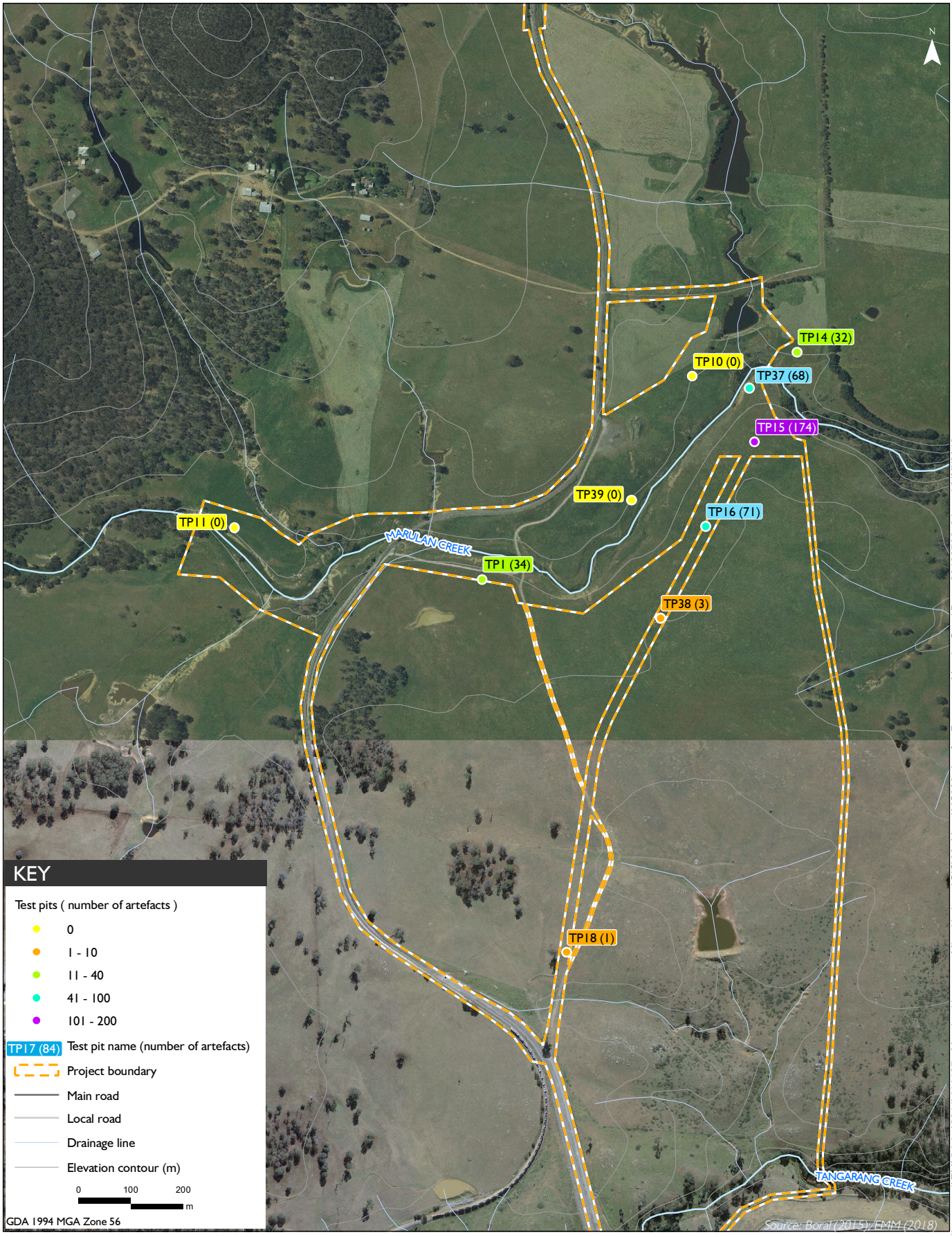
Figure 7.2



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Artefact frequency at Marulan Creek

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Figure 7.3

iv Raw material types

Silcrete and quartz were the predominant raw materials recovered from the Project site. Silcrete was slightly more pervasive, making up 60% of the artefacts, while 38% were quartz. Chert and volcanic rock were also present but together made up only 2% of the assemblage. All these materials are locally occurring; however it is possible that particular types of material may have been imported from other areas. Figure 7.9 and Plate 7.6 to 7.8 provides representations of the different raw materials.

Silcrete is a silica rich, sedimentary rock. Silcrete artefacts in the test area tended to be light grey or reddish brown and ranged in quality. The more fine grained stone resulted in thinner, sharper flakes. Coarser varieties of silcrete had more quartz grain inclusions and the artefacts tended to be larger and blunter. Silcrete was observed as locally occurring in the banks by Marulan Creek. It was generally red in colour and coarse in appearance. The fine grey silcrete also identified in the assemblage was not observable locally and may have been imported from other silcrete sources in the region.

Quartz artefacts found in the test area ranged from milky white or smoky grey opaque, to clear crystal-like material. Quartz is a locally available resource as river rolled cobbles in Tangarang Creek (ERM, 2012, p.124). The quality of the quartz ranged from homogenous varieties, with conchoidal fracture characteristics to material containing numerous flaws and incipient fracture plains. This makes the material less suitable for retouching. Consequently only one quartz flake in the assemblage displayed evidence of being reworked. It is also possible that varieties of quartz may have been imported.

Cortex, the outer weathered portion of stone, was present on only 31 out of the 539 artefacts. Just less than 30% of the cores contained cortex, while only 4.5% of flakes contained any cortex. Cortex was slightly more likely to be present on the quartz cores (37.5%) than the silcrete cores (25%). However, as there are only 28 cores in the assemblage, the small sample size needs to be taken into account. The ratio of flakes containing cortex was similar for both silcrete and quartz.

While most areas contained more silcrete artefacts than quartz, TP17 and TP1 had more than twice as many quartz artefacts as silcrete.

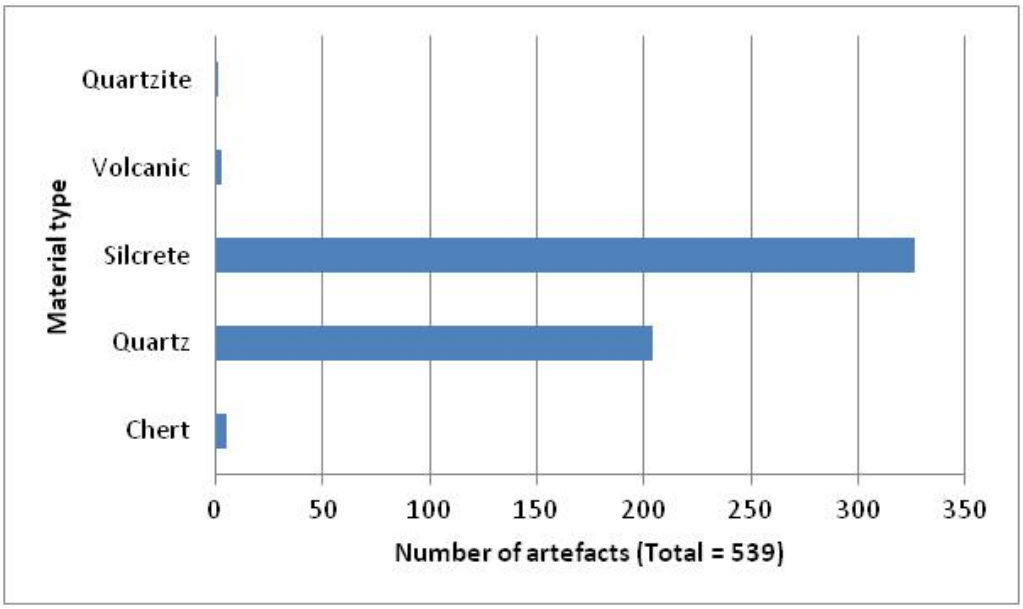


Figure 7.4 Raw material types



Plate 7.7 **A group of artefacts from TP15 showing the range of artefact material and types**



Plate 7.8 **A group of flakes showing the different types of silcrete and chert present in the Project site**



Plate 7.9 A group of quartz artefacts showing the different types of quartz present in the Project site

v Artefact types

Of the 25 test pits excavated, 17 contained a total of 539 artefacts. Figure 7.10 shows the different artefact types excavated. Nearly a third came from a single trench, TP15. The most common artefact type collected was complete flakes (60%). Yet, of these 323 flakes, only 16 demonstrated evidence of being retouched, putting them in the category of "tool" (see Section vi below). Broken flakes were generally distal flakes (19%). Medial, proximal, longitudinally split and flaked pieces together made up 16% of the assemblage. Plate 7.9 and 7.10 show some of the different artefact types identified in the Project site.

While the total number of cores retrieved from the test area was quite low (29), most of them had been substantially worked. This was evident by the direction of negative scars, demonstrating that the cores had usually been rotated and knapped from several angles. Cortex was present in less than a third of the cores and where it was still present, tended to be less than 40%, indicative of extensive working of the stone.

The use of local rather than imported raw material in the Project site could be a factor in the abundance of un-retouched flakes because the material was readily available and there was no need to conserve it. Consequently, the assemblage appears to be primarily debitage, as a by-product of stone tool manufacture.

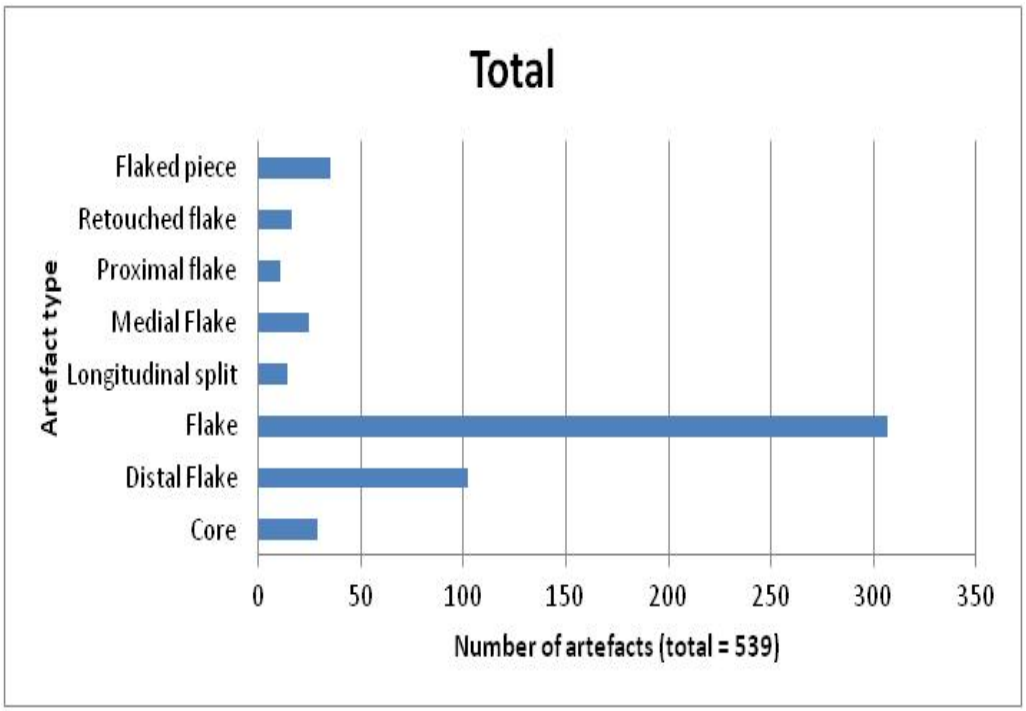


Figure 7.5 **Artefact types in the Project site**



Plate 7.10 **Silcrete core collected from the test excavation**



Plate 7.11 A group of flakes of silcrete and chert

vi Tool types

A total of 16 artefacts were identified as tools and all but one of these were silcrete. The artefacts were recovered from ten test pits with between 1 and 3 in each test pit. Table 7.2 provides the number of tools in each pit. Generally the tools were incomplete backed artefacts with one Bondi point also being identified (Photograph 7.6). Flakes that had been reworked were mostly retouched on one or both of the lateral margins. Retouch on the platform or distal end was less common. In general, flakes were removed from the ventral surface but examples of bifacial and dorsal retouch were also present. Tools represented 3% of the overall artefact assemblage.

Table 7.2 Distribution of tools

Test pit	Bondi point	Incomplete backed artefact	Total
TP14		2	2
TP15	1	2	3
TP16		2	2
TP19		1	1
TP30		1	1
TP31		2	2
TP32		1	1
TP35		2	2
TP37		1	1
TP38		1	1
Total	**1**	**15**	**16**

It is not unusual to have only small samples of tools in an assemblage. Tools were frequently used and reused and as such may be subject to different use and discard patterns when compared to knapping events or other discard patterns. The previous collection of artefacts at the Marulan South Limestone Mine also identified no formal tools in its assemblage of 91 artefacts, suggesting that the final stages of reduction may not have occurred in these areas or that the tools were taken and used in different places.

In excavations at Peppertree Quarry backed and retouched artefacts were identified as a small portion of the assemblage. Formal tools were identified but were not subject to detailed analysis, though it was noted that most backed artefacts were Bondi points and geometric microliths and some may have had rounding or polishing evident (ERM 2012, p.160). The analysis that did occur on backed and retouched artefacts identified that retouching and backing were mostly found on silcrete artefacts (ERM 2012, p.149). The shape of tools (Bondi points) and the material (silcrete) both correlate with the results during this Project's test excavation. Excavations at Lynwood Quarry did not identify Bondi points or backed artefacts, and although some artefacts were identified with retouch, most were flakes used as cores (Umwelt 2008, p.5.40). These results correlate with the small number of tools identified in the current excavations.



Plate 7.12 The silcrete Bondi point

vii Size and weight

The total weight of artefacts recovered from the test excavation was 1892.49 g. The relative weights of quartz and silcrete artefacts are consistent with the proportion of artefacts. The largest, heaviest artefact was a core made of brown volcanic stone (253 g).

Complete flakes recovered from the test pits had an average length of 16.37 mm and an average weight of 2.26 g. Cores, were on average about twice as long (32.69 mm), but substantially heavier, with an average weight of 31.57 g.

7.3.3 Discussion: test excavation

The results from the test excavation provide information on the variability of the subsurface assemblage of the Project site. In areas close to reliable watercourses, in this case, Marulan Creek, extensive subsurface assemblages have been shown to exist both above and below the ground surface. Many parts of the Project site also confirmed low subsurface artefact assemblages, even in areas where surface artefact assemblages were identified; this was most common in the southern and western portions of the Project site, which displayed shallow soils and high wind and water erosion, and artefacts, if present, were on the surface.

The results at the Project site correlate with the excavations occurring at Peppertree Quarry in similar landforms. The excavation by ERM (2012) at Peppertree Quarry centred on the waterway of Tangarang Creek. Marulan and Tangarang creeks are of a similar class (third or fourth order ephemeral stream), and have similar associated landforms including open rolling hills and a number of spur like flat areas overlooking the creek. Notwithstanding, similar results to that at Tangarang Creek have been found during recent salvage excavation and topsoil monitoring at Peppertree Quarry. The areas with the highest artefact frequencies are on broad spurs on rolling hills and are adjacent to a second order stream (Boral 2017). However, the artefacts recovered from these more recent salvage measures are yet to be catalogued and analysed.

The excavations by ERM at Tangarang Creek also identified hearth structures, domestic areas, intensively used areas suggesting trade and large scale habitation of the area (ERM 2012, draft, p.100). It is possible that a salvage excavation at Marulan Creek Dam would have similar artefact densities as identified at Tangarang Creek. Similar material types were also identified at both sites, including red and grey silcrete, quartz and chert. More generally both these excavations confirm the connection between reliable watercourses and higher density sites with the highest densities recovered from flat spurs near reliable watercourse.

The artefact assemblage is dominated by silcrete and quartz, the results of which are linked to the abundance of these materials in the natural environment. Some artefact materials including grey silcrete did not occur in the local landscape, suggesting that they were brought in through trade or importation. The artefacts and material types uncovered at the Project site also correlate with the wider region. Smaller numbers of chert and other materials excavated at Lynwood Quarry were identified in open artefact scatters (Williams 2004, Umwelt 2006).

The majority of the artefacts are related to discard from stone tool manufacture and are consistent with a landscape that was used for open camp sites. The results of the survey and excavation correlate with the conclusions drawn at Lynwood Quarry, particularly that the majority of stone knapping taking place is related to freehand reduction of cores and the bipolar reduction of pebbles to make flakes of stone for cutting and scraping (Umwelt 2010, p. A17). The Project site, Peppertree Quarry and Lynwood Quarry do not have evidence of large-scale backed artefact manufacture, although a small number have been recovered from Peppertree Quarry.

Two different excavation techniques were employed during the excavation; controlled machine monitoring and hand excavation. The use of these two techniques in the same excavation has provided the opportunity to compare them. One of the main perceived issues with machine excavation is its potential to damage artefacts during excavation. Damage to artefacts was not observed from either excavation technique in this test excavation. Although it is a small sample it appears there is no difference in the impact to artefacts from controlled machine excavation and hand excavation; breakages to artefacts usually occurred during manufacture or deposition but can on rare occasions result from pick strike. The one issue with machine excavation that must be considered carefully is the destruction of stratigraphically preserved sites; in these cases, machine excavation must be halted at the first sign of change and the deposit investigated by hand.

There were differences in the appropriateness of techniques when weather was considered. The first week of excavation included two days of steady rain during which machine excavation was not possible. After this period, the ground remained waterlogged and bogging of vehicles and machinery, in addition to the disturbance this would cause to the soil profiles was too great a risk to continue using the excavator. Hand excavation was used to complete the excavation and was considered a safer alternative in the conditions. Machine excavation was not suitable to access portions of the Project site.

Factors such as time to move the excavator and terrain suitable for an excavation were also factors that made machine excavation impractical. Hand excavation is also reliant on a large team to cover large areas and ensure that a timely and safe excavation is completed.

7.4 Summary

The following is a summary of the results from the test excavation:

- A total of 25 test pits were excavated across the various landforms of the Project site.
- Seventeen out of the 25 test pits contained stone artefacts. Each test pit with artefacts was recorded as a new Aboriginal site, thus, seventeen new sites were recorded and labelled consecutively from MSL 042 to MSL 058. These sites are labelled as “subsurface artefact deposits”.
- The excavation recovered 539 artefacts.
- The majority of stone artefacts related to debitage (by-product) from stone tool manufacture.
- Artefacts were mostly confined to the top 30 cm of soil (80%) but some artefacts were recovered from deeper soil profiles along Marulan Creek.
- Notably, 86% (n=466) of the artefacts were recovered from test pits near Marulan Creek despite less than half of the excavation effort being placed in that area. The average artefact frequency for test pits with artefacts near Marulan Creek is 22 artefacts per square metre.
- The remaining 73 artefacts were recovered from 10 out of 14 test pits within the proposed emplacements. Over half of these were recovered from one location (TP35). Even with the considerable outlier in TP35, the artefact frequency for test pits with artefacts is 4 artefacts per square metre.
- The highest densities of artefacts were associated with large, flat areas overlooking Marulan Creek with 174 artefacts recovered from TP15 and 71 artefacts from TP16.
- Other tested areas such as spurs near minor drainage depressions, ridgelines and plains revealed lower archaeological sensitivity, with eight locations containing no artefacts.
- The dominant materials in the assemblage were silcrete and quartz which made up 79% of the assemblage. Materials were likely to come from both the local area and through trade or importation.
- A total of 17 implements (tools) were found consisting of one Bondi point and 16 retouched tools.

8 Discussion

8.1 Discussion

Aboriginal objects are the physical expressions of past Aboriginal life demonstrating the use of the landscape and resources and provide a picture of the rich culture of Australian Aboriginal people.

The results of the survey and test excavation are discussed separately in each respective character, but they also must be considered jointly in order to characterise the archaeological landscape of the Project site. Both methods of investigation provided their own merits to the archaeological assessment which is mostly linked to the contrast in terrain and soils across the Project site; particularly between Marulan Creek and the main Project site.

The archaeological survey was most effective for the main Project site which provided larger exposures and was generally situated on skeletal soils. This resulted in the identification of a number of isolated finds and artefact scatters on spurs, ridges and hill slopes. In contrast, test excavation across the same landscape and landforms recovered only 13% of artefacts despite more than half of the test pitting occurring in this area. Moreover, over half of those artefacts were recovered from one location (MSL 055/TP35), but this landscape feature was anomalous by being a relatively flat spur in an area where the landscape starts its transition from the rolling hills associated with archaeologically sensitive Peppertree Quarry to the much steeper terrain of the main Project site.

These results show that Aboriginal occupation extended across the entire geographic extent of the Project site, but is better evidenced by surface material in the main Project site than through archaeological excavation. The presence of mainly surface artefacts and minimal subsurface artefacts in the main Project site is likely to be a combination of the following:

- less intensive long term prehistoric Aboriginal camping activities in this area because of the steeper terrain and ephemeral drainage network; followed by
- increased erosion and loss of surface artefacts because of steeper topography and skeletal soils; and
- minimal soil depth formation which would have prevented significant subsurface deposits from accumulating.

In comparison to the above, the results of the archaeological survey around Marulan Creek is an example where surface artefacts were only revealed by stream bank erosion and nearby subsurface deposits on a broad spur (MSL 046, MSL 057, and MSL 047) were covered in thick grass. As a result, the landscape bordering Marulan Creek is far better characterised through archaeological excavation. The test excavation results also indicate that higher artefact frequencies do not occur consistently across all areas of Marulan Creek, but are more dependent on prominent landforms such as broad spur crests. For example, a number of creek-side test pits (TP11, TP39 and TP10) contained no artefacts despite being within 50 m of Marulan Creek. Overall, the test excavation results indicate that Marulan Creek is likely to have experienced more intensive Aboriginal occupation on prominent landforms, possibly similar to that bordering Tangarang Creek and its tributaries as evidenced by investigations at Peppertree Quarry.

The survey and excavation also identified slope as a key factor in the distribution and intensity of occupation across the Project site. While some areas that were archaeologically tested and surveyed were located near one or more drainage depressions, many of these areas were also at a slope greater that 10 degrees. It appears these areas were too steep to be considered suitable for intensive camping. Camping required slope of 10 degrees or less to provide a suitable flat surface, but also required the distance from the watercourse to be great enough to avoid flooding but close enough to ensure easy access. The correlation of large flat areas outside the regular flood level, overlooking reliable water at Marulan Creek provided the ideal area for intensive habitation.

8.2 Archaeological sensitivity model

An archaeological sensitivity model has been developed using the implications of previous nearby assessments (primarily Peppertree Quarry) combined with the implications gathered from the results of the archaeological investigation for the Project which are summarised above in Section 8.1. The archaeological sensitivity model has been developed as a guide to indicate subsurface archaeological potential, with the primary aim of guiding the management and mitigation measures for the Project – ie where to focus salvage excavation measures.

The Project site has been divided into three levels of archaeological sensitivity which is shown on Figures 8.3 and 8.4. The areas of archaeological sensitivity are described below:

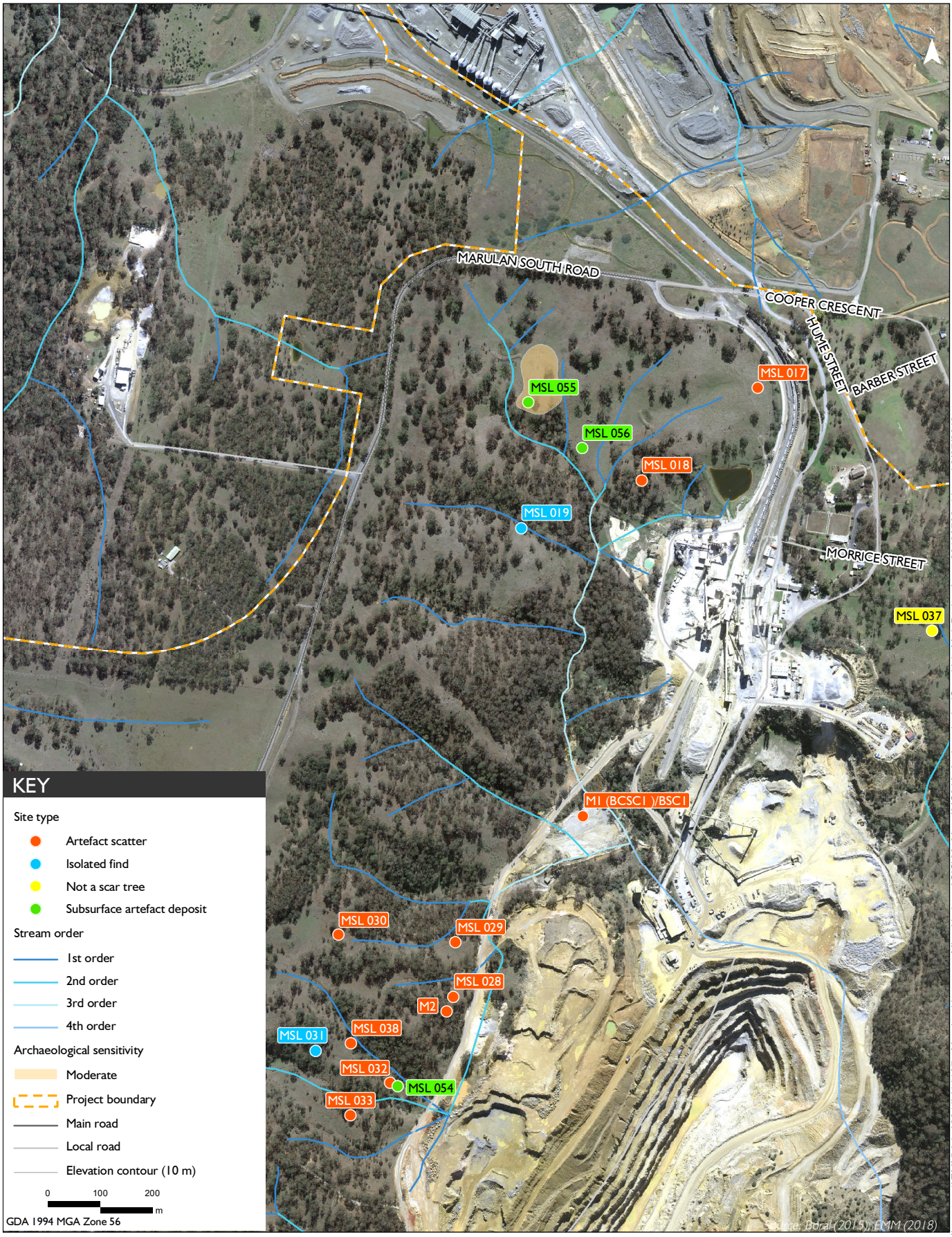
- Low sensitivity (not mapped): although surface artefacts may occur in these areas, subsurface artefact frequencies are expected to be very low (less than 2 artefacts per metre squared). This is primarily related to skeletal soils and ephemeral drainage networks. This also includes areas of disturbance and depressions which sometimes separate areas of moderate or high sensitivity, such as certain areas adjacent to Marulan Creek.

- Moderate sensitivity:

    - land within 200 m of Marulan Creek on flat or undulating landforms (not prominent) shown to feature sporadic incidences of artefact frequencies of approximately 10 artefacts per square metre; and

    - the spur crest surrounding site MSL 055 in the main Project site which is on an anomalous landscape context being a relatively flat spur in an area where the landscape transitions from the rolling hills associated with archaeologically sensitive Peppertree Quarry to the much steeper terrain of the main Project site. This area was shown to have an average artefact density of 13 artefacts per square metre.

- High sensitivity: the broad prominent crests surrounding Marulan Creek near the proposed dam. This area was found to have 174 artefacts at one location (TP15) and an average of 28 artefacts per square metres across the pits associated with this area.

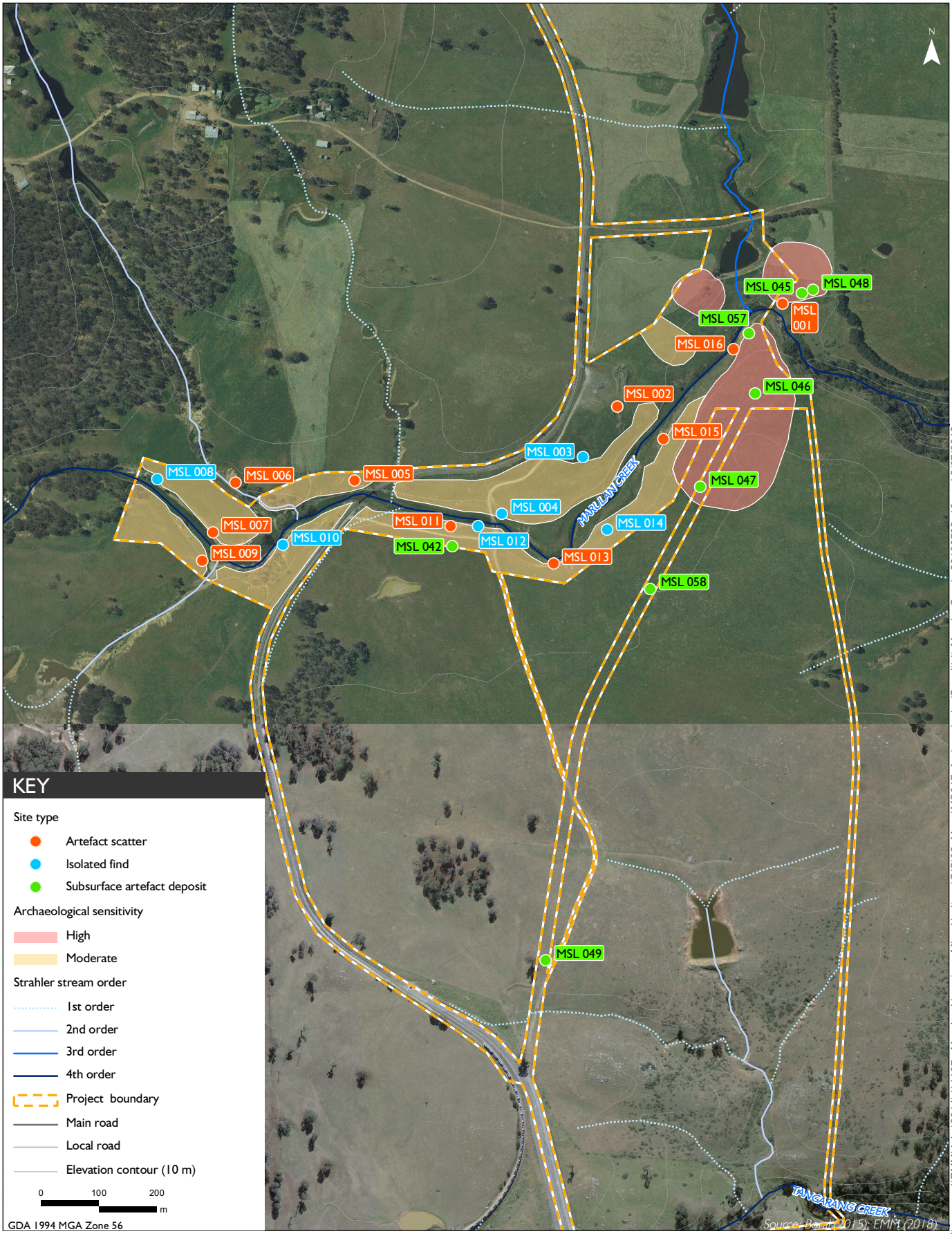


Areas of archaeological sensitivity main Project site

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 8.1



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EMM

Areas of archaeological sensitivity Marulan Creek

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 8.2

9 Significance assessment

9.1 Defining heritage significance

Heritage sites, objects and places hold value for communities in many different ways. The nature of those heritage values is an important consideration when deciding how to manage a heritage site, object or place and balance competing land-use options.

The many heritage values are summed up in an assessment of 'Cultural Significance'.

The primary guide to management of heritage places is the Australia ICOMOS Burra Charter 2013. The Burra Charter defines cultural significance as follows:

> Cultural significance means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of values for different individuals or groups.
>
> (ICOMOS 2013).

This assessment has sought to identify various aspects of Aboriginal heritage for the purpose of assessing possible development impacts. The aspect of Aboriginal heritage identified in this assessment pertains to physical Aboriginal objects and sites.

The types of heritage values are defined below, followed by an assessment of significance at landscape and site levels.

9.2 Socio-cultural value: significance to the Aboriginal community

"Non-archaeological Aboriginal heritage values" refers to places which have meaning in accordance with memory or tradition but not associated with cultural objects. These sorts of places are described as "intangible sites" and include any historic values related to historically important persons, events, phases or activities in the Aboriginal community. While it is accepted that the broader landscape is of significance to Aboriginal people, this study sought to identify whether the Project site held specific values either in itself, or as part of a specific local area of particular significance. Aboriginal cultural knowledge is defined as,

> ...accumulated knowledge which encompasses spiritual relationships, relationships with the natural environment, and the sustainable use of resources, and relationships between people, which are reflected in language, narratives, social organisations, values, beliefs, and cultural laws and customs...
>
> (DECC 2010).

Research and consultation with the Aboriginal community was conducted 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.

EMM acknowledges that the registered Aboriginal parties consider Aboriginal objects as culturally significant items.

During the survey a possible women's site was identified by an Aboriginal member of the survey team in the vicinity of the proposed Marulan Creek Dam. This site is not shown on maps in this report due to confidentiality arrangements. 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 addressed in Appendix G. Discussion of the cultural site is limited in the main body of this ACHA due to the culturally sensitive nature of the information.

9.3 Scientific value

9.3.1 Overview

Scientific value is assessed according to the research potential of a site. Rarity and representativeness are also related concepts taken into account. The following scientific values are identified as low, moderate or high for each identified Aboriginal site with an overall rating identified based on the results of each individual assessment. In the overall assessment of significance generally research potential and rarity will be weighted higher.

9.3.2 Research potential

Research potential or demonstrated research importance is considered according to the contribution that a heritage site can make to present understanding of human society and the human past. Those heritage sites, objects or places of high scientific significance are those which provide an uncommon opportunity to inform us about the people in an area, or provide a rare glimpse of artistic endeavour or provide a rare chronological record of changing life through archaeological investigation. That is, has the ability to provide information about the past that is not obtainable from any other source or it supplements written and oral sources.

9.3.3 Rarity

The comparative rarity of a site is a consideration in assessing scientific significance. A certain site type may be 'one of a kind' in one region, but very common in another. Artefacts of a particular type may be common in one region, but outside the known distribution in another. Rarity also applies to sites and objects that were once common, but have become uncommon through development and change.

9.3.4 Integrity

The integrity of a site is also a consideration in determining scientific significance. While disturbance of a topsoil deposit with artefacts does not entirely diminish research value, it may limit the types of questions that could be addressed. A heavily cultivated paddock may be unsuited to addressing research questions of small-scale site structure, but it may still be suitable for answering more general questions of stone tool distribution in a region and raw material logistics.

9.3.5 Research themes

The capacity of a site to address research questions is predicated on a definition of what the key research issues are for a region. In the local region, the key research issues revolve around the chronology of Aboriginal occupation and variability in stone artefact manufacturing technology.

9.3.6 Educational value

Educational value relates to the capacity of a site to portray more easily recognisable archaeological features. While the educational potential of Aboriginal sites can only be effectively realised through interpretation, those sites with more obtrusive elements and suitable settings offer greater potential to illustrate the main features of Aboriginal activity.

Stone artefact sites with larger and richer assemblages would be better candidates for educational purposes. Sites with retouched implements, hatchet heads and grindstones have greater educational value than sites comprising three quartz flakes in a cattle track for the simple reason that the complex site can convey a comprehensive story. Educational value is elevated in Aboriginal sites with richer features, such as larger grinding groove sites and extensive dense artefact scatters in natural creek-side settings.

An educator selecting sites to demonstrate to students the physical evidence of Aboriginal occupation in an area is more likely to choose an extensive grinding groove site or a rock shelter with art. These areas present readily identifiable and easily understandable aspects of the past. In contrast, an educator would consider areas of low frequency background scatters of artefacts not useful for educational purposes as these areas do not provide easily understandable features.

9.3.7 Sites and their significance

An assessment of scientific significance was completed for the 57 sites identified during the archaeological investigation for this assessment (MSL 001 to MSL 058, but excluding MSL 037 which is unlikely to be an Aboriginal scar tree). Additionally, the scientific significance of the 18 previously recorded sites within approximately 100 m of the disturbance footprints was also included as these sites are also addressed in the impact assessment and management measure chapters.

Table 9.1 presents the statements of scientific significance for each Aboriginal site according to the scientific value criteria set out in Section 9.3.

Of the 57 sites identified during the archaeological investigation for this assessment (excluding MSL 037 which is unlikely to be a scar tree):

- one site is of high significance (MSL 046);
- 11 sites are of moderate significance; and
- 45 sites are of low significance.

All of the previously recorded sites have previously been assessed to have low scientific significance including the one site that has been destroyed as part of the approved mining activities (M1 (BSC1)/BSC1).

Only MSL 046 (TP15) was assessed to be of high significance as it featured the highest artefact frequencies (more than double than any other test pit), including evidence of stone implements and cores. The relatively flat area tested indicates that this was a focus for Aboriginal activity in the local area. The remaining four test pits dug nearby within the area of high archaeological sensitivity (MSL 045, MSL 048 MSL 047 and MSL 057) were assessed to be of moderate significance despite the possibility that this whole area of archaeological sensitivity could be considered a singular site. The primary reason to distinguish MSL 046 at a higher level of significance was to establish a guide for salvage excavation; meaning that MSL 046 should receive the most attention.

Sites were generally attributed with moderate significance if they featured large surface scatters with a diverse range of artefacts or if they contained a subsurface artefact density that could warrant further excavation. Sites of low significance were generally low density surface or subsurface artefacts or sites within a moderate to highly disturbed context that would provide little further information through further investigation.

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 001	Artefact scatter	Low - sparse assemblage	Low - common type	Moderate - impact from erosion and cattle grazing	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 002	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 003	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 004	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 005	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 006	Artefact scatter	Low - surface expression of artefacts in an eroded creek bank, minimal integrity	Moderate - common types but in a large range	Low- artefacts are spread across eroded creek bank and are likely to have washed down from terrace above	Low- minimal integrity and therefore context is compromised	Moderate- distinctive implements, good range of artefacts	Moderate
MSL 007	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 008	Isolated find	Low - sparse assemblage	Low - common type	Moderate - impact from erosion and cattle grazing	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 009	Artefact scatter	Moderate - large site many types	Low - common type	Moderate - impact from erosion and cattle grazing	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 010	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 011	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 012	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 013	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 014	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 015	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 016	Artefact scatter	Moderate - large site different types	Moderate - common types but in a large range	Low - impact from erosion, cattle and flooding	Moderate - production process elements	Moderate - common types, large assemblage	Moderate
MSL 017	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 018	Artefact scatter	Low – surface artefacts on skeletal soils	Low - common type	Low - impact from erosion and clearing	Low - common types	Low - common types, sparse assemblage	Low
MSL 019	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 020	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 021	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 022	Artefact scatter	High - tools and large site	Low - common type	Moderate - impact from erosion and cattle grazing	Moderate - rare elements but no possible PAD	Moderate - distinctive implements	Moderate
MSL 023	Artefact scatter	Low - medium site with some types	Low - common type	Low - impact from erosion, cattle and flooding	Moderate - production process elements	Moderate - one part of the process	Low
MSL 024	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 025	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 026	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 027	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 028	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Moderate

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 029	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 030	Artefact scatter	Low - skeletal soils, unlikely to have subsurface potential	Moderate - larger example of surface scatter in local landscape context	Moderate - impact from erosion and cattle grazing	Low - rare elements	Moderate- distinctive implements, good range of artefacts	Moderate
MSL 031	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 032	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 033	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 034	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 035	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 036	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 037	Not a scar tree	N/A	N/A	N/A	N/A	N/A	N/A
MSL 038	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 039	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 040	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 041	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 042	Subsurface artefact deposit	Moderate - large site many types	Low - common types, with two uncommon elements	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Moderate - multiple parts of the process	Moderate
MSL 043	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 044	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 045	Subsurface artefact deposit	Moderate - large site many types	Low - common types, with two uncommon elements	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Moderate - multiple parts of the process	Moderate
MSL 046	Subsurface artefact deposit	High - tools, large site, platform preparation, likely PAD	Low - common type	Moderate - impact from erosion and cattle grazing	High - rare elements	High - distinctive implements, large range, all parts of the reduction process evident	High
MSL 047	Subsurface artefact deposit	Moderate - large site many types	Low - common type	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Moderate - multiple parts of the process	Moderate
MSL 048	Subsurface artefact deposit	Moderate - large site many types	Low - common type	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Moderate - multiple parts of the process	Moderate
MSL 049	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 050	Subsurface artefact deposit	Low - sparse assemblage	Moderate - one example of a retouched artefact	Low - impact from erosion, cattle and flooding	Moderate - one example of an uncommon type but assemblage is sparse	Low - common types, sparse assemblage	Low
MSL 051	Subsurface artefact deposit	Low - sparse assemblage	Moderate - one example of a retouched artefact	Low - impact from erosion, cattle and flooding	Moderate - one example of an uncommon type but assemblage is sparse	Low - common types, sparse assemblage	Low

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 052	Subsurface artefact deposit	Low - sparse assemblage	Moderate - one example of a retouched artefact	Low - impact from erosion, cattle and flooding	Moderate - one example of an uncommon type but assemblage is sparse	Low - common types, sparse assemblage	Low
MSL 053	Subsurface artefact deposit	Low - sparse assemblage	Moderate - one example of a retouched artefact	Low - impact from erosion, cattle and flooding	Moderate - one example of an uncommon type but assemblage is sparse	Low - common types, sparse assemblage	Low
MSL 054	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 055	Subsurface artefact deposit	Moderate - large site many types	Low - common type	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Moderate - multiple parts of the process	Moderate
MSL 056	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 057	Subsurface artefact deposit	Moderate -moderate artefact frequency with diverse types	Low - common type	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Moderate - multiple parts of the process	Moderate
MSL 058	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
M1 (BCSC1)/BSC1	Artefact scatter	Low - sparse assemblage	low - common type	Low. Site has been very disturbed by vehicle tracks, grading or heavy machinery and construction of a haul road.	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
M2	Artefact scatter	Low - sparse assemblage	low	Low - impact from erosion, cattle and flooding	low	low	low
BCSC AS1	Artefact scatter	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
BCSC AS2	Artefact scatter	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC AS3	Artefact scatter	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC AS4	Artefact scatter	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC AS5	Artefact scatter	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF1	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF2	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF3	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF4	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low

Table 9.1 Statements of significance

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
BCSC IF7	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF8	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF9	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF11	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF12	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF13	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low
BCSC IF14	Isolated find	Low - common types	Low - common types	Low - none of the artefacts identified were in situ. Sites have been subject to varying levels of erosion	Low - common types and do not represent the complete stone tool manufacturing process	Low - common types	Low

10 Impact assessment

10.1 Sources of development impact

The Project will result in impacts to Aboriginal objects. The following ground disturbance activities have the potential to impact known and unknown Aboriginal objects in the Project site:

- the expansion of the pit and construction of Project infrastructure including haul roads and realignment of Marulan South Road;
- the construction of the Marulan Creek Dam wall, access roads and the associated inundation of Marulan Creek; and
- the covering of areas by overburden emplacements.

10.2 Definition of impact types

Project elements will impact Aboriginal sites to varying degrees: disturbance, where artefacts are moved locally from their original setting, is distinguished from loss where artefacts will be removed or destroyed.

Disturbance means Aboriginal sites and objects will be disrupted and moved a short distance through displacement of ground. Partial disturbance occurs where a portion of a site will disturbed. Total disturbance is when the entirety of the Aboriginal site will be disturbed by the Project.

Marulan Creek Dam is an area where disturbance may occur. Any Aboriginal objects within the flood area of the dam may be inundated as the water level rises. This process is unlikely to cause concentrated water movement (such as strong currents) that would significantly move surface objects from their current position. Subsurface objects are likely to become continually buried under sediment that will accumulate within the dam. However, inundation is also likley to cause soils to structurally degrade once grass cover dies off and the soils become waterlogged. This would make the fringes of inundation more susceptible to disturbance by livestock trampling over the boggy soil.

The assessment of impact associated with the inundation level of Marulan Creek Dam has been made on a conservative basis, based on a worst case potential inundation level that may not be reached during the lifetime of the Project. It assumes that the worst case scenario is that any Aboriginal objects within the inundation area may be disturbed to some level, either by minor displacement or by being buried under sediment. Notwithstanding, this level of disturbance on subsurface artefact deposits is likely to result in less harm than if they were subject to salvage excavation. Salvage excavation would completely remove the subsurface deposit in such areas, whereas if inundated, the deposits would only be buried but left in situ.

Loss entails complete removal of a site's elements, such as large scale earthworks. The total modification of a landscape can also constitute loss, even if artefacts are collected and later returned to the modified surface in their original positions, because the context (an integral part of archaeological site value) is irretrievably lost. Total loss is when the entirety of a site will be lost as a result of the Project. Partial loss describes the loss of part of a site. It may also experience some loss of significance as a result of the loss of some of its components.

Aboriginal sites located in the footprint of the dam wall, spillway and associated haul roads will be subject to varying degrees of loss.

This report has defined the impacts from emplacement areas as loss. The creation of an emplacement involves truck movements, the deposition of large amounts of soil, landscaping and landform rehabilitation. Artefacts below the surface will not be retrievable once the emplacement is created.

Previous investigations on the short term impacts of emplacement areas (in cases where the topsoil is not stripped prior to emplacement) (KNC 2012 and 2013) indicate that while some compaction of the ground is evident, the artefact themselves remain intact beneath layers of soil if separated by a synthetic barrier. However, without using a barrier it was anticipated that the deposit would degenerate and devalue over time as bioturbation causes the stockpile soils to mix with the archaeological deposit. This loss of a secure context would reduce the scientific value of the site and make the original site almost irretrievable.

Degrees of impact from lesser to greater are:

- partial disturbance;
- total disturbance;
- partial loss; and
- total loss.

10.3 Impacts by site

The Aboriginal sites that fall within the disturbance are based on the worst case disturbance footprint associated with the continued operations of the mine for the next 30 years. Through the detailed design of all features of the Project there may be a number of Aboriginal sites that are on the edge of the disturbance footprint, which may ultimately not be directly impacted by the Project. If such changes do occur, the management of such sites will be updated to reflect their avoidance (refer Section 11.2.5). Notwithstanding, the impact assessment presented below accounts for the worst case disturbance footprint.

The impact assessment has considered 75 Aboriginal sites which comprise of:

- the 57 sites (MSL1–MSL058 but excluding MSL 037 which is not a scar tree of Aboriginal) identified during this assessment; and
- the 18 previously recorded sites within approximately 100 m of the disturbance footprints.

Out of the 75 Aboriginal sites, 49 will be impacted to some degree by the Project, leaving 25 sites not impacted and one site M1 (BCSC1)/BCSC 1 removed as part of approved mining activities. A total of 39 sites will be totally lost and 10 sites totally disturbed.

Table 10.1 shows the impact on sites and their significance levels. The one site of high significance (MSL 046) will be impacted by the Project within the Marulan Creek Dam disturbance footprint. MSL 046 is a subsurface deposit that was identified during the test excavation program. This site has the highest artefact frequency recovered during excavation and the subsurface deposit is likely to continue along the spur crest on which MSL 046 was recorded within the mapped area of high archaeological sensitivity.

Eight out of thirteen sites of moderate significance will be impacted. Four of these sites are artefact scatters (MSL 016; MSL 018; MSL 022 and MSL 028, three are subsurface deposits (MSL 047; MSL 055; and MSL 057.

MSL 047 and MSL 057 are nearby to the site of high significance (MSL 046) which collectively represents different locations of the same spur crest that slopes in a northerly direction towards Marulan South Creek. It is possible that these sites represent three different parts of a broader site concentrated across the spur crest. The remaining five sites of moderate significance (MSL 006; MSL 030; MSL 042; MSL 045 and MSL 048) will be avoided.

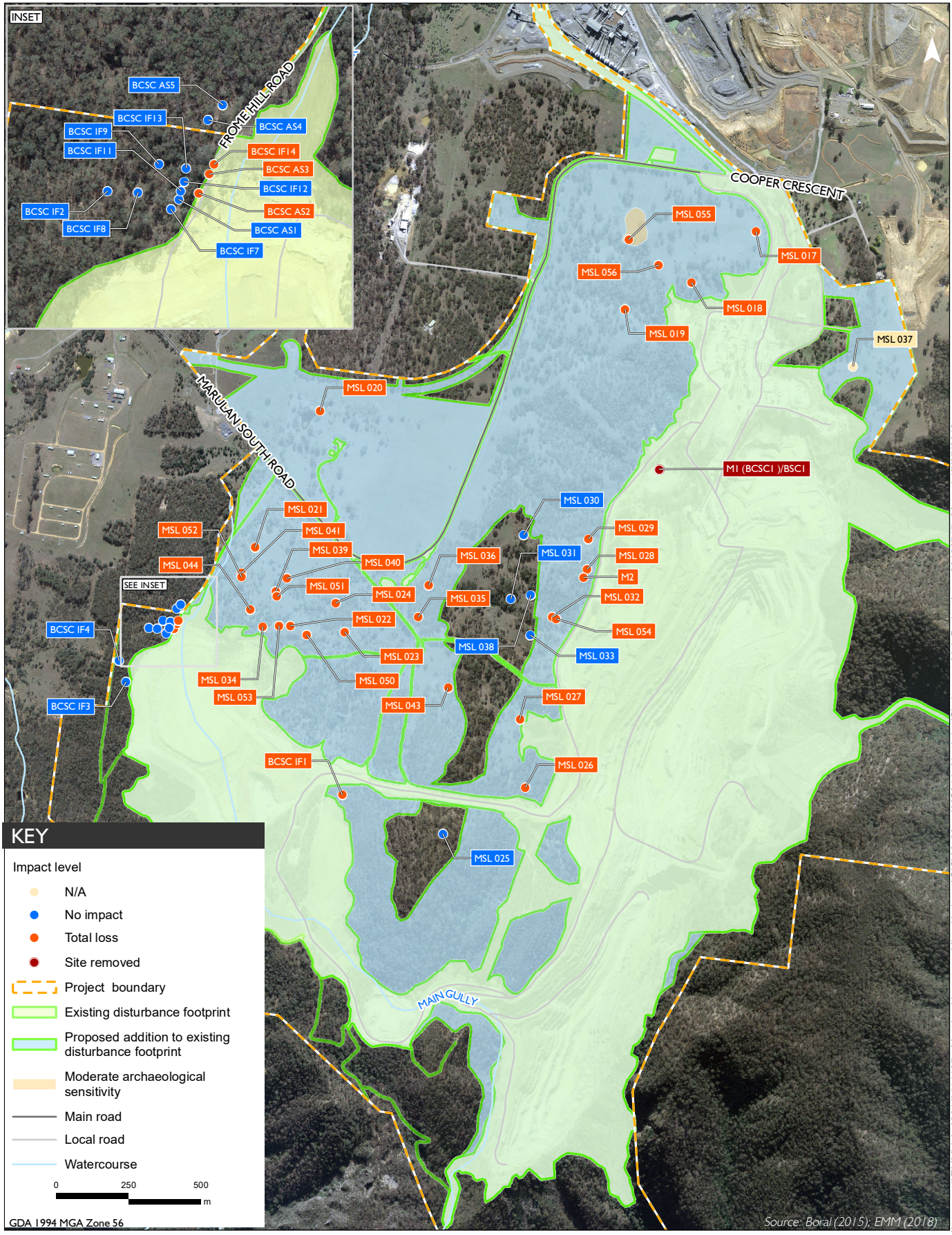
Table 10.1 Impact summary

Impact level	Low	Moderate	High	Total
No impact				
Mining (previously removed)	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 the test pit locations MSL045 and MSL 048.However, their areas of nearby sensitivity will be impacted (refer section 10.4).*

The majority of Project impacts are associated with the overburden emplacement areas, which will result in impact to 30 sites of varying significance. The construction of the dam wall and haul road in the landscape of Marulan Creek will impact the site of highest significance (MSL 046). As discussed above, the disturbance of sites along Marulan Creek Dam is a conservative analysis and may not occur during the lifetime of the Project.

As noted in the discussions in the preceding sections the majority of the Project site (ie the emplacement areas) is of low archaeological potential with skeletal soils, where most sites are represented as surface artefacts and there is minimal subsurface potential. Thus the Project will have a low impact on subsurface archaeology. The Project will impact a portion of land with high archaeological sensitivity in the area of Marulan Creek, which will be subject to loss due to the creation of the dam wall, spillway, haul roads and associated construction activities. However, this area represents a small portion of the areas of archaeological sensitivity along Marulan Creek. Additionally, a small portion of an area considered to be of moderate archaeological sensitivity will be impacted by the emplacements in the main Project site. Table 11.2 in Chapter 11 and Figures 10.1 and 10.2 provide information on each Aboriginal site and the impacts it will experience.



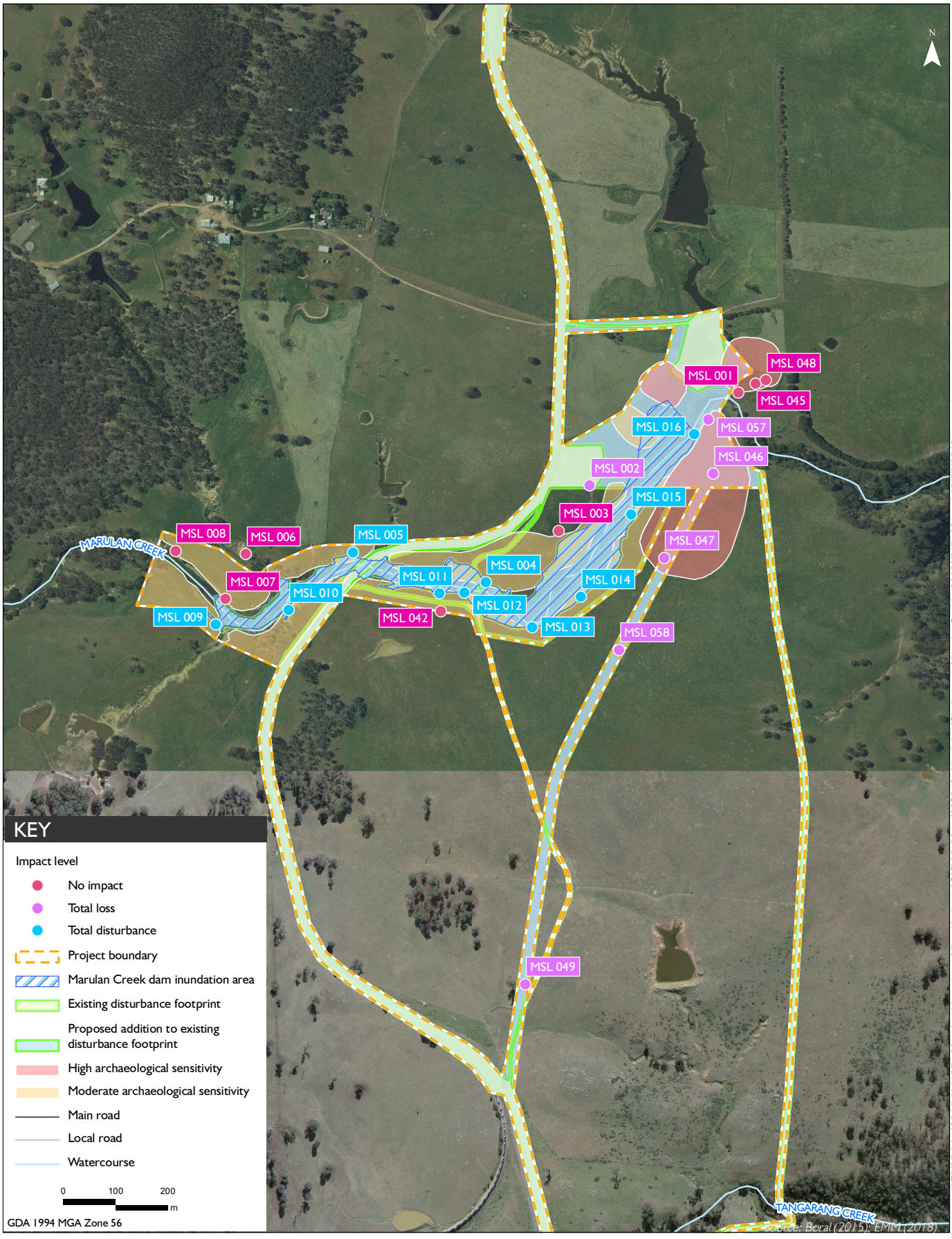
EMM

Aboriginal site impacts at main Project site

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 10.1



EMM

Aboriginal site impacts at Marulan Creek

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 10.2

10.4 Impacts on archaeologically sensitive areas

Harm to Aboriginal objects and areas of archaeological sensitivity will occur to varying degrees across the Project site. As defined earlier, areas of high archaeological sensitivity include within prominent spurs within 200 m of Marulan Creek. Parts of this area will be impacted by the construction of the Marulan Creek dam wall and spillway and haul road (refer Figure 10.2). Importantly, although the discrete 3 m x 1 m test pit locations that demarcate MSL 045 and MSL 048 will be avoided, the subsurface archaeological deposit is likely to extend to the west within the area mapped as an archaeologically sensitive area.

Most of the Marulan Creek maximum inundation level for the dam intersects with the areas mapped with moderate archaeological sensitivity. However, as noted in Section 10.2 above, any subsurface artefact deposits are likely to be submerged but left *in situ* with the potential for sediment to accumulate over the current ground surface. When compared to the current erosional impacts on the creek bank during periodic flooding, the inundation of these areas will result in less concentrated stream flow and less creek bank erosion.

The emplacements will impact an area of moderate sensitivity surrounding site MSL 055. However, because it is a relatively small area, it will be managed under the measures proposed for MSL 055.

10.5 Impacts on areas of cultural significance

Marulan Creek Dam is located in the vicinity of a cultural site that was identified during field survey. The Project design has been modified to remove all direct construction impacts on the cultural site. Forms of indirect impacts are discussed further in Appendix G.

10.6 Measures to minimise harm and alternatives

The Project is constrained by the nature of the limestone resource in this area and the angle of the resource in the ground. This requires the removal of large amounts of overburden and does not allow a large amount of movement in the location of the mine across the landscape. 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 operation of the mine as extraction of the accessible resource within the current mine pit is nearly completed. The mine supplies limestone-based building and construction materials to industry across NSW and the ACT.

The construction of Marulan Creek dam has undergone a number of design iterations, some of which are directly based on a culturally sensitive area. 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.

10.7 Ecologically sustainable development

Aboriginal heritage management is based on the principle of intergenerational equity which has the intention to ensure present generations consider future generations when making management decisions. This principle is possibly the most relevant part of the notion of ecologically sustainable development (ESD) when considering Aboriginal heritage management.

While it is acknowledged that the Project is for activities that are common in the region and will result in additional impacts to Aboriginal heritage, the proposed management measures, including collection of all surface sites proposed for impact and salvage excavation of more significant areas are anticipated to provide detailed information about the Aboriginal heritage of the Project site to ensure all information about the Aboriginal history of the area is not lost. This will help to achieve intergenerational equity by allowing retention of cultural materials for the enjoyment and education of future generations.

Additionally, areas adjacent at Peppertree Quarry and in both the Bungonia National Park and the Moreton National Park including highly sensitivity archaeological sites have been set aside for passive management and protection to ensure the area retains a record of Aboriginal sites and landscapes. The preservation of these areas will ensure that a record of Aboriginal sites is preserved in its landscape for future generations. A total of 28 nearby sites will be avoided by the Project and will be retained in the landscape.

10.8 Impacts from Peppertree Quarry

10.8.1 Overview

Boral owns and operates the Peppertree Quarry, a hard rock quarry in Marulan South which is directly north and north-east of the main Project site. Boral is seeking to modify the current Project Approval (PA 06_0074) of the Quarry under Section 75W of the EPA Act to provide for the following:

- develop a new overburden area for the Quarry referred to as the South-west Overburden Emplacement (SWOE);
- extend the Quarry's consent boundary to the south to encompass the new SWOE;
- construct a new haul road from the Quarry pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Quarry's Western Overburden Emplacement;
- remove the Quarry's Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

The proposed modification to Peppertree Quarry is referred to as Modification 5 (MOD 5).

The MOD 5 SWOE forms the northern portion of the Northern Overburden Emplacement for the Project. This change will effectively make the MOD 5 project boundary overlap with parts of the Project site boundary.

The overlap of the MOD 5 and Project site boundary is the result of the Peppertree Quarry's requirement to place overburden in the main Project site boundary in the short term. Due to timing delays for the Project SSD application, it is not possible for the Quarry to wait until the Project SSD is approved, before they need to commence emplacement of overburden within the SWOE. As such, the northern portion of the Project Northern Overburden Emplacement will be incorporated into the Peppertree Quarry project approval, while also remaining in the Project SSD application.

10.8.2 Implications for the Project

It is anticipated that MOD 5 will be approved before the Project SSD. As such, the Aboriginal cultural heritage values within the MOD 5 boundary have been assessed separately and will need to be managed prior to the Project management measures (EMM 2018). Basically, the impacts to Aboriginal sites within the shared MOD 5 and Project site area will occur as part of MOD 5 prior to the Project development. The impact from MOD 5 is summarised in Table 10.2. Notwithstanding the above, the impact assessment for this Project has also included the same sites as the outcome will be the same regardless of which project the impacts are approved under.

The implications of management for each of the five sites in the MOD 5 area are discussed further in Chapter 11.

Table 10.2 Peppertree MOD 5 impact summary

Site name	Site type	Significance	Impact
MSL 017	Artefact scatter	Low	Loss from emplacement
MSL 018	Artefact scatter	Low	Loss from emplacement
MSL 019	Isolated artefact	Low	Loss from emplacement
MSL 055	Subsurface deposit	Moderate	Loss from emplacement
MSL 056	Subsurface deposit	Low	Loss from emplacement

10.9 Cumulative impact

Unavoidable harm to Aboriginal objects is acknowledged as a result of the Project. While mining has resulted in impacts to sites in the region, the management and mitigation of impacted sites through archaeological excavation, collection and consultation with the Aboriginal community has contributed to our understanding of the Aboriginal past in this region.

The impacts to Aboriginal objects by the proposed emplacements within the main Project site will not substantially add to the cumulative impact on a local or regional level, primarily because of the low scientific significance of the sites within this area. These sites are primarily surface expressions of artefacts on eroded and skeletal soils. Apart from providing evidence that Aboriginal people occupied this landscape, these sites provide little further information. The previously recorded AHIMS sites to the west of Main Gully (eg BCSC AS1 to BCSC AS5) will remain avoided and provide a comparable resource to the sites that will be lost to the east of Main Gully.

The primary impacts to Aboriginal objects surrounding Marulan Creek will be localised to the disturbance footprint caused by the construction of the Marulan Creek Dam wall and spillway and associated infrastructure. This area has comparable landscape features to that surrounding Tangarang Creek which has been investigated extensively as part of the Peppertree Quarry project. Through extensive salvage measures

it has been identified that a considerable archaeological resource has already been impacted as part of the approved Peppertree Quarry, although cataloguing, analysis and reporting is yet to be completed (Boral 2017, p.28). Notwithstanding, large tracts of archaeologically sensitive land along Tangarang Creek have been conserved as part of the Habitat Management Area/Tangarang Creek Area (Boral 2017, p.28).

Overall, the impacts to the archaeological resource next to Marulan Creek will have a far more localised disturbance footprint as opposed to open-cut mining and therefore large tracts of Marulan Creek and its tributaries will remain undisturbed. The impacts caused by the increased inundation of Marulan Creek are considered minor as any subsurface deposits would be theoretically retrievable if the dam is removed.

11 Management

11.1 Aboriginal heritage management

This section describes the management measures for Aboriginal heritage values identified in the Project site. The management measures proposed here respond to:

- the impacts identified in the preceding chapter;
- the assessed significance of the Aboriginal sites;
- the views of the Aboriginal community as represented by RAPs;
- the need to address intergenerational equity in the enjoyment of Aboriginal heritage;
- the need to protect sites not impacted by the Project but under the care of the proponent; and
- the need to mitigate the loss and disturbance of impacted Aboriginal sites and Aboriginal objects.

While Aboriginal sites cannot be replaced once lost, the salvage of Aboriginal objects – the stone artefacts – impacted by the Project will provide a tangible monument to those sites. Furthermore, with care in curation, those salvaged materials can be studied to help understand other Aboriginal sites present in the landscape and to add to the growing body of information about past Australian Aboriginal life.

The impacts from the Project will not occur simultaneously. Impacts will occur at different stages of the mining process and the management program will be modified accordingly.

11.2 Management measures

11.2.1 Overview

A summary of the proposed management measures across the Project site is shown in Table 11.1

Table 11.1 Management summary

Row Labels	Artefact scatter	Isolated find	Subsurface artefact deposit	Total
Avoidance	1	7	2	10
Avoidance and protection	8	6		14
Collection	25	10		35
Salvage excavation			5*	5
Unmitigated impacts			10	10
None (site removed)	1			1
Total	**35**	**23**	**17**	**75**

**Includes salvage excavation linked to site MSL 045 – refer to section 11.2.7*

11.2.2 Aboriginal heritage management plan

An Aboriginal heritage management plan (AHMP) will be prepared for the Project and will provide details of:

- all Aboriginal sites identified for this Project;
- management measures and their progress towards completion;
- continuing consultation and involvement of registered Aboriginal parties including the potential creation of an Aboriginal management committee;
- a reassessment of significance for all sites post management and Project activities;
- protocols for newly identified sites;
- protocols for suspected human skeletal material; and
- provisions for review and updates of the AHMP.

11.2.3 Induction for all personnel working on site

All personnel working on the Project site will be inducted on the related Aboriginal heritage and the measures being put in place to manage Aboriginal heritage sites.

11.2.4 Management of sites within Peppertree Quarry MOD 5 boundary

As discussed in Section 10.8, the northern portion of the Project's Northern Overburden Emplacement is also part of the Peppertree Quarry MOD 5 South Western Overburden Emplacement and therefore the main Project site will share its project boundary with the Peppertree Quarry MOD 5 project boundary. The Aboriginal sites within this shared project boundary will be managed under the Peppertree Quarry MOD 5 as it is anticipated that the MOD activities will occur before Project activities. The sites and their management measures are presented in Table 11.2.

Table 11.2 Management measures Peppertree Quarry MOD 5 boundary and the Project site

Site name	Site type	Significance	Impact	Management
MSL 017	Artefact scatter	Low	Loss from emplacement	Collection
MSL 018	Artefact scatter	Low	Loss from emplacement	Collection
MSL 019	Isolated artefact	Low	Loss from emplacement	Collection
MSL 055	Subsurface deposit	Moderate	Loss from emplacement	Salvage excavation
MSL 056	Subsurface deposit	Low	Loss from emplacement	Unmitigated impact (no surface collection possible as artefacts were recovered from test excavation)

The five sites within the shared project boundary will be incorporated into a modified version of the Peppertree Quarry Aboriginal Heritage Management Plan (AHMP). Notwithstanding, the proposed management measures for these sites are presented alongside those for the Project in the following sections to represent the cumulative impact and management of all sites considered for this assessment.

11.2.5 Avoidance and protection

Avoidance of Aboriginal sites is a preferred management option as it ensures that Aboriginal sites, and their landscape information, will be preserved for future generations.

A total of 24 out of 75 Aboriginal sites will be avoided by the Project. Sites within 20 m of the Project disturbance footprint (a total of 14 sites) will be avoided with protection. This will require the installation of treated timber poles or similar painted with high visibility paint around the visible extent of the 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 property manager for more information”.

Ten sites will be avoided passively without protection – eight of such sites are over 20 m from the disturbance footprints and two sites were identified from test excavation and there are no surface artefacts to protect by fencing or signage.

Avoided sites include those near Marulan Creek and those associated with spurs and crests in the centre of the main Project site and to the west of the main Project site. These sites represent a cross section of the types of sites in the Project site and the region.

If there are sites identified in this report for collection and/or salvage that are later determined not to be impacted, but are within 20 m of the disturbance footprint, such sites will become sites to which ‘Avoidance and protection’ management measures are applied (refer to Section 10.3).

11.2.6 Collection

All surface artefact sites (artefact scatters and isolated finds) in the Project disturbance footprint will be collected by an archaeologist and members of the Aboriginal community. A total of 32 sites will be collected. This includes three sites (MSL 017, MSL 018 and MSL 019) within the shared Peppertree Quarry MOD 5 project boundary which will be managed under the Peppertree Quarry AHMP (refer Section 11.3.4).

This includes the sites that will be impacted by the proposed emplacements and also those exposed on the banks of Marulan Creek that are mapped within 5 m of the maximum dam inundation area. It is considered better to collect the surface sites within the dam inundation area, as it would be difficult to ever relocate them, even if the dam was removed at a later date.

Note that the artefacts recovered during test excavation have already been collected and are stored in the EMM office in St Leonards, NSW.

Each site will be collected into labelled bags recording the site name, location and collection date. Collected Aboriginal objects will be retained with accompanying documentation in a keeping place (see below). AHIMS records will be updated with a site impact form. Collection will occur prior to Project impacts on the site.

Artefacts from collected sites will be subject to analysis as part of the Aboriginal heritage management plan allowing these sites to contribute to the overall interpretation of the area.

11.2.7 Salvage excavation

The salvage excavation scope has been proposed based on the predicted impacts from the Project, the research questions about the area and the regional archaeological information already present. Excavation aims to provide information that would otherwise have been lost and that may not already have been obtained by previous investigations in the region. The excavation data will also become a resource for comparative analysis in the region particularly those projects nearby where excavation has occurred including the Lynwood and Peppertree Quarries. The data presented aims to be easily comparable with other sites by using best practice excavation methods and common techniques such as 1 m^2 pits.

An archaeological salvage excavation is proposed in two general areas: adjacent to Marulan Creek and the flat spur overlooking ephemeral watercourses within the main Project site.

The sites designated for salvage excavation near Marulan Creek are: MSL 046; MSL 047; MSL 057 and the areas of high archaeological sensitivity to the west of the test pitted sites MSL 045 and MSL 048 that is within the Marulan Creek dam disturbance footprint (refer to Section 10.4 and Figure 11.2). For simplicity, this last area is referred to as part of MSL 045 despite this site point being shown outside the disturbance footprint on figures in this report.

The site MSL 055 is the only site within the main Project site that will be subject to salvage excavation. This site is within the shared Peppertree Quarry MOD 5 project boundary which will be managed under the Peppertree Quarry AHMP (refer Section 11.3.4).

As discussed in Section 9.3.7, only MSL 046 was assessed to be of high significance as it featured the highest artefact frequencies (more than double than any other test pit), including evidence of stone implements and cores. The relatively flat area tested by excavation indicates that this was a focus of Aboriginal activity in the local area. The remaining four test pits dug nearby within the area of high archaeological sensitivity (MSL 045, MSL 048 MSL 047 and MSL 057) were assessed to be of moderate significance despite the possibility that this whole area of archaeological sensitivity could be considered a singular site. The primary reason to distinguish MSL 046 at a higher level of significance was to establish a guide for salvage excavation; meaning that the landform of MSL 046 should receive the most resources for salvage.

As such, the proposed salvage excavation within the area of high archaeological sensitivity around Marulan Creek will be approached by considering the area as a larger complex rather than considering each former test pit location as a discrete site. This will mean that the previous test pit locations are not simply expanded into open areas, but instead a broader excavation strategy will be developed in the AHMP.

The proposed salvage excavation at MSL 055 will focus to on the demarcated area of moderate archaeological sensitivity.

Each of the sites proposed for excavation has the potential to provide valuable information about past Aboriginal life that would otherwise be irretrievably lost. Additionally, these sites are located in areas of high archaeological sensitivity with one site identified in an area of moderate archaeological sensitivity.

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 are subject to removal as part of the Project. As noted in the previous sections, a large portion of the Project site does not demonstrate elements that are conducive to the preservation of significant subsurface archaeological deposits.

Salvage excavation is not proposed in areas subject only to water inundation because this level of disturbance on subsurface artefact deposits is likely to result in less harm than if they were subject to salvage excavation. Salvage excavation would completely remove the subsurface deposit in such areas, whereas if inundated, the deposits would only be buried but left in situ.

The excavation will aim to answer research questions about the area including but not limited to:

- What can the information from the excavation tell us able the Aboriginal use of the landscape?
- Can the excavation provide a chronology for the Aboriginal use of the Marulan South area?
- What does the artefactual material tell us about stone tools and their use? Can we understand more about the use of local and imported materials?
- How does the information from Marulan South compare to the Aboriginal archaeological record in the wider region?

Salvage excavation will aim to retrieve the most significant portions of the sites and will involve a two stage process of further sampling followed by open area excavation. The first phase will involve further sampling using regularly spaced 1 metre squared pits dug to the base of the topsoil layer in each area of investigation to understand the spatial distribution of artefacts across the investigation areas. Excavation will be undertaken manually in designated salvage pits.

The information from the first phase will be used to expand areas in to open area excavation. Expansion of pits will be based on the following:

- evidence of hearths or other features; and
- in the event that an artefact density of 50 artefacts or above is encountered in a 1 metre square, then at least one of the squares with such evidence will be expanded into an open area within the site being investigated. The final scope of the salvage areas will be determined during the preparation of the AHMP which will allow flexibility so that decisions can be made during fieldwork dependent on the results. If an artefact density of 50 artefacts or above is not identified in the area of moderate archaeological sensitivity (MSL 055), then the pit(s) with the highest artefact frequencies will be expanded.

The use of a density of 50 artefacts as a benchmark for expansion of excavation areas is based on the archaeological character of the region, with particular attention paid to excavations at the nearby Peppertree Quarry. The regional archaeological context has artefacts of over 20 per square meter as evidence of moderate to high artefact density (see Lynwood Quarry excavations). However, the similar landscape of the Peppertree Quarry excavations at Tangarang Creek with artefact densities of between 70 and 100 per square metres were evidence of high artefact density with some areas displaying very high artefact density of between 100 and 200 artefacts per square meter (ERM 2012). Furthermore, preliminary data from recent salvage excavation at Peppertree Quarry has identified some pits with concentrations between 500 and 1000 artefacts and one pit with a total of 1722 artefacts (Boral 2017) Using this data it can be suggested that regionally low artefact density is under 10 artefacts, moderate artefact density is between 10 and 50 artefacts and high artefact density is above 50 artefacts.

As such, 50 artefacts uncovered in a 1 m^2 area are likely to correlate to moderate or high artefact densities warranting a stronger focus of the archaeological investigation.

Excavation will cease once a significant drop off in artefact frequencies is encountered in an expanded area (possibly indicating the boundary of specific activity areas), or if an area of approximately 10 m^2 is reached. Open area excavation can continue in special cases, particularly if high densities continue within the Project impact areas or certain features require further investigation.

If suitable conditions are identified, excavation will also aim to obtain suitable samples for use-wear analysis, radiocarbon dating and pollen analysis. Where feasible and water is available, wet sieving may occur.

The artefacts salvaged as part of the archaeological excavation and collection program will be subject to attribute analysis to understand manufacturing technology, site function and to compare the assemblage to studies completed in the wider region.

11.2.8 Unmitigated impacts

Unmitigated impacts will apply to 10 sites in the Project site: MSL 058; MSL 056; MSL 054; MSL 053; MSL 052; MSL 051; MSL 050; MSL 049; MSL 044 and MSL 043.

This applies to eight sites within the proposed emplacement areas of the main Project site and two sites along the proposed Marulan Creek dam haul road.

MSL 056 is within the shared Peppertree Quarry MOD 5 project boundary which will be managed under the Peppertree Quarry AHMP (refer Section 11.3.4). Unmitigated impacts simply apply to these sites because they relate to sites identified during test excavation (which means they are solely subsurface sites) of low scientific significance which do not warrant further investigation or salvage.

11.2.9 Deregistration of MSL 037

OEH will be contacted to deregister the tree with natural scars that was incorrectly recorded on AHIMS as MSL 037 AHIMS (site ID #52-4-0551).

11.2.10 Cultural site

A cultural heritage specialist was engaged to complete an investigation into the significance and values associated with an area identified as a potential cultural site (Appendix G). The Project has been modified to avoid impacting this site. Specific management and mitigation measures are provided in Appendix G.

As the cultural site and its assessment contain culturally sensitive information, the Project AHMP will include procedures and protocols on confidentiality and restricted access arrangements.

11.2.11 Aboriginal ancestral remains

In the event that known or suspected human skeletal remains are encountered during the activity, the following procedure will be followed:

- all work in the immediate vicinity will cease and the find will be immediately reported to the work supervisor who will immediately advise the Environmental Advisor or other nominated senior staff member;

- the Environmental Advisor or other nominated senior staff member will promptly notify the police and the state coroner (as required for all human remains discoveries);
- the Environmental Advisor or other nominated senior staff member will contact the OEH for advice on identification of the skeletal material as Aboriginal and management of the material; and
- if it is determined that the skeletal material is Aboriginal ancestral remains, the RAPs will be contacted and consultative arrangements will be made to discuss ongoing care of the remains.

11.2.12 Aboriginal artefact management

Management of Aboriginal artefacts salvaged for this Project will be either kept in a keeping place or reburied after analysis, dependent upon consensus with the RAPs. The establishment of a keeping place will be based on the nomination of a suitable facility and if a suitable facility cannot be identified reburial of artefacts should be a priority. This will include further discussions as to how the salvaged material will be managed in relation to the measures previously adopted for Peppertree Quarry.

11.2.13 Discovery of new Aboriginal sites

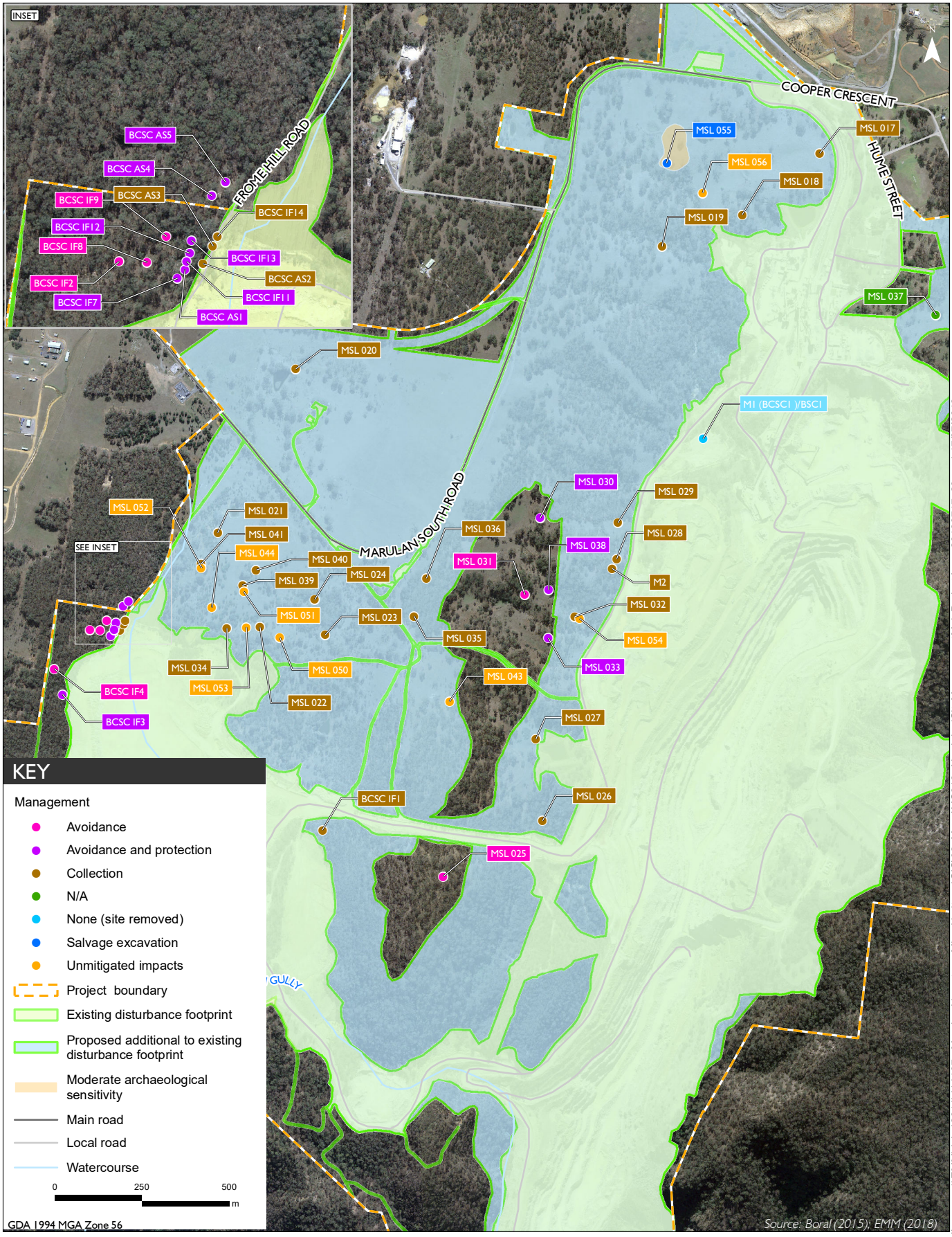
At the completion of the salvage excavation further monitoring or excavation is not recommended as this program will provide sufficient information to understand past Aboriginal life in this area. In the event of discovery of new Aboriginal sites outside of the areas of moderate and high archaeological sensitivity mapped in Figures 8.3 and 8.4 all work should halt and the relevant Boral Environment Manager contacted to determine the relevant course of action (consultation with an archaeologist or RAPs or an Aboriginal Management Committee to determine the significance of the objects). Objects are to be managed based on their sensitivity in a manner consistent with the management measures outlined above, including appropriate forms of salvage for items of moderate to high significance.

11.3 Summary

The management measures proposed in response to the impacts and significance levels comprise:

- avoidance and protection of 24 Aboriginal sites will not be impacted by the proposed disturbance footprint;
- avoidance of the cultural site on Marulan Creek (refer to Appendix G);
- collection of 35 Aboriginal sites within the disturbance footprint (all surface artefact sites within the disturbance footprint);
- a salvage excavation of five subsurface artefact deposits (one site relates to the archaeological potential west of the mapped location of MSL 045 (refer Section 11.3.5);
- procedures that specify actions to be taken in the event of discovery of Aboriginal skeletal remains, discovery of new Aboriginal sites, and for the ongoing care of salvaged Aboriginal objects within a keeping place; and
- a management plan detailing management measures and additional consultation information.

Figures 11.1 and 11.2, and Table 11.1 provide specific information on the management of Aboriginal sites.



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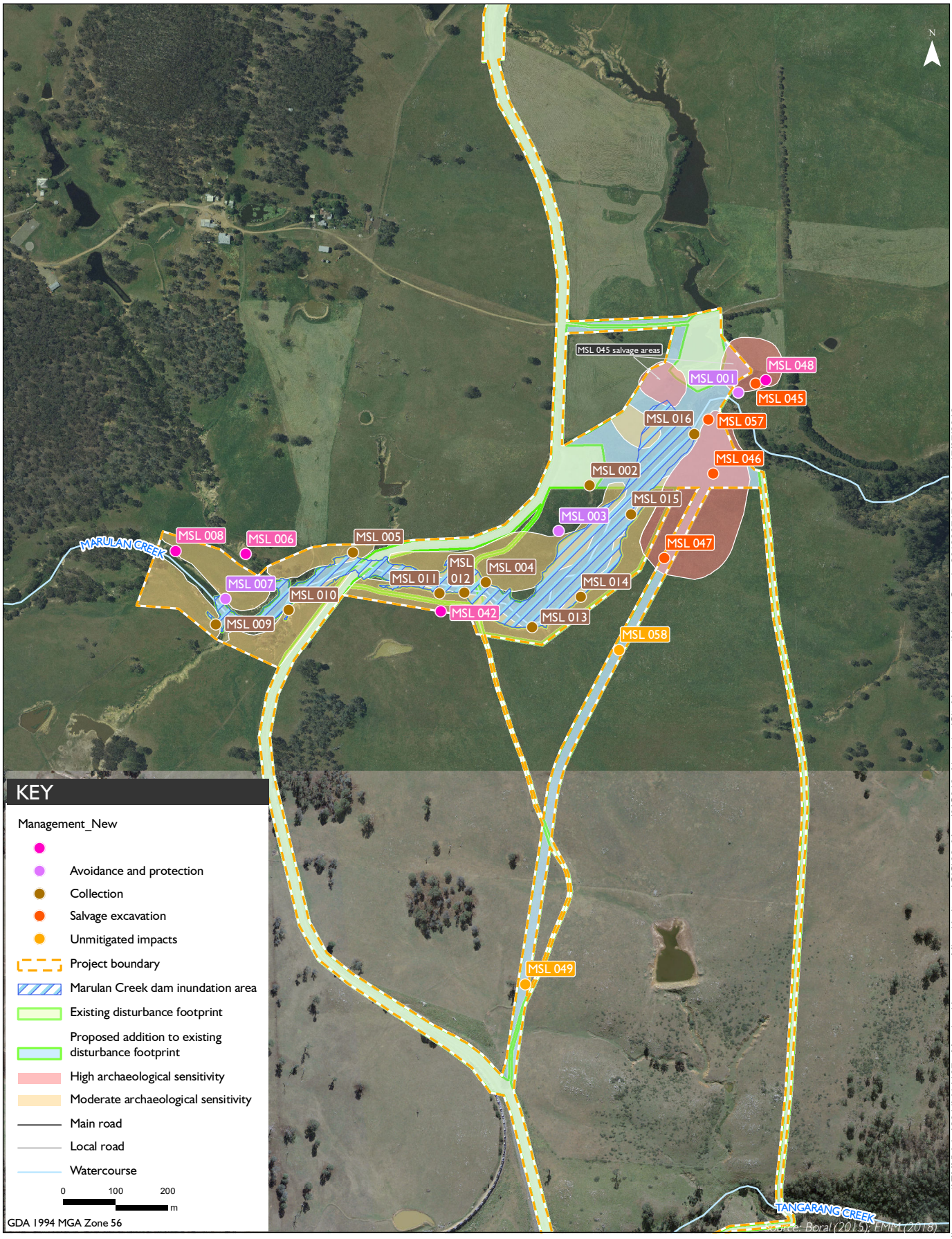
EMM

Aboriginal site management at main Project site

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 11.1



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Aboriginal site management at Marulan Creek

Marulan South Limestone Mine Continued Operations Project

Aboriginal Cultural Heritage Assessment

Figure 11.2

Table 11.2 Site impact assessment and management summary

Site Name	AHIMS number	Site type	Overall significance level	Development type	Impact Level	Management
MSL 001	52-4-0518	Artefact scatter	Low	None	No impact	Avoidance and protection
MSL 002	52-4-0519	Artefact scatter	Low	Marulan Creek Dam disturbance footprint	Total loss	Collection
MSL 003	52-4-0520	Isolated find	Low	None	No impact	Avoidance and protection
MSL 004	52-4-0521	Isolated find	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 005	52-4-0522	Artefact scatter	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 006	52-4-0523	Artefact scatter	Moderate	None	No impact	Avoidance
MSL 007	52-4-0524	Artefact scatter	Low	None	No impact	Avoidance and protection
MSL 008	52-4-0525	Isolated find	Low	None	No impact	Avoidance
MSL 009	52-4-0526	Artefact scatter	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 010	52-4-052	Isolated find	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 011	52-4-052	Artefact scatter	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 012	52-4-052	Isolated find	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 013	52-4-0527	Artefact scatter	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 014	52-4-0528	Isolated find	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 015	52-4-0529	Artefact scatter	Low	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 016	52-4-0530	Artefact scatter	Moderate	Marulan Creek Dam flood area	Total disturbance	Collection
MSL 017	52-4-0531	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 018	52-4-0532	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 019	52-4-0533	Isolated find	Low	Emplacement	Total loss	Collection
MSL 020	52-4-0534	Isolated find	Low	Emplacement	Total loss	Collection
MSL 021	52-4-0535	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 022	52-4-0536	Artefact scatter	Moderate	Emplacement	Total loss	Collection
MSL 023	52-4-0537	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 024	52-4-0538	Isolated find	Low	Emplacement	Total loss	Collection
MSL 025	52-4-0539	Isolated find	Low	None	No impact	Avoidance
MSL 026	52-4-0540	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 027	52-4-0541	Artefact scatter	Low	Emplacement	Total loss	Collection

Table 11.2 Site impact assessment and management summary

Site Name	AHIMS number	Site type	Overall significance level	Development type	Impact Level	Management
MSL 028	52-4-0542	Artefact scatter	Moderate	Emplacement	Total loss	Collection
MSL 029	52-4-0543	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 030	52-4-0544	Artefact scatter	Moderate	None	No impact	Avoidance and protection
MSL 031	52-4-0545	Isolated find	Low	None	No impact	Avoidance
MSL 032	52-4-0546	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 033	52-4-0547	Artefact scatter	Low	None	No impact	Avoidance and protection
MSL 034	52-4-0548	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 035	52-4-0549	Isolated find	Low	Emplacement	Total loss	Collection
MSL 036	52-4-0550	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 037	52-4-0551	Not a scar tree	N/A	N/A	N/A	N/A
MSL 038	52-4-0552	Artefact scatter	Low	None	No impact	Avoidance and protection
MSL 039	52-4-0553	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 040	52-4-0554	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 041	52-4-0555	Artefact scatter	Low	Emplacement	Total loss	Collection
MSL 042	52-4-0556	Subsurface artefact deposit	Moderate	None	No impact	Avoidance
MSL 043	52-4-0557	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 044	52-4-0558	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 045	52-4-0559	Subsurface artefact deposit	Moderate	None	No impact	Salvage excavation
MSL 046	52-4-0060	Subsurface artefact deposit	High	Marulan Creek Dam disturbance footprint	Total Loss	Salvage excavation
MSL 047	52-4-0575	Subsurface artefact deposit	Moderate	Marulan Creek Dam disturbance footprint	Total Loss	Salvage excavation
MSL 048	52-4-0061	Subsurface artefact deposit	Moderate	None	No impact	Avoidance

Table 11.2 Site impact assessment and management summary

Site Name	AHIMS number	Site type	Overall significance level	Development type	Impact Level	Management
MSL 049	52-4-0062	Subsurface artefact deposit	Low	Marulan Creek Dam Haul Road	Total Loss	Unmitigated impacts
MSL 050	52-4-0063	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 051	52-4-0576	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 052	52-4-0064	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 053	52-4-0065	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 054	52-4-0066	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 055	52-4-0067	Subsurface artefact deposit	Moderate	Emplacement	Total loss	Salvage excavation
MSL 056	52-4-0068	Subsurface artefact deposit	Low	Emplacement	Total loss	Unmitigated impacts
MSL 057	52-4-0069	Subsurface artefact deposit	Moderate	Marulan Creek Dam disturbance footprint	Total loss	Salvage excavation
MSL 058	52-4-0070	Subsurface artefact deposit	Low	Marulan Creek Dam Haul Road	Total loss	Unmitigated impacts
M1 (BCSC1)/BSC1	52-4-0195 and 52-4-0161	Artefact scatter	Low	Mining (previously removed)	No impact	None (site removed)
M2	52-4-0246	Artefact scatter	low	Emplacement	Total loss	Collection
BCSC AS1	52-4-0266	Artefact scatter	Low	None	No impact	Avoidance and protection
BCSC AS2	52-4-0267	Artefact scatter	Low	Haul Road	Total loss	Collection
BCSC AS3	52-4-0268	Artefact scatter	Low	Haul Road	Total loss	Collection
BCSC AS4	52-4-0269	Artefact scatter	Low	None	No impact	Avoidance and protection
BCSC AS5	52-4-0574	Artefact scatter	Low	None	No impact	Avoidance and protection
BCSC IF1	52-4-0263	Isolated find	Low	Emplacement	Total loss	Collection
BCSC IF2	52-4-0270	Isolated find	Low	None	No impact	Avoidance

Table 11.2 Site impact assessment and management summary

Site Name	AHIMS number	Site type	Overall significance level	Development type	Impact Level	Management
BCSC IF3	52-4-0271	Isolated find	Low	None	No impact	Avoidance and protection
BCSC IF4	52-4-0272	Isolated find	Low	None	No impact	Avoidance
BCSC IF7	52-4-0273	Isolated find	Low	None	No impact	Avoidance and protection
BCSC IF8	52-4-0274	Isolated find	Low	None	No impact	Avoidance
BCSC IF9	52-4-0279	Isolated find	Low	None	No impact	Avoidance
BCSC IF11	52-4-0276	Isolated find	Low	None	No impact	Avoidance and protection
BCSC IF12	52-4-0277	Isolated find	Low	None	No impact	Avoidance and protection
BCSC IF13	52-4-0278	Isolated find	Low	None	No impact	Avoidance and protection
BCSC IF14	52-4-0279	Isolated find	Low	Haul Road	Total loss	Collection

Abbreviations

Abbreviation	Term
$	dollars
AHIMS	Aboriginal heritage information management system
BOM	Bureau of Meteorology
c	circa
cm	centimetres
DP&E	Department of Planning and Environment
EMM	EMM Consulting Pty Limited Pty Limited
EP&A Act	*Environmental Planning and Assessment Act 1979*
km	kilometres
LEP	Local Environmental Plan
LGA	Local Government Area
m	metres
m^2	metres squared
mm	millimetres
NSW	New South Wales
OEH	Office of Environment and Heritage
PAD	Potential archaeological deposit
RMS	Roads and Maritime Services
SHR	State Heritage Register
t	Tonne
TP	Test pit

Glossary of Terms

Many of these definitions have been taken from the *Code of Practice for archaeological investigation of Aboriginal objects in NSW* (DECCW 2010).

Aboriginal object: A physical manifestation of past Aboriginal activity. The legal term is defined in the National Parks and Wildlife Act 1974 section 5 as: any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.

Typical examples include stone artefacts, grinding grooves, Aboriginal rock shelters which by definition include physical evidence of occupation, midden shell, hearths, stone arrangements and other landscape features which derive from past Aboriginal activity.

Archaeological survey: A method of data collection for Aboriginal heritage assessment. It involved a survey team walking over the land in a systematic way recording information. Activities are not invasive or destructive.

Aboriginal culturally modified tree: A tree of sufficient age to have been mature at the time of traditional Aboriginal hunter-gatherer life and therefore generally of more than 220 years of age with evidence of bark or cambium wood removal for the purpose of implement manufacture, footholds, bark sheet removal for shelter, or extraction of animals or other food. Care must be taken to distinguish Aboriginal scars from the much more common natural causes of branch tear, insect attack, animal impact, lightning strike and dieback. Culturally modified tree recognition guidelines exist to distinguish these features. Naturally scarred trees are often misidentified as Aboriginal culturally modified trees.

Aboriginal site: The location where a person in the present day can observe one or more Aboriginal objects. The boundaries of a site are limited to the extent of the observed evidence. In the context of this report a 'site' does not include the assumed extent of unobserved Aboriginal objects (such as archaeological deposit). Different archaeologists can have varying definitions of a 'site' and may use the term to reflect the assumed extent of past Aboriginal activity beyond visible Aboriginal objects. Such use of the term risks defining all of Australia as a single 'site'.

Aboriginal stone artefact: A stone object with morphological features derived from past Aboriginal activity such as intentional fracture, abrasion or impact. Artefacts are distinguished by morphology and context. Typically flaked stone artefacts are distinguished from naturally broken stone by recognition of clear marginal fracture initiation (typically herzian/conchoidal or wedging initiation) on highly siliceous stone types which can often be exotic to the area. Care must be taken to distinguish modern broken stone in machine impacted contexts and therefore context must be carefully considered as well as morphology.

AHIMS: Aboriginal Heritage Information Management System – a computer software system employed by the Office of Environment and Heritage to manage many aspects of Aboriginal site recording and permitting. AHIMS includes an Aboriginal sites database which can be accessed via an internet portal.

Archaeological deposit: Aboriginal objects occurring in one or more soil strata. The most common form of archaeological deposit relates to the presence of a single conflated layer of Aboriginal stone artefacts worked into the topsoil through **bioturbation**.

Backed artefact: A thin flake or blade-flake that has been shaped by secondary flaking (**retouch**) along one lateral margin. The retouched margin is typically steep and bipolar to form a blunt 'back' in the manner of a modern scalpel blade. Distinctive symmetrical and asymmetrical forms are typically found called geometric **microliths** and Bondi points respectively. A thick symmetrical form, called an Elouera, is typically the size of a mandarin segment.

Bioturbation: is the reworking of soils and sediments by animals or plants. Its effects include changing texture of sediments (diagenetic), bioirrigation and displacement of microorganisms and non-living particles.

Bipolar flaking: Where the stone to be worked is rested on an anvil or other stone before being hit by the hammerstone. This results in the presence of negative flake scars on both ends of the core.

Bondi point: See backed artefact definition.

Culturally modified tree: A tree that has been scarred carved or modified by an Aboriginal person using traditional methods.

Conchoidal: A term used in relation to fracture surfaces on Aboriginal stone artefacts - bulb-like in the manner of a bulbous protrusion on a bivalve shell.

Elouera: See backed artefact definition.

Eraillure scar: The small flake scar on the dorsal side of a flake next to the platform. It is the result of rebounding force during percussion flaking.

Exposure: estimates the area with a likelihood of revealing buried artefacts or deposits, not just an observation of the amount of bare ground.

Geometric microlith: See backed artefact definition.

Grinding grooves: Grinding grooves typically derive from the sharpening of stone hatchet heads on sandstone rock. Grooves appear as elliptical depressions of around 25 cm length with smooth bases. Although mostly occurring in association with water to wash the abraded stone dust away from the groove, such sites have been recorded away from water. Narrow grooves or broad abraded areas may occur less commonly and may be derived from spear sharpening or other grinding activities.

Holocene: A period of time generally 10,000 years, which marks the end of the last ice age, to the present.

Isotropic: Having a physical property that has the same value when measured in different directions. In relation to stone used for stone tools a fracture path is not hindered by layer boundaries or other favoured plane of cleavage.

Microlith: Very small fragments of flakes retouched into geometric shapes and usually present on tools like barbed spears, arrows and sickles.

Midden: A collection of shells and associated economic remains resulting from Aboriginal food gathering and processing activity. Middens comprise shellfish remains of consistent size in a rich dark earth matrix commonly associated with stone artefacts, fish bone and animal bone although shells are commonly the most obtrusive element.

Keeping place: A room or facility with the express and exclusive purpose of storing Aboriginal cultural heritage materials with accompanying documentation in a secure and accessible manner which protects their cultural heritage values.

Open stone artefact site/stone artefact site: An unenclosed area where Aboriginal stone artefacts occur – typically exposed from a topsoil archaeological deposit by erosion. Typically the term is used to refer to two or more artefacts although this is an arbitrary distinction. A general 'rule of thumb' boundary definition employed by archaeologists is that artefacts or features more than 50 m apart are regarded as separate sites; however there is no theoretical imperative dictating such as rule. (The 50 m separation rule is used for the most part in EMM's work).

Pleistocene: A period of time 2.6 million years ago to 10,000 years ago. Reference to 'Pleistocene sites' generally means reference to sites older than 10,000 years.

Point cluster: A group of GPS points used to identify the locations of individual artefacts in the field.

Potential Archaeological Deposit: An area where there is an inferred presence of Aboriginal objects in the soil based on the environmental context which is typically associated with discovery of Aboriginal objects in analogous areas. This is not strictly a 'site' type, although AHIMS records it as such for the purpose of associating Aboriginal heritage Impact Permits with geographical areas.

Retouch: The modification of the edges of a flake or tool by the removal of a series of small flakes.

Stone artefact concentration (SAC): See open stone artefact site.

Survey Unit: A unit of land which have been surveyed on foot and is used as the minimum analytical or descriptive unit for the survey.

Thumbnail scraper: A thumbnail sized thin flake with steep unidirectional retouch or use-wear around a convex working edge.

Visibility: The amount of bare ground on exposures which might reveal artefacts or other archaeological materials.

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Appendix A

Aboriginal stakeholder consultation documentation

A.1 Consultation log and communications record

Aboriginal Consultation Log — Marulan Limestone Mine Project

Stage 1 - Advisory Requests Sent

Organisation	Contact type	Date Sent	Comment
Office of Environment and Heritage Regional Operations Group (South Bran	Letter	2-Feb-15	Response recieved 17-Feb-15
the Registrar, Aboriginal Land Rights Act 1983	Letter	2-Feb-15	
National Native Title Tribunal	Letter	2-Feb-15	Response recieved 5-Feb-15
Native Title Services Corporation (NTSCORP)	Letter	2-Feb-15	Response recieved 4 Feb 15
Southern Rivers Catchment Management Authority	Letter	2-Feb-15	Response recieved 9-Feb-15
Goulburn Mulwaree Council	Letter	2-Feb-15	Response recieved 11-Feb-15
Pejar Local Aboriginal Land Council	Letter	2-Feb-15	Response recieved 23 Feb 15

Aboriginal Group Notifications Sent - see "addresses" sheet

Organisation	Contact type	Date	Comments
Pejar LALC	letter	19-Feb-15	Response received 23-Feb-15
Illawarra LALC	letter	19-Feb-15	No response after calling and emailing
Batemans Bay LALC	letter	19-Feb-15	No response after calling and emailing
Ngunnawal Elders Corporation	letter	19-Feb-15	No response after calling and emailing
Mr Peter Falk Consultancy	letter	19-Feb-15	Response received 27-Feb-15
Buru Ngunawal Aboriginal Corporation	letter	19-Feb-15	Response received 13-Feb-15
Ngunnawal Elder	letter	19-Feb-15	No response after calling and emailing
Gundungurra Aboriginal Heritage Association Inc	letter	19-Feb-15	Response received 4-Mar-15
Ngunawal Heritage Aboriginal Corporation	letter	19-Feb-15	Response received 8-Feb-15
Konaggo Aboriginal Cultural Heritage Services	letter	19-Feb-15	No response after calling and emailing
Yurwang Gundana Consultancy	letter	19-Feb-15	No response after calling and emailing
King Brown Tribal Group	letter	19-Feb-15	Response received 11-Mar-15
Gunjeewong Cultural Heritage Aboriginal Corporation	letter	19-Feb-15	No response after calling and emailing
Yukkumbruk	letter	19-Feb-15	No response after calling and emailing (email undeliverable)
Koomurri Ngunawal Aboriginal Corporation	letter	19-Feb-15	Response received 2-Feb-15
Corroboree Aboriginal Corporation	letter	19-Feb-15	Response received 4-Mar-15
Murri Bidgee Mullangari Aboriginal Corporation	letter	19-Feb-15	Response received 23-Feb-15
Nundagurri	letter	19-Feb-15	Response received 27-Feb-15
Walbunja Aboriginal Corporation	letter	19-Feb-15	Response received 27-Feb-15
Goobah Development Pty Ltd	letter	19-Feb-15	No response after calling and emailing
Gunyuu	letter	19-Feb-15	Response received 19-Feb-15
Wullung	letter	19-Feb-15	Response received 27-Feb-15
Badu	letter	19-Feb-15	Response received 27-Feb-15
Yerramurra	letter	19-Feb-15	Response received 27-Feb-15
Jerringong	letter	19-Feb-15	No response after calling and emailing
Merrigarn Aboriginal Corporation	letter	19-Feb-15	Response received 24-Feb-15
Gulgunya Ngunawal Heritage Aboriginal Consultancy	letter	19-Feb-15	Response received 2-Feb-15
Thunderstone Aboriginal Cultural and Land Management Services	letter	19-Feb-15	Response received 27-Feb-15
Duncan Falk Consuntancy	letter	19-Feb-15	Response received 16-Feb-15

OEH & LALC notified of Registered Stakeholders

Organisation	Contact type	Date	Comments
Office of Environment and Heritage	letter	16-Mar-15	
Pejar Local Aboriginal Land Council	letter	16-Mar-15	

Stage 2 & 3 - Project Presentation & Methodology Advice Sent

Organisation	Contact type	Date Sent	Comments
Pejar LALC	letter	13-Mar-15	
Mr Peter Falk Consultancy	letter	13-Mar-15	
Buru Ngunawal Aboriginal Corporation	letter	13-Mar-15	
Gundungurra Aboriginal Heritage Association Inc	letter	13-Mar-15	
Ngunawal Heritage Aboriginal Corporation	letter	13-Mar-15	
King Brown Tribal Group	letter	13-Mar-15	
Koomurri Ngunawal Aboriginal Corporation	letter	13-Mar-15	Response received 15-May-15, replied 4-Jun-15
Corroboree Aboriginal Corporation	letter	13-Mar-15	
Murri Bidgee Mullangari Aboriginal Corporation	letter	13-Mar-15	Response received 6-May-15, replied 4-Jun-15
Nundagurri	letter	13-Mar-15	
Walbunja Aboriginal Corporation	letter	13-Mar-15	
Gunyuu	letter	13-Mar-15	
Wullung	letter	13-Mar-15	
Badu	letter	13-Mar-15	Response received 11-May-15, replied 4-Jun-15
Yerramurra	letter	13-Mar-15	
Merrigarn Aboriginal Corporation	letter	13-Mar-15	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	letter	13-Mar-15	Response received 11-May-15, replied 4-Jun-15
Thunderstone Aboriginal Cultural and Land Management Services	letter	13-Mar-15	
Duncan Falk Consuntancy	letter	13-Mar-15	

Stage 2 & 3 - Test excavation review

Organisation	Contact type	Date Sent	Comments
Pejar LALC	letter	8-May-15	
Mr Peter Falk Consultancy	letter	8-May-15	

Buru Ngunawal Aboriginal Corporation	letter	8-May-15	
Gundungurra Aboriginal Heritage Association Inc	letter	8-May-15	Response received 19-May-15
Ngunawal Heritage Aboriginal Corporation	letter	8-May-15	
King Brown Tribal Group	letter	8-May-15	
Koomurri Ngunawal Aboriginal Corporation	letter	8-May-15	Response received 15-May-15, replied 4-Jun-15
Corroboree Aboriginal Corporation	letter	8-May-15	
Murri Bidgee Mullangari Aboriginal Corporation	letter	8-May-15	Response received 6-May-15, replied 4-Jun-15
Nundagurri	letter	8-May-15	
Walbunja Aboriginal Corporation	letter	8-May-15	
Gunyuu	letter	8-May-15	
Wullung	letter	8-May-15	
Badu	letter	8-May-15	Response received 11-May-15, replied 4-Jun-15
Yerramurra	letter	8-May-15	
Merrigarn Aboriginal Corporation	letter	8-May-15	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	letter	8-May-15	Response received 11-May-15, replied 4-Jun-15
Thunderstone Aboriginal Cultural and Land Management Services	letter	8-May-15	
Duncan Falk Consuntancy	letter	8-May-15	

Stage 4 - Draft Reports for Review - Sent

Organisation	Contact type	Date Sent	Feedback Received & Date
Pejar LALC	email	27/11/2015	
Mr Peter Falk Consultancy	email	27/11/2015	
Buru Ngunawal Aboriginal Corporation	email	27/11/2015	Response received 11 Jan 2016
Gundungurra Aboriginal Heritage Association Inc	email	27/11/2015	
Ngunawal Heritage Aboriginal Corporation	email	27/11/2015	Response received 10 Jan 2016
King Brown Tribal Group	email	27/11/2015	
Koomurri Ngunawal Aboriginal Corporation	email	27/11/2015	Response received 09 Jan 2016
Corroboree Aboriginal Corporation	email	27/11/2015	Response received 11 Jan 2016
Murri Bidgee Mullangari Aboriginal Corporation	email	27/11/2015	
Nundagurri	email	27/11/2015	
Walbunja Aboriginal Corporation	email	27/11/2015	
Gunyuu	email	27/11/2015	
Wullung	email	27/11/2015	
Badu	email	27/11/2015	
Yerramurra	email	27/11/2015	
Merrigarn Aboriginal Corporation	email	27/11/2015	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	email	27/11/2015	Response received 09 Jan 2016
Thunderstone Aboriginal Cultural and Land Management Services	email	27/11/2015	
Duncan Falk Consuntancy	email	27/11/2015	

Notification of continuing consultation

Organisation	Contact type	Date sent	Feedback received & date
Pejar LALC	email	28/10/2016	
Mr Peter Falk Consultancy	email	28/10/2016	
Buru Ngunawal Aboriginal Corporation	email	28/10/2016	
Gundungurra Aboriginal Heritage Association Inc	email	28/10/2016	
Ngunawal Heritage Aboriginal Corporation	email	28/10/2016	
King Brown Tribal Group	email	28/10/2016	
Koomurri Ngunawal Aboriginal Corporation	email	28/10/2016	
Corroboree Aboriginal Corporation	email	28/10/2016	
Murri Bidgee Mullangari Aboriginal Corporation	email	28/10/2016	
Nundagurri	email	28/10/2016	
Walbunja Aboriginal Corporation	email	28/10/2016	
Gunyuu	email	28/10/2016	
Wullung	email	28/10/2016	
Badu	email	28/10/2016	
Yerramurra	email	28/10/2016	
Merrigarn Aboriginal Corporation	email	28/10/2016	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	email	28/10/2016	
Thunderstone Aboriginal Cultural and Land Management Services	email	28/10/2016	
Duncan Falk Consuntancy	email	28/10/2016	

Notification of continuing consultation

Organisation	Contact type	Date sent	Feedback received & date
Pejar LALC	email	9/11/2017	
Mr Peter Falk Consultancy	email	9/11/2017	
Buru Ngunawal Aboriginal Corporation	email	9/11/2017	
Gundungurra Aboriginal Heritage Association Inc	email	9/11/2017	
Ngunawal Heritage Aboriginal Corporation	email	9/11/2017	
King Brown Tribal Group	email	9/11/2017	
Koomurri Ngunawal Aboriginal Corporation	email	9/11/2017	
Corroboree Aboriginal Corporation	email	9/11/2017	
Murri Bidgee Mullangari Aboriginal Corporation	email	9/11/2017	
Nundagurri	email	9/11/2017	
Walbunja Aboriginal Corporation	email	9/11/2017	
Gunyuu	email	9/11/2017	

Wullung	email	9/11/2017	
Badu	email	9/11/2017	
Yerramurra	email	9/11/2017	
Merrigarn Aboriginal Corporation	email	9/11/2017	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	email	9/11/2017	
Thunderstone Aboriginal Cultural and Land Management Services	email	9/11/2017	
Duncan Falk Consuntancy	email	9/11/2017	
Issue of Draft ACHA to RAPs			
Organisation	Contact type	Date sent	Feedback received & date
Pejar LALC	email	13/08/2018	
Mr Peter Falk Consultancy	email	13/08/2018	
Buru Ngunawal Aboriginal Corporation	email	13/08/2018	
Gundungurra Aboriginal Heritage Association Inc	email	13/08/2018	
Ngunawal Heritage Aboriginal Corporation	email	13/08/2018	
King Brown Tribal Group	email	13/08/2018	
Koomurri Ngunawal Aboriginal Corporation	email	13/08/2018	
Corroboree Aboriginal Corporation	email	13/08/2018	
Murri Bidgee Mullangari Aboriginal Corporation	email	13/08/2018	
Nundagurri	email	13/08/2018	
Walbunja Aboriginal Corporation	email	13/08/2018	
Gunyuu	email	13/08/2018	
Wullung	email	13/08/2018	
Badu	email	13/08/2018	
Yerramurra	email	13/08/2018	
Merrigarn Aboriginal Corporation	email	13/08/2018	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	email	13/08/2018	
Thunderstone Aboriginal Cultural and Land Management Services	email	13/08/2018	
Duncan Falk Consuntancy	email	13/08/2018	

COMMUNICATIONS RECORD

Date	RAP	RAP Person	EMM person	Details
20-Mar-15	Pejar LALC	Darlene Freeman	RN	Calling re upcoming meeting - left message she called back to confirm Justin would be present
20-Mar-15	Mr Peter Falk Consultancy	Peter Falk	RN	Calling re upcoming meeting - left message call returned he will be coming alone
20-Mar-15	Buru Ngunawal Aboriginal Corporation	Wally Bell	RN	Calling re upcoming meeting - left message
20-Mar-15	Gundungurra Aboriginal Heritage Association Inc	Sharyn Halls	RN	Confirmed kieran for meeting may also be Sharon
20-Mar-15	Ngunawal Heritage Aboriginal Corporation	Dean Delponte	RN	Tammy Mitchell will be coming Graeme will need to be inducted when he comes
20-Mar-15	King Brown Tribal Group	Carl Brown	RN	needs things posted
20-Mar-15	Koomurri Ngunawal Aboriginal Corporation	Donna Dobson	RN	Calling re upcoming meeting - left message
20-Mar-15	Corroboree Aboriginal Corporation	Steve Johnson	RN	Calling re upcoming meeting - left message call returned he will be coming alone
20-Mar-15	Murri Bidgee Mullangari Aboriginal Corporation	Darleen Johnson	RN	Ryan will be coming
20-Mar-15	Nundagurri Aboriginal Corporation	Aaron Borad	RN	He is sick please call back next week
20-Mar-15	Walbunja Aboriginal Corporation	Hike Tekowahi	RN	two people will be present for meeting
20-Mar-15	Gunyuu	Darlene hoskins mac	RN	two people will be present for meeting
20-Mar-15	Badu	Kaira	RN	two people will be present for meeting
20-Mar-15	Yerramurra	Nicholas Gover	RN	Calling re upcoming meeting - left message
20-Mar-15	Merrigarn Aboriginal Corporation	Shaun Carroll	RN	one person will be present
20-Mar-15	Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman	RN	Calling re upcoming meeting - left message he called back to say he would be present for the meeting
20-Mar-15	Thunderstone Aboriginal Cultural and Land Management Services	Tyrone Bell	RN	Calling re upcoming meeting - left message
23-Mar-15	Buru Ngunawal Aboriginal Corporation	Wally Bell	RN	Calling re upcoming meeting - left message
4/12/2015	Pejar LALC	Darlene Freeman	PC	Calling re upcoming meeting - spoke to a representative - will get back to us
4/12/2015	Mr Peter Falk Consultancy	Peter Falk	PC	Calling re upcoming meeting - Unable to attend
4/12/2015	Buru Ngunawal Aboriginal Corporation	Wally Bell	PC	Calling re upcoming meeting- Spoke to Wally. He is going to check and let us know by email if he can come
4/12/2015	Gundungurra Aboriginal Heritage Association Inc	Sharyn Halls	PC	Calling re upcoming meeting - Left a message. Sharon called back to say she can't come
4/12/2015	Ngunawal Heritage Aboriginal Corporation	Dean Delponte	PC	Calling re upcoming meeting - Will send a representative across from Peppertree
4/12/2015	King Brown Tribal Group	Carl Brown	PC	Calling re upcoming meeting - Carl will attend
4/12/2015	Koomurri Ngunawal Aboriginal Corporation	Donna Dobson	PC	Calling re upcoming meeting - will send someone
4/12/2015	Corroboree Aboriginal Corporation	Steve Johnson	PC	Calling re upcoming meeting - Probably won't come but if anything changes then he will
4/12/2015	Murri Bidgee Mullangari Aboriginal Corporation	Darleen Johnson	PC	Calling re upcoming meeting - Left a message
4/12/2015	Nundagurri	Aaron Borad	PC	Calling re upcoming meeting - he requested I send him the info as a text message (I've sent one from my phone) as he is having trouble with email
4/12/2015	Walbunja Aboriginal Corporation	Hike Tekowahi	PC	Calling re upcoming meeting - Left a message
4/12/2015	Gunyuu	Darlene hoskins mac	PC	Calling re upcoming meeting - she will call back - she will attend. She requested that copies of the emails be resent
4/12/2015	Wullung	Leroy	PC	Calling re upcoming meeting - Left a message
4/12/2015	Badu	Kaira	PC	Calling re upcoming meeting - She will probably come
4/12/2015	Yerramurra	Nicholas Gover	PC	Calling re upcoming meeting - Nicholas will attend
4/12/2015	Merrigarn Aboriginal Corporation	Shaun Carroll	PC	Calling re upcoming meeting - Phone number has been disconnected
4/12/2015	Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman	PC	Calling re upcoming meeting - Glen will come and possibly bring a female rep with him because of the women's site
4/12/2015	Thunderstone Aboriginal Cultural and Land Management Services	Tyrone Bell	PC	Calling re upcoming meeting - Tyrone might come across from Peppertree
4/12/2015	Duncan Falk Consultancy		PC	Spoke to Peter Falk (see above) who said Duncan will be on fieldwork elsewhere
7/12/2015	All registered parties	All	PC	Email confirming start time for meeting on Thursday 10th Dec and reminder of closing date for comment on draft report
7/12/2015	Walbunja Aboriginal Corporation	Hike Tekowahi	PC	Hika called to say he can't make the meeting. He expressed concern about the concentration of activity in the west of the project. I encouraged him to read the report and make a written submission before Jan 11th
8/12/2015	Murri Bidgee Mullangari Aboriginal Corporation	Darleen Johnson	PC	Email received from Darleen with apologies that she can't attend Thursday's meeting but will respond to the report in writing.
9/12/2015	Corroboree Aboriginal Corporation	Steve Johnson	PC	Email received from Steve with apologies that she can't attend Thursday's meeting but will be reviewing the draft
8/01/2016	All registered parties	All	PC	Reminder email - Closing date for written responses to draft ACHA is next Monday.
8/01/2016	Gunyuu	Darlene hoskins mac	PC	Darlene phoned to say she didn't receive the hightail link but is going to recheck spam etc and call back.
28/10/2016	All registered parties	ALL	PBK	Email notifying of continuing consultation while project modifications being made
17/11/2016	Buru Ngunawal Aboriginal Corporation	Wally Bell	PBK	Email from Wally ackowledging continuing consultation letter sent 28/10/2016 and notifying EMM of change of address.
15/11/2016	Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman	PBK	Email from GF responding to continuing consultation letter send 28/10/2016
9/12/2016	Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman	PBK	Email from PBK responding to GNHAC advising that desing not finalised
9/11/2017	All registered parties	ALL	KA	Email notifying of continuing consultation while project modifications being made
23/11/2017	Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman	PBK	Telephone conversation: Glen advised that Koomurri has been deregistered and is no longer consulting on this project

A.2 Stage 1 – Notification and registration

This section contains the following documents:

- Government agency requests and responses;
- Public media notifications;
- Aboriginal party invitation to register for the project;
- Aboriginal party registrations of interest; and
- Notification to OEH and the Armidale LALC of registered parties.

Notice of Aboriginal Consultation
Project name: Marulan South Limestone Mine Continued Operations
Proponent: Boral Cement Ltd (Boral)
Location: Marulan South

Boral owns and operates the Marulan South Limestone Mine, an open cut mine that produces limestone and lime based products for the cement, steel, agricultural and construction markets. Boral is seeking approval for continued operations at the mine through a development application for a State Significant Development including a 30 year mine plan, associated overburden emplacement areas and a mine water supply dam.

Aboriginal organisations or Aboriginal persons who hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or Aboriginal places in the area of the proposed project are invited to register an interest in a process of community consultation with the proponent regarding the proposed activity.

The purpose of community consultation with Aboriginal people is to assist the proposed applicant in: 1) assessing the Aboriginal heritage values of the area, 2) preparing an Environmental Impact Statement under Part 4, Division 4.1 of the Environmental Planning and Assessment Act 1979, and 3) to assist regulators in the assessment of Aboriginal heritage reports prepared for this project.

Registrations of interest must be submitted in writing on or before 17 February 2015. Registrations should include the name of a contact person, address and other relevant contact details, preferably including an email address. The names of registered Aboriginal parties will be passed on to the relevant Local Aboriginal Land Council and the Office of Environment and Heritage unless a request to the contrary is made.

Send registrations of interest to:
Marulan South Limestone Mine
Continued Operations Project
C EMGA Mitchell McLennan Pty Ltd
PO Box 21, St Leonards, NSW, 1590
Fax: 02 93939539

Registration of interest does not guarantee paid involvement.

2 February 2014

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

www.emgamm.com

Re: Aboriginal consultation Marulan South Limestone Mine Continued Operations project - re identification of Aboriginal parties

Dear Sir/Madam,

Boral Cement Ltd (Boral) owns and operates the Marulan South Limestone Mine. It is an open cut mine that has produced limestone and lime based products for the cement, steel, agricultural and construction markets for over a century. EMGA Mitchell McLennan Pty Ltd (EMM) on behalf of Boral, is seeking to identify Aboriginal organisations or Aboriginal persons who hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or Aboriginal places in the area of the Marulan South Limestone Mine at Marulan South (see attached map). Boral is seeking approval for continued operations at the mine through a development application for a State Significant Development including a 30 year mine plan, associated overburden emplacement areas and a mine water supply dam (the project).

In accordance with the OEH *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* EMM requests information about relevant Aboriginal persons and Aboriginal organisations who you consider may have cultural knowledge relevant to the project and should be invited to register for consultation.

EMM requests information of the Aboriginal persons or organisations to enable us to contact them and invite them to participate in the project. I would be appreciative of your response by 18 February 2015 to:

c/o EMGA Mitchell McLennan
ATN: Rebecca Newell
PO Box 21
St Leonards NSW 1590
[redacted]

Please advise us at your earliest convenience if additional time is required to provide this information. Information received after 18 February 2015 might not be considered in the consultation process due to the assessment timeframe.

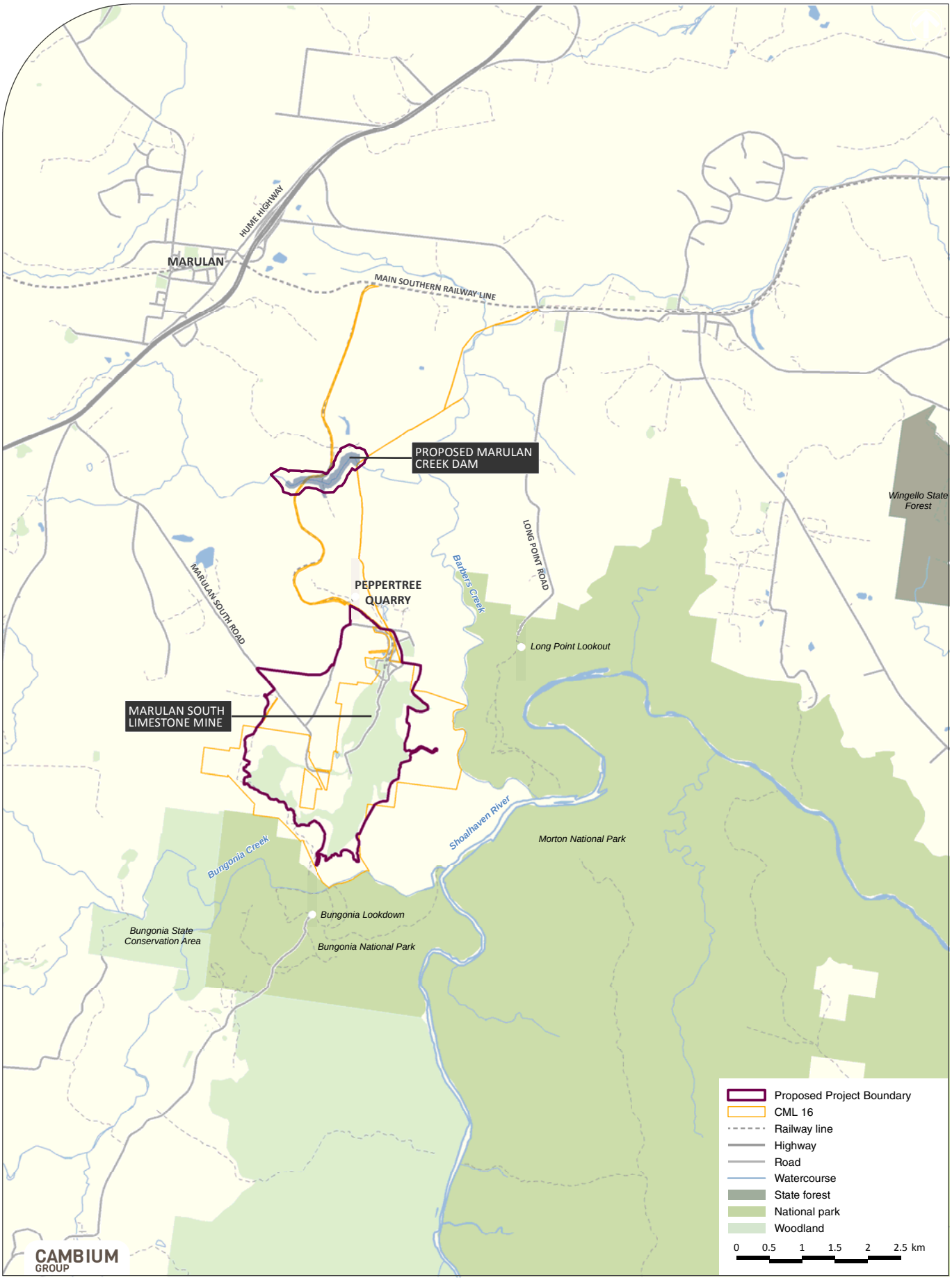
Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

FIGURE 1
Regional context

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION



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Rebecca Newell

From: Jagtman, [redacted]
Sent: Thursday, 5 February 2015 3:40 PM
To: Rebecca Newell
Subject: Native title search request 0393/15 [SEC=UNCLASSIFIED]
Attachments: Search results.pdf

UNCLASSIFIED

Dear Rebecca

Please find attached the results of your recent native title search request over Marulan South within the Goulburn Mulwaree Council LGA.

Regards,

Sylvia Jagtman | SENIOR CASE MANAGEMENT ASSISTANT
National Native Title Tribunal | Sydney Office
[redacted]
Telephone [redacted] Facsimile [redacted] Email [redacted]
[redacted]
Shared country, shared future.

National Native Title Tribunal

Sydney Office, Operations East
Level 16
Law Courts Building
[redacted]

5 February 2015

EMGA Mitchell McLennan
PO Box 21
ST LEONARDS NSW 1590

Attention: Rebecca Newell

Our Ref: 0393-15SJ

Dear Ms Newell

Native Title Search Results for Marulan South
within the Goulburn Mulwaree Council Local Government Area

Thank you for your search request received on 4 February 2015 in relation to the above area.

Search Results
The results provided are based on the information you supplied and are derived from a search of the following Tribunal databases:

Register Type	**NNTT Reference Numbers**
Schedule of Applications (unregistered claimant applications)	Nil.
Register of Native Title Claims	Nil.
National Native Title Register	Nil.
Register of Indigenous Land Use Agreements	Nil.
Notified Indigenous Land Use Agreements	Nil.

At the time this search was carried out, there were **no relevant entries** in the above databases.

Please note: There may be a delay between a native title determination application being lodged in the Federal Court and its transfer to the Tribunal. As a result, some native title determination applications recently filed with the Federal Court may not appear on the Tribunal's databases.

Tribunal accepts no liability for reliance placed on enclosed information
The enclosed information has been provided in good faith. Use of this information is at your sole risk. The National Native Title Tribunal makes no representation, either express or implied, as to

the accuracy or suitability of the information enclosed for any particular purpose and accepts no liability for use of the information or reliance placed on it.

If you have any further queries, please do not hesitate to contact me on the numbers listed below.

Yours sincerely



Sylvia Jagtman | SENIOR CASE MANAGEMENT ASSISTANT
National Native Title Tribunal | Sydney Office
[redacted]
Telephone [redacted] | Facsimile [redacted] | Email [redacted]

Shared country, shared future.

Rebecca Newell

From: Jackie Taylor [redacted] on behalf of ROG South East Region Mailbox [redacted]
Sent: Tuesday, 17 February 2015 7:16 PM
To: Rebecca Newell
Cc: ROG South East Region Mailbox
Subject: OEH stakeholder list for Marulan South Limestone Mine
Attachments: DOC15-52187 EGMA Marulan South Mine operations.pdf

Dear Rebecca,

Attached is the OEH stakeholder list for Marulan South Limestone Mine Continued Operation Project within the Goulburn Mulwaree LGA.

Regards,
Jackie

Jackie Taylor
Team Leader Aboriginal Heritage - South East
Regional Operations Group (South Branch)
Office of Environment and Heritage
[redacted]

In order to ensure a high level of customer service and monitor work flow, the Office of Environment and Heritage (OEH) South East Planning Team has a new email address: [redacted] Please forward all further email correspondence in relation to Planning and Aboriginal cultural heritage regulation matters to this address. If appropriate, emails can be marked to the attention of your usual contact in the Team.

This email is intended for the addressee(s) named and may contain confidential and/or privileged information.
If you are not the intended recipient, please notify the sender and then delete it immediately.
Any views expressed in this email are those of the individual sender except where the sender expressly and with authority states them to be the views of the NSW Office of Environment and Heritage.

PLEASE CONSIDER THE ENVIRONMENT BEFORE PRINTING THIS EMAIL

Office of Environment & Heritage

NSW GOVERNMENT

Your reference:
Our reference: EF15/327 & DOC15/52187
Contact: Jackie Taylor [redacted]

c/o EMGA Mitchell McLennan
PO Box 21
St Leonards NSW 1590

Attention: Rebecca Newell

Dear Rebecca,

WRITTEN NOTIFICATION OF PROPOSAL AS REQUIRED UNDER DECCW ABORIGINAL CULTURAL HERITAGE CONSULTATION REQUIREMENTS FOR PROPONENTS 2010

RE: Aboriginal Consultation Marulan South Limestone Mine Continued Operations project – re identification of Aboriginal Parties

I refer to your letter, dated 2 February 2015, to the Office of Environment and Heritage (OEH) regarding the above matter.

I apologise for the delay in replying however; as your letter was incorrectly addressed c/- of the South Coast Region, National Parks and Wildlife Service, Nowra Office, your request has only just been received by the OEH South East Region Office responsible for the administering Aboriginal heritage regulation matters within the Goulburn Mulwaree local government area.

Attached is a list of known Aboriginal parties for the Goulburn Mulwaree local government area that OEH feels is likely to have an interest in the development. This list is not necessarily an exhaustive list of all interested Aboriginal parties and receipt of this list does not remove the requirement of a proponent/ consultant to advertise in local print media and contact other bodies seeking interested Aboriginal parties, in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (April 2010).

Please note: the contact details in the list provided by OEH may be out of date as it relies on Aboriginal parties advising OEH when their details need changing. If individuals/ companies undertaking consultation are aware that any groups contact details are out of date, or letters are returned unopened, please contact either the relevant stakeholder group (if you know their more current details) and/ or OEH. AHIP applicants should make a note of any group they are unable to contact as part of their consultation record.

If you wish to discuss any of the above matters further please feel free to contact me on (02) 6229 7089.

Yours sincerely

17 February 2015

JACKIE TAYLOR
Team Leader, Aboriginal Heritage - South East
Regional Operations Group
Office of Environment and Heritage

[redacted]

ATTACHMENT 1: Goulburn Mulwaree local government area

Organisation/Individual Name	Address	Contact Details
Pejar Local Aboriginal Land Council Primary Contact: Delise Freeman	[redacted]	[redacted]
Ngunnawal Elders Corporation: Mr Arnold Williams CEO	[redacted]	[redacted]
Mr Peter Falk Consultancy	[redacted]	[redacted]
Buru Ngunawal Aboriginal Corporation. Contact Person: Wally Bell	[redacted]	[redacted]
Ngunnawal Elder	[redacted]	[redacted]
Gundungurra Aboriginal Heritage Association Inc. Secretary Sharyn Halls	[redacted]	
Ngunawal Heritage Aboriginal Corporation: Mrs Dorothy Carroll	[redacted]	[redacted]
Konanggo Aboriginal Cultural Heritage Services – Mr Robert Young	[redacted]	[redacted]
Yurwang Gundana Consultancy Cultural Heritage Services: Dean Bell	[redacted]	[redacted]
King Brown Tribal Group: Carl and Tina Brown	[redacted]	[redacted]
Gunjeewong Cultural Heritage Aboriginal Corporation: Cherie Carroll Turrise	[redacted]	[redacted]
Yukkumbruk (Contact: Serena Williams)	[redacted]	[redacted]
Koomurri Ngunawal Aboriginal Corporation (KNAC) Contact/Director: Glen Freeman	[redacted]	[redacted]
Corroboree Aboriginal Corporation Director: Steve Johnson	[redacted]	[redacted]
Murri Bidgee Mullangari Aboriginal Corporation. Contact: Darleen Johnson	[redacted]	[redacted]

Nundagurri Aboriginal Corporation. Contact: Aaron Broad - Chief Cultural Heritage Officer (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)	[redacted]	[redacted]
Walbunja Aboriginal Corporation: Senior Technical Services Officer - Hika Te Kowhai	[redacted]	[redacted]
Goobah Development Pty Ltd. Contact: Basil Smith Chief Cultural Heritage Officer (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)		[redacted]
Gunyuu Contact: Darlene Hoskins-McKenzie CEO (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)		[redacted]
Wullung: Contact Person Lee-Roy Boota - Chairperson (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)	[redacted]	[redacted]
Badu: Contact person Karia Lea Bond - Chairperson (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)	[redacted]	[redacted]
Yerramurra: Contact Person - Nicholas Wade Glover - Chairperson (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)	[redacted]	[redacted]
Jerringong: Contact Person - Jodie Stewart - Chairperson (Murrin Clan: This group's states that their boundaries extend from the Hawkesbury River to the Snowy River)	[redacted]	[redacted]
Merrigarn Aboriginal Corporation: Contact person Shaun Carroll	[redacted]	[redacted]

OFFICE OF THE REGISTRAR
ABORIGINAL LAND RIGHTS ACT 1983 (NSW)

[redacted]

Rebecca Newell
EMGA Mitchell McLennan
PO Box 21
ST LEONARDS NSW 1590

Dear Rebecca

Re: Request - Search for Registered Aboriginal Owners

I refer to your letter dated 2 February 2015 regarding Aboriginal Cultural Heritage Assessment within the area of Marulan, NSW.

I have searched the Register of Aboriginal Owners and the project area described *does not appear* to have Registered Aboriginal Owners pursuant to Division 3 of the *Aboriginal Land Rights Act* 1983 (NSW).

I suggest that you contact the Pejar Local Aboriginal Land Council. They will be able to assist you in identifying other Aboriginal stakeholders for this project.

Yours sincerely

Bianca Ceissman
Administration Officer
Office of the Registrar, *Aboriginal Land Rights Act* (1983)

19 February 2015

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

www.emgamm.com

Re: Aboriginal consultation for the Marulan South Limestone Mine Continued Operations project - re identification of Aboriginal parties

Dear Sir/Madam,

Boral Cement Ltd (Boral) owns and operates the Marulan South Limestone Mine. It is an open cut mine that has produced limestone and lime based products for the cement, steel, agricultural and construction markets for over a century. EMGA Mitchell McLennan Pty Ltd (EMM), on behalf of Boral, is seeking to identify Aboriginal organisations or Aboriginal persons who hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or Aboriginal places in the area of the Marulan South Limestone Mine (see attached map). The project is located approximately 10 km south of Marulan.

Boral is seeking approval for continued operations at the mine through a development application for a State Significant Development including a 30 year mine plan, associated overburden emplacement areas and a mine water supply dam (the project).

Your organisation has been identified as having potential interest in registering for consultation in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010).

The project involves development activities under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act* 1979. Consultation will also encompass future Aboriginal Heritage Impact Permit (AHIP) applications for the Project issued under s.90 of the *National Parks and Wildlife Act 1974.*

If you wish to register your interest as an Aboriginal party your registration must be in writing (letter, fax or email), and include:

- your name/organisation; and
- current contact details (postal address, email, phone number/s).

EMM is seeking to engage all future correspondence with registered Aboriginal Parties (RAPs) via email. This method is considered the most reliable, cost-effective, and timely manner of consultation. As such, EMM requests your agreement to undertake the consultation via email as the official method of contact. A simple response in writing stating 'I agree to be contacted by email as the main source of consultation' is requested.

This information must be received by Rebecca Newell (see contact details below) by close of business on Friday 6 March 2015.

As required by OEH guidelines, details of people registering as Aboriginal Parties will be forwarded to OEH and the relevant Local Aboriginal Land Council unless you specify otherwise.

Registration of interest does not guarantee employment on fieldwork.

Please send correspondence to:

Marulan South Limestone Mine Continued Operations project
Rebecca Newell
EMGA Mitchell McLennan
PO Box 21
St Leonards NSW 1590
Fax: 02 9493 9519
Email: [redacted]

If you have any questions or would like to discuss the project further please don't hesitate to contact me.

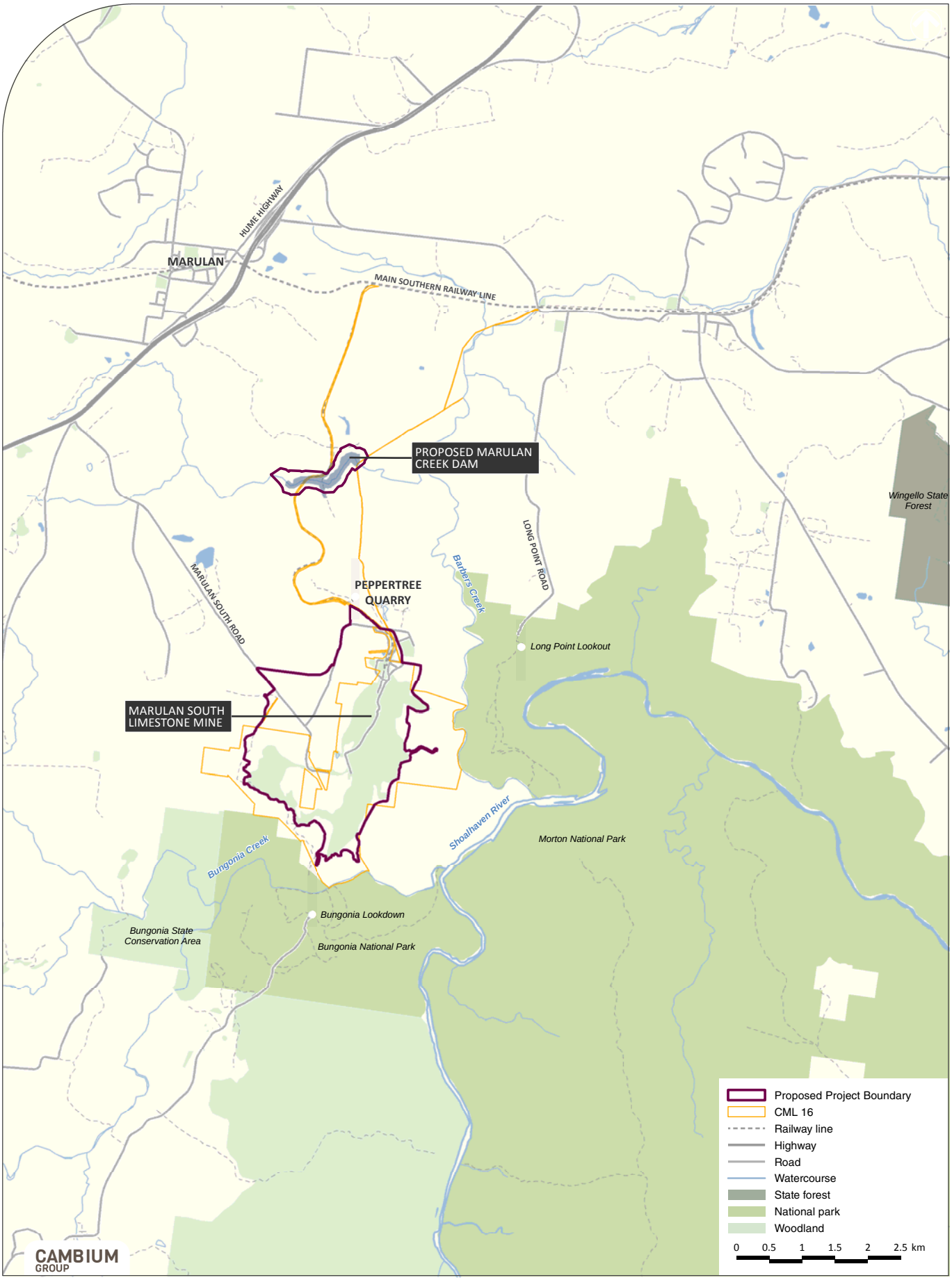
Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

FIGURE 1
Regional context

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION



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Rebecca Newell

From: Karia Bond [redacted]
Sent: Saturday, 28 February 2015 12:21 AM
To: Rebecca Newell
Subject: Registration of interest

Badu formally registers interest in the Marulan South Limestone Mine Continued Operations project.

Regards

Karia Bond
Badu

Rebecca Newell

From: Wally Bell [redacted]
Sent: Friday, 13 February 2015 12:06 PM
To: Rebecca Newell
Subject: Marulan South Limestone Mine - BNAC EOI
Attachments: Marulan Limestone Mine - EMM - Feb '15.docx

Dear Rebecca,

Please find attached our EOI for the above project.

Regards,

Wally Bell
Director/Chair
Mb: [redacted]

Buru Ngunawal Aboriginal Corporation
Traditional Custodian Group
[redacted]

Rebecca Newell

From: steve johnson [redacted]
Sent: Wednesday, 4 March 2015 11:21 PM
To: Rebecca Newell
Subject: EXPRESSION OF INTEREST MARULAN SOUTH LIMESTONE MINE PROJECT
Attachments: corroboreee marulan south mine EOI.docx

Hi Rebecca
Please refer attachment

Kind Regards
Steve Johnson
Director

CORROBOREE ABORIGINAL CORPORATION
Preserving Aboriginal Culture & Heritage



[redacted]

CORROBOREE ABORIGINAL CORPORATION
PRESERVING OUR HERITAGE & CULTURE

4/3/2015
Marulan South Limestone Mine Continued Operations project
Rebecca Newell
EMGA Mitchell McLennan
PO Box 21
St Leonards NSW 1590

Dear Rebecca

RE: EXPRESSION OF INTEREST AT Marulan South Limestone Mine Continued Operations project

Our Corroboree Aboriginal Corporation members are interested in consulting to assist in the Cultural Heritage Assessment Report for this Proposed Development which is for approval under S.90 Aboriginal Heritage Impact Permit application under Part 6 of the National Parks and Wildlife Act 1974 which will assist the Director General of OEH in considering that application.

As per Section 4.1.2 of the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (DECCW 2010) our organisation have interest in the project area. We also are holders of knowledge relevant to determining the cultural significance of Aboriginal objects and/or places within the subject area.

We are interested in being consultants in relation to the above project and hereby submit expression of interest for your consideration. Our nominated representative to receive all future correspondence is Steve Johnson and agree to be contacted by email.

Yours sincerely

Marilyn Johnson

Rebecca Newell

From: Sharyn Halls [redacted]
Sent: Wednesday, 4 March 2015 11:34 AM
To: Rebecca Newell
Subject: Fw: Marulan South Limestone Mine Continued Operations Project

From: Sharyn Halls
Sent: Wednesday, March 04, 2015 11:22 AM
To: [redacted]
Subject: Marulan South Limestone Mine Continued Operations Project

Hi Rebecca
I would like to register Gundungurra Aboriginal Heritage Association INC interest In the Marulan South Limestone Mine operations project.

I'm will be your contact person on this email address [redacted] mobile [redacted]
Address

[redacted]

Kind Regards
Sharyn Halls

Rebecca Newell

From: [redacted] on behalf of Glen Freeman
Sent: Monday, 23 February 2015 5:56 PM
To: Rebecca Newell
Subject: RE: Marulan South Limestone Mine Continued Operations

Dear Rebecca,

As per our discussion of this afternoon the 23rd February 2015 I am formally notifying you as the agent for the proponent
that as you will not accept registration on the grounds that the same person for two organisations is the Public Officer, namely
Koomurri Ngunawal Aboriginal Corporation and Gulgunya Ngunawal Heritage Consultancy and as also discussed.

The need to change the Contact / Public Officer details of one or the other of the nominated organisations which i might add, hasn't
been a necessity with other agent's with whom i have registered interest with on other projects since our organisation made these necessary changes in order to address the imbalance of the current and unfair system now in place on too many projects,in particular in the last 2 to 3 years .

As such Koomurri Ngunawal Aboriginal Corporation has changed it's Contact/ Public Officer Details to the following.
Glen.

Donna Dobson
Director/ Contact
[redacted]

From: [redacted]
To: [redacted]
Date: Mon, 23 Feb 2015 08:50:43 +1100
Subject: Marulan South Limestone Mine Continued Operations

Hi Glen,

We thank you for your recent correspondence in regards to the Marulan South Limestone Mine Continued Operations project. We are aiming to ensure the consultation process with groundsall Aboriginal stakeholders is as fair as possible. As such we do not accept registrations for groups with the same contact person as is the case with the Gulgunya Ngunawal Heritage Aboriginal Consultancy and the Koomurri Ngunawal Aboriginal Corporation which are both registered under your name.

If you have any further questions please don’t hesitate to contact me.

Regards,
Rebecca Newell

Archaeologist

Sydney, Newcastle and Brisbane.

EMGA Mitchell McLennan

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20 Chandos Street
St Leonards NSW 2065
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St Leonards NSW 1590
T 02 9493 9500 | [redacted] F 02 9493 9599
www.emgamm.com

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Rebecca Newell

From: [redacted] on behalf of Glen Freeman

Sent: Thursday, 2 April 2015 1:49 PM
To: Rebecca Newell
Subject: RE: Confidentiality Deed Boral Cement

Hi Rebecca,

As you well know my stance on outsiders working on Ngunawal Country without permission from us, according to
Ancient Tradition, I am requesting of you to be only rostered to work with people of Ngunawal Descent, or at the
very least those of Gunndangurra or Narigo Descent as these people are the only people that we have shared
Country with in the aspects of hunting and gathering according to Ancient Tradition, although in the matters of
Bunan(Initiation Ceremony) all Peoples of the Local Country and it's immediate surrounds gathered together for
this purpose.

I can only hope you understand my purpose for this in the context of Aboriginal Politics which it would appear there is a distinct lack of understanding of these matters. Please understand this is not a personal criticism of you, it is what it is
so to speak; all Ancient Traditions will die out if somebody doesn't make a stand and as I come from an age of the old
school way of doing things as opposed to the so called furphy of Political Correctness.... Assimilation and Reconciliation
which are more aligned with the false science of Eugenics than any sense of Fairness and Equality in this Land.

In wonder I ask what is it that Boral are doing to end the illegal and apartheid practices of the Federal Government in the Northern Territory in Regards to false Allegations to enforce the Intervention there? Not to mention
what is happening in the Racist State of WA will your Organisation be tendering for work when the people are iliegally
and forcibly removed from their Ancestral Lands?

You may be asking yourself why have I sent you this email Rebecca? it is not to be critical of you in any way but to in
some small way, hopefully purvey some understanding that there is always a larger agenda to Aboriginal Politics than people
in privileged positions can understand. I do this with a view to help those who are not of this same mind to gain some understanding of the way in which our social and political structures are impacted by the enforced political agendas of others outside those structures.

When you said to me about the number of RAP's registered for this project and that you had to be Fair to all, you completely missed my point, in regards to who belongs to and on Ngunawal Country, a false and tokenistic sense of Fairness has no place in Aboriginal Politics, what about Fairness to us as the Local Custodians of and on our Country.

I have no respect or confidence in the DECWW2010 legislation, indeed I view it as an excuse for not doing the right thing by the Local Custodians of this our Dhawra(Land) of we the People the Ngunawal.

With sincere regards
Glen

From: [redacted]
To: [redacted]
Date: Thu, 2 Apr 2015 08:18:30 +1100
Subject: RE: Confidentiality Deed Boral Cement

Hi Glen,

Thank you very much. Hope all is well.

Regards,
Rebecca Newell
Archaeologist

Sydney, Newcastle and Brisbane.

EMM
EMGA Mitchell McLennan

Ground Floor, Suite 01
20 Chandos Street
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St Leonards NSW 1590
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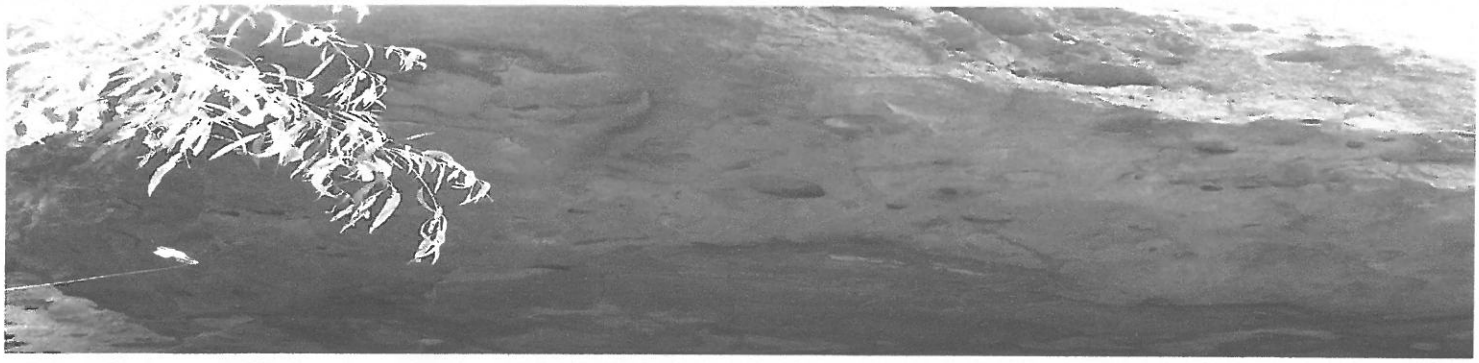
From: [redacted] **On Behalf Of** Glen Freeman
Sent: Wednesday, 1 April 2015 11:14 AM
To: Rebecca Newell
Subject: Confidentiality Deed Boral Cement

Hi Rebecca

Please find attached signed document as requested.

Glen



Gulgunya
Ngunawal Heritage Aboriginal Consultancy

Through unbroken links from our Ancestors, Mother Earth, Father Sky, Family Spirituality and Language in the oral tradition of our lore and the commune With the elements over many tens of thousands of years in north west, south east NSW and the ACT establishes our connection to all tangible and intangible Matters of Culture, Earth, Land, and Country (Dhawra) of Ngunawal People.

Marulan South Limestone Mine

Continued Operations Project

C/O EMGA Mitchell Mclennan Pty Ltd

Po Box 21, St Leonards, NSW, 1590

FAX: 0293939539

To Whom It May Concern,

Gulgunya Ngunawal Heritage Aboriginal Consultancy (GNHAC) ***are contacting your organisation as the agent for the proponent Boral Cement Ltd (Boral) Location: Marulan South to Register Our Interest in the Project Re: Marulan South Limestone Mine Continued Operations.***

Yours Sincerely,

Glen (Gilan) Freeman

Glen Freeman
Principal/Contact
ABN: 4816 6886 533

[redacted]

[redacted]

[redacted]

Rebecca Newell

From: Darlene Hoskins-McKenzie [redacted]
Sent: Thursday, 19 February 2015 4:52 PM
To: Rebecca Newell
Subject: Re: Invitation for registration

Good afternoon Rebecca Newell

Could you please register my name, Darlene Hoskins-McKenzie (trading as Gunyuu) for consultation in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW 2010).

My details are follows:

Name: Darlene Hoskins-McKenzie

Address: [redacted]

Email: [redacted]

Contact Mobile: [redacted]

Please note that I do not wish for my details to be released or forwarded to relevant Local Aboriginal Land Councils or OEH.

And secondly my preferred method of contact is by email as noted above.

Kind regards
Darlene Hoskins- McKenzie

On Thursday, 19 February 2015, Rebecca Newell [redacted] wrote:

Hi Darlene,

Please find attached an invitation to register for the Marulan South Limestone Mine Continued Operations project.

If you have any questions please don't hesitate to contact me.

Regards,

Rebecca Newell

Archaeologist

Sydney, Newcastle and Brisbane.

EMM
EMGA Mitchell McLennan

Ground Floor, Suite 01

20 Chandos Street

St Leonards NSW 2065

PO Box 21

St Leonards NSW 1590

T 02 9493 9500 | [redacted] | F 02 9493 9599

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Rebecca Newell

From: Jamie Wharemate
Sent: Wednesday, 11 March 2015 10:56 AM
To: Rebecca Newell
Cc: [redacted]
Subject: FW: King Browns Tribal Group

Hi Rebecca,

Please find below an email from Tina Williams, for some reason she email wouldn't send to your email address.

Thanks

Jamie

From: Tina [redacted]
Sent: Wednesday, 11 March 2015 10:55 AM
To: Jamie Wharemate
Subject: FW: King Browns Tribal Group

Please pass onto to Rebecca Newell, thank you.

From: Tina
Sent: Wednesday, 11 March 2015 10:49 AM
To: [redacted]
Subject: King Browns Tribal Group

Hi Rebecca

On behalf of my Father I would like to put forward his expression of interest for the upcoming heritage works. My father is a Ngunnawal Elder and holds lots of knowledge around our heritage and has worked on many projects in the past with private clients and Government agencies. His name is Carl Brown and his contact number is 0414 283 216 or you can also send information for my Father to this email. Thank you kindly.

Tina Williams
Training Manager
Habitat Personnel Indigenous Specialist
Vocational Training Employment Centre





[redacted]



Download our APP

Koomurri Ngunawal  Aboriginal Corporation

Marulan South Limestone Mine
Continued Operations Project
C/O EMGA Mitchell Mclennan Pty Ltd
Po Box 21, St Leonards, NSW, 1590
Fax: 0293939539

2nd February 2015

Culture Language Knowledge Spirituality Identity Family

As part of the oldest and continuous living culture in human history Aboriginal spiritual and cultural heritage is recognised and valued as a unique and essential component of the identity of all Australian people. Having occupied the ACT and NSW landscape for more than 42 000 years knowledge of important spiritual and cultural places and meanings resonate throughout this landscape. Aboriginal cultural and spiritual heritage also lives in the memories and oral histories, stories and associations of Aboriginal people to their traditional land and connection to country.

Aboriginal spiritual and cultural heritage through family, language, ceremony and education, as well as the ongoing custodianship of the ecology of the land, mother earth, is an essential and vital part of Aboriginal peoples spiritual and cultural identity, connection and sense of belonging to country. The ongoing effective protection and conservation of this cultural and spiritual heritage is of utmost importance in maintaining the identity, health, spiritual and cultural well being of Aboriginal people.

Registration of Interest – Marulan South Limestone Mine Continued Operations Project

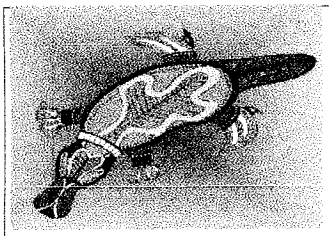
To Whom It May Concern,

As the contact person for the Koomurri Ngunawal Aboriginal Corporation I am contacting you to register our expression of interest for the above Project.

Looking forward to consulting with you on this Project.

With Regards

Glen(Gilan) Freeman
Director/Contact / Ph: [redacted]
Koomurri Ngunawal Aboriginal Corporation (KNAC)
ICN:7812 Email:[redacted]
[redacted]



Murra Bidgee Mullangari Aboriginal Corporation

Cultural Heritage
ICN: 8112

23/02/2015

Attention: Rebecca Newell
EMGA Mitchell McLennan
P.O Box 21,
St Leonards NSW 1590
Email: [redacted]

Re:Marulan Sth Limestone Mine continued operations project

Dear Rebecca,

Thank you for your letter dated 19th February 2015. Our Corporation would like to register as an interested group for this project. I would also like to request to be contacted by email as the official method of contact. Please let me know if you require further information.

Regards

Darleen Johnson

[redacted]
Phone: [redacted]
[redacted]

Rebecca Newell

From: shaun carroll [redacted]
Sent: Monday, 23 February 2015 5:24 PM
To: Rebecca Newell
Subject: Marulan South Limestone Mine Continued Operations Project
Attachments: rebecca Newell.pdf

Hi Rebecca,
Please find attached our letter to register as an interested party. If you require further details please contact me.
Regards
Darleen
Murra Bidgee Mullangari Aboriginal Corporation

Rebecca Newell

From: Shaun Carroll [redacted]
Sent: Tuesday, 24 February 2015 9:20 PM
To: Rebecca Newell
Subject: Marulan South Limestone Continued Operations Project
Attachments: merrigarn acceptance letter EMM.pdf

Dear Rebecca,
Please find attached our letter of registration
Regards
Shaun Carroll

Merrigarn Indigenous Corporation

Cultural Heritage

ICN:8128

24/2/2015

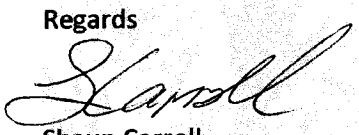
Attention: Rebecca Newell

EMGA Mitchell McLennan
P.O.Box 21
St Leonards NSW 1590

Dear Rebecca,

Our members at the Merrigarn Indigenous Corporation would like to submit an expression of interest in being involved in the consultation for the Marulan South Limestone Project. Please send all correspondence to my email address. If you require further details please contact me.

Regards



Shaun Carroll

[redacted]

[redacted]

Ngunawal Heritage
Aboriginal Corporation

[redacted]
ICN 4755
ABN 31494344309

8 February 2015

Rebecca Newell
EMGAMM Pty Ltd
Ground Floor Suite 01
20 Chandos Street
St Leonards NSW 1590

RE: Marulan South Limestone Mine Continued Operations Project

Dear Rebecca,

We are pleased to express our interest in participating in the proposed Marulan South Limestone Mine Continued Operations Project.

Our consultants are passionate about their Aboriginal heritage and are dedicated to working with Governments, proponents, archaeologists and other aboriginal organisations to ensure that Aboriginal objects and places with Aboriginal cultural heritage significance are appropriately protected.

All our consultants have completed the WorkCover course in OHS General Induction for Construction Work in NSW and we also have current certificates of Public Liability and Workers Compensation Insurances.

Previous Experience

Our consultants have extensive experience in Aboriginal heritage assessment work. Members have worked on a variety of sites around the Canberra and South Eastern New South Wales region and have helped to identify many different types of objects and places with Aboriginal cultural heritage significance.

Project involvement has included but not limited to:

- Eastern Gas Pipeline between Melbourne, Canberra and Sydney – Duke Energy
- Department of Defence Headquarters Joint Operations Project, Queanbeyan – URS and Leightons Contractors
- Marulan South Quarry Project for the Construction of 2 Dams – Blue Circle Southern Cement
- Coolac By-Pass, Hume Highway – RTA
- Fibre Optic Cabling, Yass – Telecom
- Edwin Land Drive, Jerrabomberra – RTA
- Gounyan Curves, Yass – RTA
- Bungonia State Conservation Area Camp Upgrade – NPWS
- Black Andrew Nature Reserve Wee Jasper – TransGrid
- Wallaroo Rd Gooramon Ponds Hall – United Group Services
- Boral Peppertree Quarry – Marulan
- Wanna Wanna Rd Sub-Division – Captains Flat Queanbeyan
- Highlands Source Project – Goulburn Mulwaree Council

Across these projects, our consultants have typically been involved in the following work:

- Surveying - walking with the archaeologists across the proposed development area within the defined boundaries to identify scattered aboriginal artefacts on top of the soil;
- Marking the identified areas and recording their GPS position;

- Digging spits of specified dimensions at gradual levels until clay is reached;
- Bucketing the contents of each spit and marking each bucket with the spit position;
- Dry sieving and wet sieving to find and identify Aboriginal artefacts;
- Working with the archaeologist to sort and identify genuine Aboriginal artefacts including bagging and marking the artefacts;
- Heavy machinery monitoring (including road graders, bulldozers, trucks etc) - following and monitoring excavations done by heavy machinery and inspecting soil stockpiles to identify aboriginal artefacts that come to the surface;
- Data recording of any artefacts found;
- Providing advice on the cultural significance and values of the objects or places identified;
- Reporting daily finds to relevant Aboriginal stakeholders; and
- Working with archaeologists and proponents to develop preferred site management options.

Connection to the Study Area

Ms Carroll is of Ngunawal descent, being the second youngest child of James Leslie Carroll and Christina Mary Brown. Ms Carroll is 82 years old and grew up on the Aboriginal Reserve (also known as Hollywood mission) in Yass.

All members and consultants of NHAC are also descendants of the Carroll family or spouses of such descendants. Our consultants are passionate about their Aboriginal heritage and are dedicated to working with Governments, proponents, archaeologists and other aboriginal organisations to ensure that Aboriginal objects and places with Aboriginal cultural heritage significance are appropriately protected.

In 1998, Dr Nicolas Peterson, senior lecturer at the ANU Anthropology Department, prepared a genealogy report on the Ngunawal and Wiradjuri people for the ACT Chief Minister's Department. The report confirms Ms Carroll's Ngunawal descent and her status as a Ngunawal Elder.

Being of Ngunawal origin, Ms Carroll has a connection with the land in the ACT and surrounding districts. The Ngunawal people have a traditional connection with the land across a wide area including the Australian Capital Territory, Queanbeyan, Braidwood, Cooma, Tumut, Goulburn, Yass, Gundagai and Murrumburrah.

We look forward to your response and working with you on this project and if you require any further information please do not hesitate to contact me.

Kind Regards

Dean Delponte
Director

Rebecca Newell

From: Ngunawal Heritage Aboriginal Corporation [redacted]
Sent: Sunday, 8 February 2015 4:38 PM
To: Rebecca Newell
Cc: Makin, Sharon
Subject: Marulan South Limestone Mine Continued Operations Project
Attachments: NHAC_Letter_Rebecca_Newell_EMGAMM_08.02.15.pdf

Hi Rebecca,

Please find attached our Registration of Interest for the proposed Marulan South Limestone Mine Continued Operations Project. If you require any further information please do not hesitate to contact me.

Kind Regards

Dean Delponte
Director
[redacted]

Ngunawal Heritage Aboriginal Corporation
ICN 4755

Rebecca Newell

From: Jodie Stewart [redacted]
Sent: Saturday, 28 February 2015 12:18 AM
To: Rebecca Newell
Subject: Registration of interest

Nundagurri formally registers interest in the Marulan South Limestone Mine Continued Operations project.

Regards

Aaron Broad
Nundagurri

Rebecca Newell

From: Pejar LALC [redacted]
Sent: Monday, 23 February 2015 11:03 AM
To: Rebecca Newell
Subject: Continued Expression of Interest - Boral

Good Morning Rebecca

Please accept this email as Pejar LALCs continued expression of Interest in the Marulan Limestone Quarry. We have been fully involved in this project since its initial inspections and would like to continue to be involved.

Our Contact details are:

Delise Freeman
CEO
Pejar LALC
[redacted]
Email: [redacted]

If there is any further information that you may require or wish to discuss something further , then please do not hesitate to contact me on the numbers listed above.

Yours sincerely

Delise Freeman
CEO

Rebecca Newell

From: Peter Falk[redacted]
Sent: Friday, 27 February 2015 12:56 PM
To: Rebecca Newell
Subject: Marulan South limestone Mine Continued Operations Project

Hi Rebecca,
I wish ti be registered for the above project as I have worked on the site of the Limestone Mine before.
my contact details are:
Peter Falk

Peter Falk Consultancy
[redacted]

[redacted]

Regards
Peter
Peter Falk Consultancy
[redacted]

THUNDERSTONE
Aboriginal Cultural & Land Management Services
ABN: 33 861 394 646



EMGA Mitchell McLennan
C/- Ryan Desic
PO Box 21
ST LEONARDSNSW1590

We wish to lodge an expression of interest for:

ABORIGINAL CULTURAL HERITAGE ASSESSMENT – MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS PROJECT, MARULAN SOUTH

We offer the following information in support of our expression of interest in relation to Aboriginal Cultural Heritage:

Organisation:	Thunderstone Cultural & Land Management Services Aboriginal Corporation (Thunderstone)	
Name:	Mr Tyronne Bell	
Contact Details:	Postal Address: Phone: Email:	[redacted]

Thunderstone represents the Ngunawal people who are the Traditional Custodians for this area and all members are of direct Ngunawal descent. The Ngunawal people are the Indigenous Australian inhabitants whose traditional lands encompass much of the area now occupied by the city of Canberra and the surrounding Australian Capital Territory.

When first encountered by European settlers in the 1820s, the Ngunawal people lived in an area roughly bounded by what is now the towns of Braidwood, Goulburn, Boorowa, Harden, Gundagai and Cooma. The Ngunawal people are neighbours of the Yuin (on the coast), Ngarigo (south east of Canberra), Wiradjuri (to the west of Yass) and Gundungurra (to the north) peoples.

As the Traditional Custodians we possess knowledge of local Ngunawal Aboriginal cultural heritage sites and customs. The qualifications and previous experience that we have in Aboriginal cultural heritage assessment work has come from over 29year's experience working on projects that take place within the Ngunawal peoples traditional lands, which is arbitrary, in both urban and rural situations.

As Traditional Custodians we have a cultural connection with the proposed project area and wish to participate in the program, we also hold cultural knowledge relevant to determining the cultural significance of objects and places in the project area.

Being part of the consultative/planning process will ensure that the proper protection and preservation of our culture and heritage continues.

We are able to provide supporting/additional documentation if required.

Mr Tyronne Bell (Ngunawal Traditional Custodian)
Director

16 February 2015

[redacted]

Rebecca Newell

From: Tyronne Bell [redacted]
Sent: Monday, 16 February 2015 2:48 PM
To: Ryan Desic
Cc: Rebecca Newell
Subject: EOI- Aboriginal Cultural Heritage Assessment – Marulan South Limestone Mine Continued Operations Project
Attachments: Thunderstone Cultural Heritage Assessment - Expression of Interest South Marulan Mine Continued Operations Project Feb 2015.docx

Hi Ryan

Please find attached Thunderstone's Expression of Interest for the above cultural heritage assessment project.

I note in the EOI advertisement that the names of registered Aboriginal parties will be passed on to the relevant local Aboriginal land council. Thunderstone respectfully requests that our name/details are not passed on to any local Aboriginal land councils.

I can be contacted on the number below if you wish to discuss.

Kind regards

Tyronne Bell
Thunderstone Aboriginal Cultural and Land Management Services
[redacted]

Rebecca Newell

From: hika te-kowhai [redacted]
Sent: Saturday, 28 February 2015 12:16 AM
To: Rebecca Newell
Subject: Registration of interest.

Walbunja formally registers interest in the Marulan South Limestone Mine Continued Operations project.

Regards

Hike Tekowhai
Walbunja

Rebecca Newell

From: Leroy Boota [redacted]
Sent: Friday, 27 February 2015 11:46 AM
To: Rebecca Newell
Subject: registration of interest

Hi its leeroy boota.Wullung would like to register a interest for the aboriginal consultation for the Marulan south limestone mine continued operations project.wullung
contact e-mail :[redacted]
Phone:[redacted]
Address:[redacted]

Rebecca Newell

From: Leroy Boota [redacted]
Sent: Monday, 6 April 2015 1:42 PM
To: Rebecca Newell
Subject: Marulan South Limestone Mine Continued Operations - inception meeting and induction

Hi Rebecca

Wullungs rep is Leroy boota of [redacted]

I has worked with workforce international on the bypass at gerringong,bypass gerringong to fox ground,fox ground to berry and Albion park bypass over the last 7 years.

Also I'm waiting for my worker comp policy from gio because of the public holiday and long week end.
I should receive it by Wednesday if that's ok but have public liability policy number below

Public liability insurance :**GS00407326**

Thank you
Leeroy boota

On Thursday, April 2, 2015, Leroy Boota [redacted] wrote:
Thank you

On 4/2/15, Rebecca Newell <rnewell@emgamm.com> wrote:
> Hi Leeroy,
>
> That is fine, please send them through on Monday.
>
> Regards,
> Rebecca Newell
> Archaeologist
>
> Sydney, Newcastle and Brisbane.
>
>
> Ground Floor, Suite 01
> 20 Chandos
> Street
>
> St Leonards NSW
> 2065
>
> PO Box
> 21
>
> St Leonards NSW 1590
>
> T 02 9493 9500 | [redacted] | F 02 9493 9599

> www.emgamm.com
> Π Please consider the environment before printing my email.
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> information herein if you are not the intended recipient.
>
>
> -----Original Message-----
> From: Leroy Boota [redacted]
> Sent: Thursday, 2 April 2015 4:10 PM
> To: Rebecca Newell
> Subject: Re: Marulan South Limestone Mine Continued Operations - inception
> meeting and induction
>
> Hi Rebecca
>
> I wont be able to send anything untill Monday due to I don't have a
> key to wullung office and other board members are on holiday and
> return Monday.
>
> Thank you
> Leeroy boota
>
> On 3/31/15, Rebecca Newell <rnewell@emgamm.com> wrote:
>> Hi Leeroy,
>>
>> Thank you for your signed fieldwork agreement. I have attached the
>> confidentiality agreement which still needs to be signed. We also need a
>> couple of other things:
>>
>> - Public liability insurance;
>>
>> - Workers compensation insurance; and
>>
>> - Information on the experience of your fieldwork
>> representatives
>> including previous survey work.
>>
>>
>> Regards,
>> Rebecca Newell
>> Archaeologist
>>
>> Sydney, Newcastle and Brisbane.
>> [cid:image001.png@01D06B8D.7839D080]
>>
>> Ground Floor, Suite 01
>> 20 Chandos Street
>> St Leonards NSW 2065

>> PO Box 21
>> St Leonards NSW 1590
>> T 02 9493 9500 | [redacted] | F 02 9493 9599
>> www.emgamm.com<http://www.emgamm.com/>
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>> information herein if you are not the intended recipient.
>>
>> From: Leroy Boota [redacted]
>> Sent: Monday, 30 March 2015 1:27 PM
>> To: Rebecca Newell
>> Subject: Re: Marulan South Limestone Mine Continued Operations -
>> inception
>> meeting and induction
>>
>> Hi Rebecca
>>
>> I have handed in the confidentiality agreement in.Do I need to send any
>> information about who will be working for Wullung.
>>
>> Thank you
>> Leeroy boota
>>
>> On Tuesday, March 24, 2015, Rebecca Newell
>> [redacted] wrote:
>> Hi all,
>>
>> Just a reminder that the inception meeting and induction for the Marulan
>> South Limestone Continued Operations Project is on tomorrow from 12 –
>> 4pm.
>> We look forward to seeing many of you there and if you are unable to make
>> it
>> we will be updating you after the meeting.
>>
>> Please remember to either email me a signed confidentiality agreement or
>> bring it to the meeting tomorrow.
>>
>> Any last minute questions please feel free to call [redacted]
>>
>> Regards,
>> Rebecca Newell
>> Archaeologist
>>
>> Sydney, Newcastle and Brisbane.

>> [cid:image001.png@01D06B8D.7839D080]
>>
>> Ground Floor, Suite 01
>> 20 Chandos Street
>> St Leonards NSW 2065
>> PO Box 21
>> St Leonards NSW 1590
>> T 02 9493 9500 | [redacted] | F 02 9493 9599
>> www.emgamm.com<http://www.emgamm.com/>
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>>
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>> transmission. If you have received this email in error, or are not the
>> intended recipient, please notify the sender immediately and delete this
>> email from your computer. You must not disclose, distribute, copy or use
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>> information herein if you are not the intended recipient.
>>
>>
>

Rebecca Newell

From: Nicolas Wade Glover [redacted]
Sent: Saturday, 28 February 2015 12:22 AM
To: Rebecca Newell
Subject: Registration of interest

Yerramurra formally registers interest in the Marulan South Limestone Mine Continued Operations project.

Regards

Nicholas Glover
Yerramurra

16 March 2015

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

www.emgamm.com

Jackie Taylor
Team leader Aboriginal Heritage South East Regional Operations Group
Office of Environment and Heritage
PO Box 733
Queanbeyan NSW 2620

Re: Registered Aboriginal parties for the Marulan South Limestone Mine Continued Operations Project

Dear Jackie,

In accordance with section 4.1.6 of the *Aboriginal cultural heritage consultation requirements for proponents* (the guidelines) (DECCW 2010) the Office of Environment and Heritage (OEH) is hereby notified that a total of 18 Aboriginal parties responded to either an advertisement or an invitation sent in accordance with the guidelines for the Marulan South Limestone Mine Continued Operations Project (client Boral Property Group Pty Limited). The forms of notification are attached.

The 18 registered Aboriginal parties (RAPs) are listed below bar the two groups who requested that their details not be released.

Table 1 List of RAPs for the Marulan South Limestone Mine Project

Organisation	Contact name	Contact details
Pejar Local Aboriginal Land Council	Delise Freeman	[redacted]
Mr Peter Falk Consultancy	Peter Falk	
Buru Ngunawal Aboriginal Corporation	Walter Bell	
Gundungurra Aboriginal Heritage Association Inc	Sharyn Halls	
King Brown Tribal Group	Carl Brown	
Koomurri Ngunawal Aboriginal Corporation	Donna Dobson	

Table 1 List of RAPs for the Marulan South Limestone Mine Project

Organisation	Contact name	Contact details
Corroboree Aboriginal Corporation	Steve Johnson	[redacted]
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	

If you have any questions or would like to discuss the information further please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

16 March 2015

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

www.emgamm.com

Delise Freeman
CEO
Pejar Local Aboriginal Land Council
[redacted]

Re: Registered Aboriginal parties for the Marulan South Limestone Mine Continued Operations Project

Dear Delise,

In accordance with section 4.1.6 of the *Aboriginal cultural heritage consultation requirements for proponents* (the guidelines) (DECCW 2010) the Pejar Local Aboriginal Land Council is hereby notified that a total of 18 Aboriginal parties responded to either an advertisement or an invitation sent in accordance with the guidelines for the Marulan South Limestone Mine Continued Operations Project (client Boral Property Group Pty Limited). The forms of notification are attached.

The 18 registered Aboriginal parties (RAPs) are listed below bar the two groups who requested that their details not be released.

Table 1 List of RAPs for the Marulan South Limestone Mine Project

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Gundungurra Aboriginal Heritage Association Inc	Sharyn Halls	
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Table 1 List of RAPs for the Marulan South Limestone Mine Project

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Wullung	Leeroy Bota	
Badu	Karia Bond	
Yerramurra	Nicholas Glover	
Merrigarn Aboriginal Corporation	Shaun Carroll	
Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman	

If you have any questions or would like to discuss the information further please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

A.3 Stages 2 and 3 – presentation of information and gathering cultural information

This section contains the following documents:

- project information and draft assessment methodology letters;
- meeting slides for the first Aboriginal consultation meeting held on 25 March 2015; and
- RAP comments to the proposed methodologies and EMM responses.

13 March 2015

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

www.emgamm.com

Re: Marulan South Limestone Mine Continued Operations project: Aboriginal cultural heritage assessment, presentation of information, draft assessment methodology and request for cultural information.

Dear Registered party,

1 Introduction

Thank you for registering your interest in being consulted on Aboriginal cultural heritage matters for the Marulan South Limestone Mine Continued Operations project (the project). EMGA Mitchell McLennan Pty Limited (EMM), on behalf of Boral Cement Limited (Boral), is preparing an Aboriginal cultural heritage assessment (ACHA) for the project.

This letter presents information on the project and describes a draft ACHA method for your review and comment. We welcome your written feedback at your earliest opportunity, and no later than **10 April 2015**. **Letters attached to email is the preferred mode of written communication as it will reduce postal waiting periods.** This document is provided in accordance with sections 4.2 and 4.3.1 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*, which is the Aboriginal consultation framework for the project.

For those registered parties who are sole traders we will only accept responses from the sole trader nominated as part of the registration.

2 Aboriginal heritage values

If you are aware of any other form of Aboriginal heritage values (which might include archaeological sites or other types of values), please let us know so that we can take these values into account in the assessment. We would welcome any statement that describes how the land might be significant.

We invite you to include the following in a letter:

- how the project area land is significant to Aboriginal people; and
- your views on the site survey method described below.

Please respond by email, letter, fax as soon as possible and no later than **10 April 2015** to allow us to take all values into account in the Aboriginal heritage impact assessment. We will ensure that the information presented to us is kept confidential where it is demonstrated that confidentiality is required.

2.1 Identifying non-archaeological Aboriginal heritage values

2.1.1 Background

Non-archaeological Aboriginal heritage values refer to places which have meaning in accordance with memory or tradition but not necessarily associated with cultural objects. Natural features of the landscape may figure in traditional stories; places may be associated with historical resource use; areas may have been used as historical fringe camps; and an area may have figured within a known traditional pathway. All such values can only be identified through archival research or interview with Aboriginal people with Aboriginal cultural knowledge.

2.1.2 Request for cultural information

In accordance with Section 4.3 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010,* EMM is seeking cultural information about the study area from registered Aboriginal parties (RAPs).

Aboriginal heritage incorporates a wide range of values such as stories, traditions and cultural practices. EMM welcomes any advice from the Aboriginal community about any form of Aboriginal heritage values (which might include archaeological sites or other types of values) relevant to the study area.

EMM is relying on the Aboriginal community for advice on non-archaeological Aboriginal values for the study area. We are happy to meet to discuss any information which you may be willing to share, and will respect confidentiality where requested. Email is our preferred method of communication (see contact details at the end of this letter) but we will also accept letters and faxes, and information given in person during one of the project meetings planned over the coming months.

Knowledge of areas of cultural significance may include, but are not limited to:

- sites or places associated with ceremonies, spiritual/mythological beliefs and traditional knowledge, which date from pre-contact period; these activities do not have to have persisted until the present time;
- sites or places associated with historical associations, which date from the post-contact period and are remembered today (e.g. plant and animal resource use areas and known camp sites); and
- sites or places of contemporary significance, for which the significance has been acquired in recent times.

3 Project overview

3.1 Study area

The mine is located in Marulan South, 10 kilometres (km) southeast of Marulan village, 35 km east of Goulburn and 50 km southwest of Moss Vale, within the Goulburn Mulwaree Local Government Area (LGA) in the Southern Tablelands of NSW (**Figure 1**).

3.2 Project components

Boral owns and operates the Marulan South Limestone Mine. It is an open cut mine that has produced limestone and lime-based products for the cement, steel, agricultural and construction markets for over a century. Boral is seeking approval for continued operations at the mine through a development application for a State Significant Development, which includes a 30 year mine plan, associated overburden emplacement areas and a mine water supply dam (Figure 1).

4 Archaeological background

Previous archaeological investigations in the Boral mine lease have identified a total of 17 Aboriginal sites. These sites include isolated finds and open artefact scatters. The majority of these sites were located in the western portion of the mine lease area.

The results from the regional and local studies have indicated that the most common Aboriginal site types are open artefact scatters and isolated finds. These sites are usually found in relation to water with site size and frequency dependant on the distance to the water source.

5 Draft assessment methodology

5.1 Overview

It is anticipated that the Secretary's Environmental Assessment Requirements (SEARs) for the project will stipulate the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (the guidelines — DEC 2005) as the ACHA framework. As stipulated in the 2005 guidelines, the *Aboriginal Cultural Heritage Standards and Guidelines Kit* (guidelines kit) (DEC 1997) provides the framework for the archaeological assessment component of the ACHA. The more recent *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010a) will also be used as a model because it encapsulates and expands on many features of the guidelines kit.

A draft method is suggested here for your review and comment. We welcome your feedback at your earliest opportunity but no later than **10 April 2015.**

The purpose of the assessment is to identify the Aboriginal heritage values of all areas that will be affected by the continued mining operations. Aboriginal heritage values will be identified from the following methods:

- consultation with registered Aboriginal parties to identify social values of the study area and places of special significance that should be considered;
- a search of the Aboriginal Heritage Information Management System (AHIMS - Aboriginal sites register) for records of previously registered Aboriginal sites (a completed search has not identified any previously recorded sites within the study area);
- a review of past Aboriginal heritage reports covering the study area;
- a review of environmental characteristics to develop a landscape map of possible archaeological site location; and
- an archaeological inspection or survey with Aboriginal stakeholders focusing on landform transects in impact areas; and if indicated by the previous steps
- an archaeological test excavation focusing on characterising the archaeological potential of impact areas.

5.2 Aboriginal consultation

It is anticipated that the SEARs will stipulate the DEC 2005 guidelines as the project consultation requirements.

The guidelines make reference to the *National Parks and Wildlife Act 1974: Part 6 Approvals Interim Community Consultation Requirements for Applicants* (ICCRs — DEC 2004) as providing 'guidance' on the process. The ICCRs and their successor, the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010b) were established for applications for approvals under Part 6 of the *National Parks and Wildlife Act 1974*. Part 6 approvals are not required for the project as it is a State Significant Development.

The procedures in the 2010 consultation guidelines will however, also be used in this assessment. Therefore, whilst the 2005 guidelines are the statutory requirement for Aboriginal consultation for the project, the 2010 guidelines are referred to as a model as they capture all the required steps.

In accordance with the 2010 guidelines, each private Aboriginal organisation or individual who responded with a written request to be registered for consultation is referred to as a RAP. Government agencies who registered interest will also be consulted in parallel with RAPs.

5.3 Meetings

A meeting between RAPs, EMM and Boral is scheduled to **occur on 25 March 2015 from 12pm - 4pm.** The meeting place is the Marulan South Limestone Mine administration building (map attached). The aim of this meeting will be to present further details about the project and discuss the implications for Aboriginal cultural heritage values in the study area.

Subsequent meetings are anticipated after fieldwork results have been compiled and then soon after a draft ACHA has been distributed to RAPs for comment.

5.4 Confidentiality

Boral will require a confidentiality agreement to be signed to work on the project. Each RAP must sign the provided confidentiality agreement and return it before the meeting on 25 March 2015.

5.5 Field survey

5.5.1 Overview

An Aboriginal heritage field survey strategy has been prepared to target all landforms with high to moderate potential for Aboriginal sites and capture a representative sample of other landform units. The aim of the archaeological survey is to identify Aboriginal sites and areas of potential archaeological deposit (PAD). Only those areas with Aboriginal objects will be recorded and reported as Aboriginal sites and areas of PAD will be recorded as possessing 'archaeological sensitivity'. Other places or features of interest will be noted in the ACHA.

5.5.2 Field survey strategy

A pedestrian field survey is proposed, led by EMM's archaeologists and involving RAP representatives. The surveys will take place over approximately two weeks. A series of survey tracks (transects) will be walked and form a sample of the key landform classes and important geological units divided broadly into sandstone, shale and volcanic areas. Survey coverage will be directed towards areas of potential impact,

The survey will inspect all areas of ground within survey transects which will be covered by survey participants spread out across a c. 50 m path where possible. All mature trees will be inspected for scars of Aboriginal origin and areas relevant stone outcrops inspected for grinding grooves. It is expected that visibility in paddocks and heavily vegetated areas will be constrained so transects will aim to target areas of exposures within these areas e.g. vehicle or cattle tracks. All Aboriginal sites will be marked through flagging and then GPS waypoint recording by an archaeologist.

Survey transects will be undertaken with reference to a survey plan that will be prepared prior to fieldwork. The survey effort will generally follow predetermined transects comprised of discrete landform units that have been identified using topographic maps. However, there will be provision for changes to the survey plan once on site, to account for inaccessible areas or where landform units, unfruitful for the survey effort, are identified.

Reconnaissance and additional recording of some previously recorded Aboriginal sites in the project area will be incorporated into the survey, where there may be potential impacts to these sites.

For areas not covered by survey, a predictive assessment, or predictive model of site location, will be made based on the results for the surveyed areas. Reliability of the predictive model will be dependent on the outcomes of the fieldwork.

A letter will be distributed in the coming days setting out upcoming fieldwork dates, arrangements for representative involvement, essential safety requirements and payment details. Equivalent letters will be distributed for all future fieldwork.

5.5.3 Landform division for sampling

The survey will cover extensive areas as a continuous series of transects covering a representative sample of landform elements across the study area. The broad spread of landforms anticipated comprises:

- watercourses — generally second order (Strahler System) and above, including their near banks;
- open depressions — such as ephemeral drainage lines dissecting slopes or open depressions eroded by sheet wash;
- slopes — comprising simple, upper, mid and lower slopes;
- flat — such as alluvial floodplains, terraces and valley floors;
- spur crests;
- ridge tops — comprising ridge crests and saddles; and
- cliff/scarp — comprising the head and foot of the cliff/scarp and its slope if accessible.

Survey units will reference the landform units listed above in conjunction with the underlying geology of the area, comprising the Bungonia Limestone Group including limestone, sedimentary rocks and volcanic rocks. It is expected that landform elements, when paired with the underlying geology, will provide greater understanding of Aboriginal site location and assist in predictive modelling.

5.6 Test excavation

If the outcomes of the assessment support it, up to two weeks of test excavation under the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (the Code – DECCW 2010) are anticipated.

The aim of the test excavation would be to determine whether Aboriginal objects (such as stone artefact sites) are present beneath the ground surface through archaeological excavation using a systematic sample of test pits. The test excavation will involve a series of between 50 cm^2 and 100 cm^2 test pits in transects in areas of potential archaeological deposit (Figure 1). Some variation to the method may be made dependant on the areas of potential and consultation.

If Aboriginal objects are identified, excavation must continue to the extent where enough data are retrieved to allow an assessment of their cultural significance and to characterise the landscape. The resulting information will be combined with the results of the survey and serve as the basis of the ACHA

report and would assist in identifying the type of archaeological management appropriate to the nature of the archaeological deposits and their significance.

5.7 Post-fieldwork

After fieldwork, a draft report will be prepared by EMM. Each RAP will be invited to submit relevant information on Aboriginal heritage values which will be addressed in the report after which each group (or individual if not part of a group) will be issued with a draft report for review and comment. EMM and Boral intend to hold a meeting with RAPs when all stages of the survey have been completed to review the results and consider the most appropriate mitigation measures from a cultural and archaeological perspective. All comments will be addressed in the final report.

6 What's next?

We look forward to receiving any response your organisation wishes to make about the proposed methodology by **10 April 2015.** Your response will be documented and considered for the assessment. Most importantly, your cultural information is also welcome within this timeframe but it can also be submitted up until the completion of the draft ACHA.

EMM will be contacting RAPs shortly with an additional letter of invitation to apply for participation in fieldwork.

7 Any questions?

Please feel free to contact me with any questions or queries about the project via email (provided below) or telephone on [redacted]

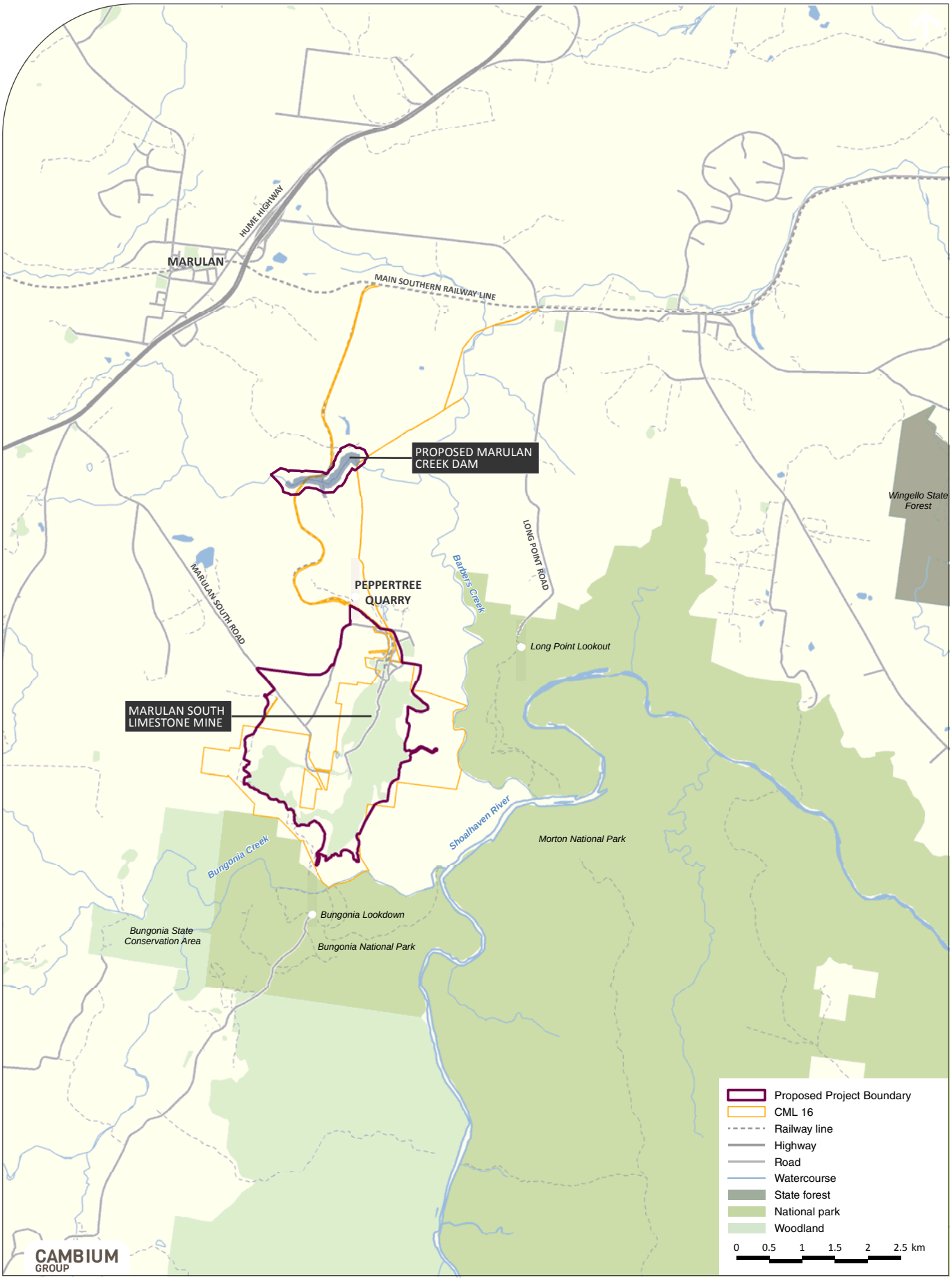
Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

FIGURE 1
Regional context

MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS - SSD APPLICATION



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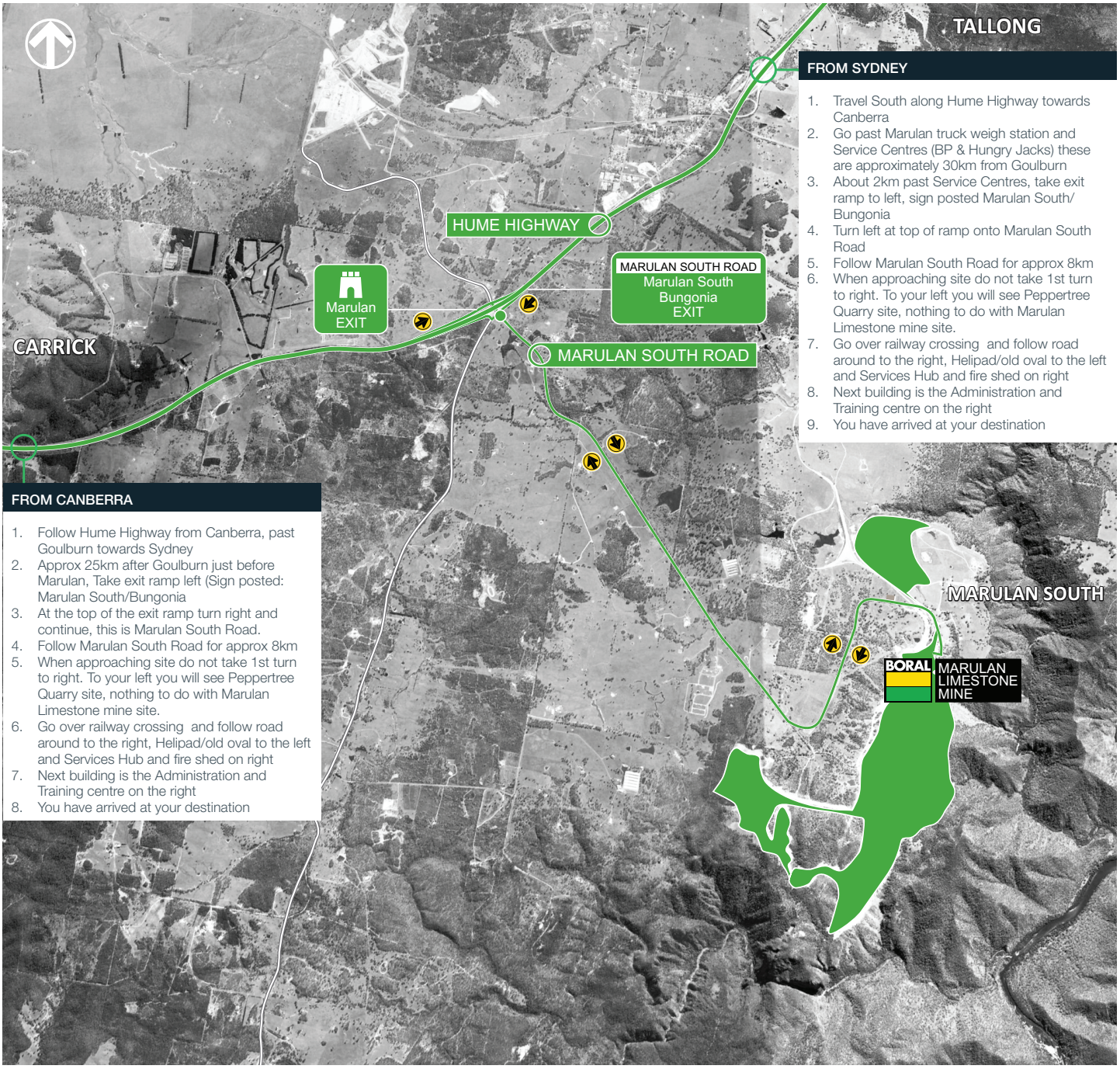
Boral Limited
Build something great ™

Direction to Marulan South Limestone Mine

LOT 4 HUME STREET, MARULAN SOUTH, NEW SOUTH WALES, 2579



FROM SYDNEY

1. Travel South along Hume Highway towards Canberra
2. Go past Marulan truck weigh station and Service Centres (BP & Hungry Jacks) these are approximately 30km from Goulburn
3. About 2km past Service Centres, take exit ramp to left, sign posted Marulan South/ Bungonia
4. Turn left at top of ramp onto Marulan South Road
5. Follow Marulan South Road for approx 8km
6. When approaching site do not take 1st turn to right. To your left you will see Peppertree Quarry site, nothing to do with Marulan Limestone mine site.
7. Go over railway crossing and follow road around to the right, Helipad/old oval to the left and Services Hub and fire shed on right
8. Next building is the Administration and Training centre on the right
9. You have arrived at your destination

FROM CANBERRA

1. Follow Hume Highway from Canberra, past Goulburn towards Sydney
2. Approx 25km after Goulburn just before Marulan, Take exit ramp left (Sign posted: Marulan South/Bungonia
3. At the top of the exit ramp turn right and continue, this is Marulan South Road.
4. Follow Marulan South Road for approx 8km
5. When approaching site do not take 1st turn to right. To your left you will see Peppertree Quarry site, nothing to do with Marulan Limestone mine site.
6. Go over railway crossing and follow road around to the right, Helipad/old oval to the left and Services Hub and fire shed on right
7. Next building is the Administration and Training centre on the right
8. You have arrived at your destination

Planning + Environment + Acoustics

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EMGA Mitchell McLennan

Marulan South Limestone Mine Continued Operations project

Aboriginal stakeholder consultation meeting 1 – Marulan South Limestone Mine 25 March 2015



EMM
EMGA Mitchell McLennan

Acknowledgment

Before we begin the proceedings I would like to acknowledge and pay respect to the traditional owners of the land on which we meet.

I invite a community-nominated person to offer a welcome to country…

Agenda

- Introductions (All)
- Marulan South Limestone Mine Continued Operations project description (RW)
- Aboriginal heritage assessment method (RN)
- Fieldwork plans (RN)
- Questions (All)

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Introductions

- Boral Property Group
  - Rod Wallace (Planning and Development Manager NSW/ATC)
  - Les Longhurst (Mine Manager)
  - Sharon Makin (Stakeholder and Environmental Advisor)
  - Vince Scarcella (Indigenous Affairs Manager)
- EMM
  - Rebecca Newell (Archaeologist) is preparing the Aboriginal cultural heritage assessment
  - Pamela Kottaras (Heritage Services Manager)
  - Ryan Desic (Archaeologist)

Project description

- Marulan South is a limestone mine producing lime and lime based products.
- In operation for over 100 years.
- Boral is seeking approval for continued operations at the mine through a development application for a State Significant Development.
- The development will include a 30 year mine plan, associated overburden emplacement areas and a mine water supply dam.

Project description

- Insert Map

Aboriginal heritage assessment method

- The assessment will consider:
  - Archaeology
  - History
  - Traditional stories
  - Any other relevant aspect of Aboriginal heritage value
- We’re not just interested in the Aboriginal archaeological sites
  - EMM relies on the Aboriginal stakeholders to advise us of Aboriginal heritage values other than archaeological sites
  - You are invited to share relevant information with us by talking, letter or short report
  - We will respect confidentiality at all times (but will need to be guided as to what and why)

Aboriginal consultation

- We are following government guidelines
  - *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005 – draft)
  - *Aboriginal heritage consultation guidelines for proponents* (DECCW 2010)
- How?
  - Identification of stakeholders (completed February – March)
  - Seeking feedback on assessment method
  - Inviting RAPs to assist in identifying and assessing heritage values
  - Inviting review of the draft assessment and management measures
  - Addressing issues raised by Aboriginal stakeholders
  - Presentation of final report to Aboriginal stakeholders

Archaeological background

- A total of 17 Aboriginal sites previously identified.
- These sites include isolated finds and open artefact scatters.
- The majority of these sites were located in the western portion of the mine lease area.

Archaeological survey

- We will be aiming to identify Aboriginal sites and areas of potential archaeological deposit (PAD).
- We will be following transects based on landscape units.
- Survey will cover areas not previously assessed or disturbed from mining activities.
- Based on the results of the survey a test excavation may occur.
- Responses to the survey are due by **10 April 2015**

Post fieldwork

- EMM will prepare a draft report for review by all RAPs
- EMM and Boral intend to hold a meeting with RAPs when all stages of the survey have been completed:
  - to review the results; and
  - consider the most appropriate mitigation measures from a cultural and archaeological perspective.
- All comments will be addressed in the final report.

Fieldwork details

- Monday 13 April to Friday 17 April 2015 and Monday 23 April to Friday 27 April 2015 if required.
- Monday to Friday 8.30am to 4.30pm.
- Due to safety and transport, limited Aboriginal fieldworker positions are available each day according to a roster
  - areas of organisation coverage/country will be considered.
- Applications to be part of the fieldwork team close on 3 April 2015 and you will be notified of the roster by 8 April 2015.
- Only experienced, fit, insured personnel will be invited to participate.

Fieldwork details

- RAPs will be contracted to EMM on behalf of Boral for the duration of the Aboriginal cultural heritage assessment.
- Invoices are to be made out and sent to EMM.
- Payment is on a monthly cycle and if invoices are not received before the end of the month they will be included in the next months payment cycle.
- Payment has been set at $800 for five years or more experience and $400 for less than five years experience not including GST
- If you are registered for GST include those charges on your invoice.

Essential fieldwork safety requirements

Fieldwork will be hard, hot work

– only for fit and willing participants

No compliance = No field participation

- Hard hat with sun brim, sun block, safety glasses (or sunglasses that provide equivalent protection).
- Suitable clothing and footwear (i.e. high visibility shirt or vest, long sleeved shirt, long pants, wet weather gear, work gloves and steel-capped lace-up boots; no sneakers or running shoes).
- No serious health problems or recent surgery.
- All participants to stay together.
- Bring your own lunch and water.
- Supporting and respectful environment

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EMGA Mitchell McLennan

Questions?

Contacts

- Rebecca Newell
  - [redacted]
  - [redacted]

- EMGA Mitchell McLennan office:
  - 02 9493 9500 (general office number)
  - 02 9493 9599 (fax)
  - PO Box 21, St Leonards, NSW 1590
  - Suite 1, 20 Chandos St, St Leonards, NSW

Thank you for your time today

8 May 2015

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St Leonards, NSW, 1590

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F +61 2 9493 9599
E info@emgamm.com

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Re: Marulan South Limestone Mine Continued Operations Project - test excavation method and information

Dear ,

This letter contains information on the proposed method for the test excavations as part of the Marulan South Limestone Mine Continued Operations Project and invites your feedback on the proposed method in accordance with the consultation approach generally adopted for the project. A separate letter will be sent providing further information on the participation arrangements for the fieldwork.

This method is subject to change based on discussions with the Department of Planning and Environment and we will let all groups know as soon as possible once these discussions have been completed.

Archaeological test excavation is proposed in certain limited areas within the Marulan South project area. Soil testing is required within archaeologically sensitive areas. The soil testing is required to complete a soil verification certificate for the project and will inform the soil and landscapes assessment. Soil testing includes test pits of approximately 06. m by 2.5 m dug by small excavator bucket. Soil samples are taken from these pits and detailed records made of the soil profile. The depth of test pits is usually 1.5 m or when bedrock is reached.

Some of these test pits are located in areas that were identified during the Aboriginal heritage survey as being of Aboriginal heritage sensitivity or areas of potential archaeological deposit. To assist in the Aboriginal cultural heritage assessment the soil test pits will be excavated archaeologically prior to being analysed for their soil information. Additional machine test pits in areas not covered by the soil test pits are also proposed to investigate the archaeological potential of the project area. The results will be useful for the Aboriginal heritage assessment and will be appended to the Aboriginal Cultural Heritage Assessment report.

The indicative test excavation areas are presented in Figure 1. The proposed method is as follows:

- A 3 m by 1 m pit will be dug to the base of the topsoil by machine at the locations of the proposed soil testing holes. The test pits will be dug in 1 m x 1 m area units. The 1 m x 1 m units will allow estimate of average, mean and median artefacts per 1 m^2. This area is larger than that proposed for the soil test pits to provide leeway for the soil testing to occur within this area.

- Each pit will be excavated until basal clay is reached, or, two sterile spits below the artefact bearing level or where there is evidence of soil movement into deeper levels through bioturbation (e.g. through obvious animal burrows or root cavities).

- All excavated soil will be dry-sieved through 5 mm screens. Should the soil be too waterlogged or difficult to dry sieve, wet sieving will be considered.

The excavation supervisor will determine the specific number and location of test pits depending on results gathered during excavation (e.g. encountering high levels of subsurface disturbance that would make further excavation unfruitful).

Test pits may be reduced in size or terminated if conditions warrant such change. Additional test pits may be dug to clarify the local artefact distribution. Test pits may be extended if needed and determined in the field to explore the distribution of artefacts or a feature if encountered. These decisions will be made by the supervising archaeologist in the field based on the archaeological results as they come to hand, however such deviations from the intended work-plan will only be adopted in compelling circumstances.

The excavation effort at each area will be informed by which landform unit it covers and its representativeness of similar landforms in the project footprint. For example, the results from one comprehensively tested landform in one area are likely to represent subsequent test areas with the same landform type. Therefore less test pitting may be required in the subsequent areas to adequately characterise the Aboriginal objects in the area.

Artefacts will be retained temporarily by EMM for required analysis of technological attributes and eventually stored with the salvaged site material in the agreed keeping place or returned to country as agreed by all Aboriginal groups. All artefacts will be recorded in the EMM office. All excavated artefacts will be transferred back to the Marulan South project area at the earliest reasonable opportunity.

It is proposed that after completion of the archaeological test excavations that soil testing will occur in the excavated locations or the excavated area will be backfilled.

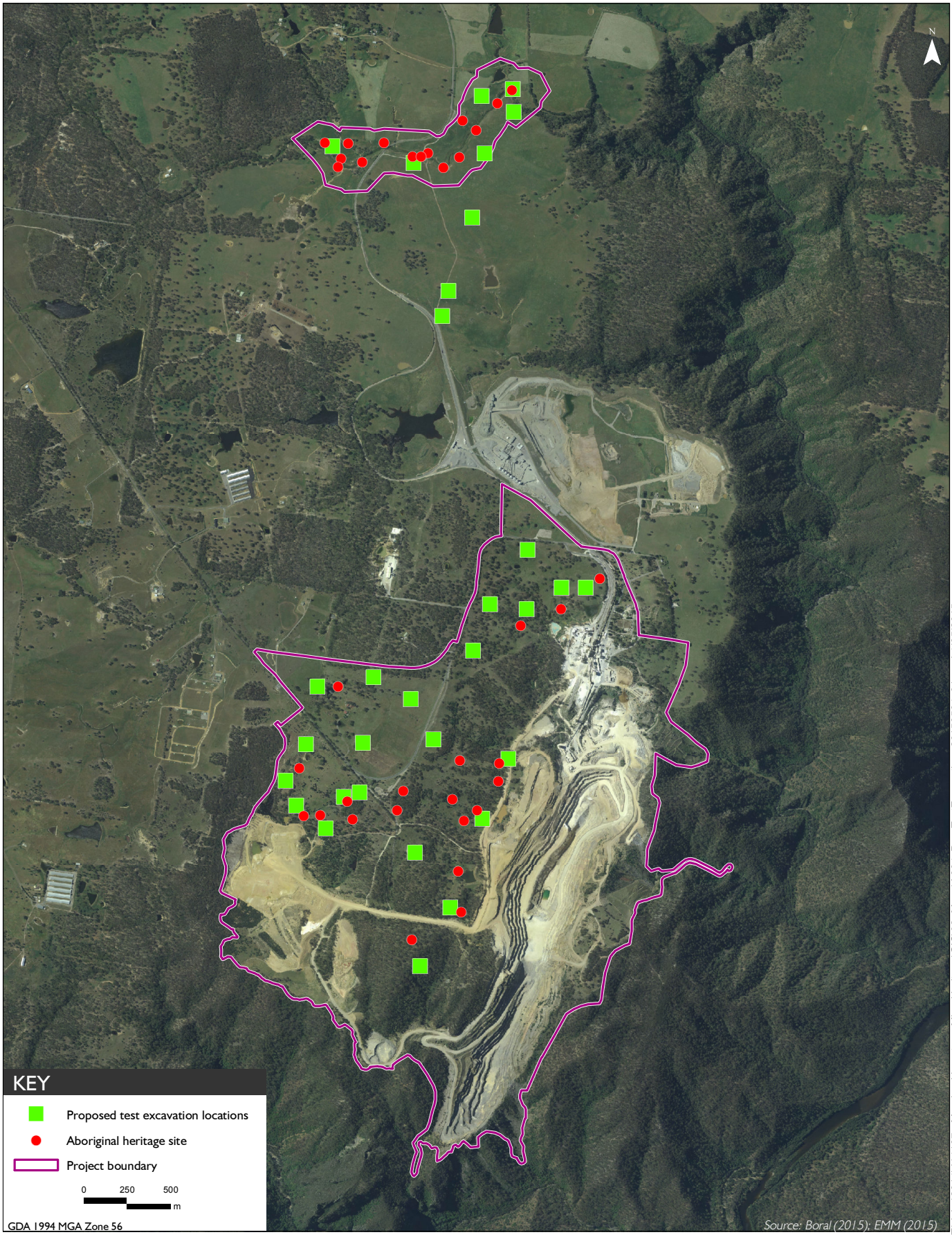
Your comment on this draft methodology is invited by 5 June 2015.

If you have any questions or require further information please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]



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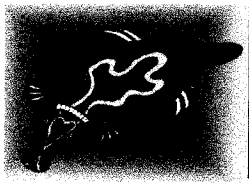
Proposed test excavation locations
Marulan South Limestone Mine Continued Operations Project
Aboriginal cultural heritage assessment
Figure 1



Murra Bidgee Mullangari Aboriginal Corporation, Cultural Heritage
ICN:8112

06/05/2015

Attention: **Rebecca Newell**

EMM
P.O Box 21,
St Leonards NSW 1590
[redacted]

Re: Marulan South Limestone Mine Continued Operations Project-Test excavation method & information

Dear Rebecca,

MBMAC does not agree with an excavator bucket excavating land in areas that have been identified as being of Aboriginal heritage sensitivity or areas of potential archaeologist deposits.

Being an archaeologist i.e. Rebecca Newell would you use an excavator in other situations when looking for artefacts of any kind. These test pits need to be dug by hand. The damage that could be caused by the excavator bucket is not something that our organisation would agree with, and I'm sure most organisations would feel the same.

These areas that EMM plan on digging with an excavator bucket have been identified as being areas of potential archaeologist deposit and or Aboriginal heritage sensitive areas, and as such it is in our organisations opinion that any Aboriginal artefacts that were to be found intact would no longer be intact if dug by the recommendation of Rebecca Newell i.e. Excavator bucket.

I'm disappointed with EMM approach to this project, in any other situation if EMM were digging for dinosaur bones or artefacts associated with this part of history would they use an excavator bucket or do it by hand, that's a question that needs to addressed by Rebecca Newell (archaeologist).

MBMAC value our ancestor's history, so should EMM when digging parts of our ancestors land. Please contact me if you require further information, as I am not happy with your draft methodology for this project, a more sensitive approach needs to be taken into account.

Kind regards

Darleen Johnson

[redacted]

Email: [redacted]

Rebecca Newell

From: [redacted] on behalf of Glen Freeman
[redacted]
Sent: Monday, 11 May 2015 4:18 PM
To: Rebecca Newell
Subject: RE: Marulan South - Test excavation method for review

To whom it May Concern,

After reviewing the proposed methodology for this project, Re; Zone 1 It would seem that the main principal
with it is one of haste why? Surely as archaeologists your main focus would be that of achieving the best analasys
in the Scientific sense if not in the Cultural sense which i expect should have been high on your list of priorities
in regards to this project.

Previous to this proposed expansion project i have been involved with the project for the Boral Hard Rock Mine
where it has been established beyond doubt that this whole area is one of high Significance 100,000 artifacts
and still counting,at no time in my involvement have there been any reason to use machine excavation methods
over traditional hand excavation methods except in the case of roadwork excavation per medium of soil distraction
by machinery then monitoring of the overburden by hand.

Of course we are at the early stages of this project so this as yet is not of concern in regards to this project, as you
as the agent for this project have engaged many other RAP's i would think that there are ample people to carry out
the excavations by hand, and disagree strongly with the proposal of using machine excavation methods at all in this
area, for one the least machinery as possible should be allowed to access the project area at this early stage of proceedings.

I as much as any other of the RAP's am keen to get started on this project but will not let that override my concerns
in the fact that i am a local custodian of my ancestral lands and the protection and preservation of any and all artifacts
be they one or one thousand in number deserve the same respect, to some these artifacts are just things be they trees
stone, rivers ,womens and mens places or whatever is defined as artifactual tangible and intangible, and why may i ask
has there been no mention of scarred trees in your schematic of the proposed project area.

It is always a part of any diatribe on every project, thankfully not this one,that there was no input of cultural Knowledge

Peter Falk Consultancy

[redacted]

EMM

Ground Floor Suite 01, 20 Chandros Street

St Leonards, NSW 2065

Attn: Rebecca Newell June 5, 2015

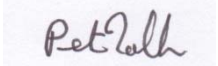
Subject: Marulan South limestone Mine, Aboriginal Cultural Excavations method

Further to your letter of 8 May, 2015, you have stated that you wish to use a small excavator bucket to assist in the excavations.

1. Can you as an archaeologist in all honesty permit the use of mechanical means to excavate?
2. As you know, when GML did their survey and excavation in the area of your proposed excavations, they found Aboriginal Burial Sites. They also only did hand excavations.
3. As I have worked on a site with Navin Officer (Goulburn Water Pipeline) and they used a mechanical Auger 600mm and it was found to break artefacts, can you guarantee that NO ARTEFACTS will be broken?
4. I am aware that with the use of mechanical means of excavation is more expedient for you client but is not ensuring that the Aboriginal Cultural heritage values will be maintained.
5. All test pits should be dug in accordance with OEH guidelines inasmuch hand dig by 10 cm spits until clay bearing soil, hole size to start is 60X60 Cm and expanded if required.

If you require further information on this sensitive please do not hesitate to call me

Regards



Peter Falk

imparted to anybody by any of the RAP,s seems it was so on this project as well.

Regards
Glen(Gilan) Freeman
Gulgunya Ngunawal Heritage Aboriginal Consultancy(GNHAC)
Principal/Contact

From: [redacted]
To: [redacted]
Date: Fri, 8 May 2015 17:02:01 +1000
Subject: Marulan South - Test excavation method for review

Hi all,

We are progressing the Aboriginal cultural heritage assessment and as part of that we are asking all groups to review our proposed test excavation method. We are aiming to discuss this method with the Department of Planning and the Environment before the test excavations commence and while we do not expect it, there may be some changes as a result. We will keep you all updated as to the progress of these discussions. A letter will follow providing information on the exact dates planned for test excavation.

If you have any questions please don't hesitate to contact me. We look forward to your feedback.

Regards,
Rebecca Newell
Archaeologist

Sydney, Newcastle and Brisbane.

EMGA Mitchell McLennan

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Rebecca Newell

From: Karia Bond |[redacted]
Sent: Monday, 11 May 2015 3:56 PM
To: Rebecca Newell
Subject: Re: Marulan South - Test excavation method for review

BADU is formally objecting against any test pit being done by an excavator and any siving being done by way of dry screening.

Badu is objecting against this proposal, it does not have Badu support.

Yours Truly
Karia Bond
Chairperson
Badu

On Friday, May 8, 2015, Rebecca Newell <[redacted]> wrote:

Hi all,

We are progressing the Aboriginal cultural heritage assessment and as part of that we are asking all groups to review our proposed test excavation method. We are aiming to discuss this method with the Department of Planning and the Environment before the test excavations commence and while we do not expect it, there may be some changes as a result. We will keep you all updated as to the progress of these discussions. A letter will follow providing information on the exact dates planned for test excavation.

If you have any questions please don't hesitate to contact me. We look forward to your feedback.

Regards,

Rebecca Newell

Archaeologist

Sydney, Newcastle and Brisbane.

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Rebecca Newell

From: Sharyn Halls [redacted]
Sent: Tuesday, 19 May 2015 7:42 AM
To: Rebecca Newell
Subject: Re: Marulan South - Test excavation method for review

Hi Rebecca
We have read the Test excavation method you have provided to us. The method of excavation as outlined in your attachment looks fine to us.

We look forward to working with you on this project
Regards
Sharyn Halls
Gundungurra Aboriginal Heritage Ass Inc

From: Rebecca Newell
Sent: Friday, May 08, 2015 5:02 PM
To: Ryan Desic
Subject: Marulan South - Test excavation method for review

Hi all,

We are progressing the Aboriginal cultural heritage assessment and as part of that we are asking all groups to review our proposed test excavation method. We are aiming to discuss this method with the Department of Planning and the Environment before the test excavations commence and while we do not expect it, there may be some changes as a result. We will keep you all updated as to the progress of these discussions. A letter will follow providing information on the exact dates planned for test excavation.

If you have any questions please don't hesitate to contact me. We look forward to your feedback.

Regards,
Rebecca Newell
Archaeologist

Sydney, Newcastle and Brisbane.

EMM
EMGA Mitchell McLennan

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Rebecca Newell

From: Koomurri Ngunawal Aboriginal Corporation [redacted]
Sent: Friday, 15 May 2015 1:42 PM
To: Rebecca Newell
Subject: RE: Marulan South - Test excavation method for review

Dear Rebecca,

I have viewed the proposed methodology for this project, and wish to inform you that Koomurri cannot support the use of machinery for the excavation work which you propose for this project, KNAC at all times prefer the method of doing this by hand with hand tools.

Kind Regards,

Donna Dobson
Director/Contact Person
Koomurri Ngunawal Aboriginal Corporation
ICN: 7812

From: [redacted]
To: [redacted]
Date: Fri, 8 May 2015 17:02:01 +1000
Subject: Marulan South - Test excavation method for review

Hi all,

We are progressing the Aboriginal cultural heritage assessment and as part of that we are asking all groups to review our proposed test excavation method. We are aiming to discuss this method with the Department of Planning and the Environment before the test excavations commence and while we do not expect it, there may be some changes as a result. We will keep you all updated as to the progress of these discussions. A letter will follow providing information on the exact dates planned for test excavation.

If you have any questions please don't hesitate to contact me. We look forward to your feedback.

Regards,
Rebecca Newell
Archaeologist

Sydney, Newcastle and Brisbane.

EMM
EMGA Mitchell McLennan

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4 June 2015

Glen(Gilan) Freeman
Director
Gulgunya Ngunawal Heritage Aboriginal Consultancy

Re: Marulan South - response to test excavation method

Dear Glen,

Thank you for your recent response to the proposed test excavation method for the Marulan South Continued Operations Project dated 11 May 2015. We appreciate your time in commenting on our proposed methods. We note that you have raised concerns about potential damage to artefacts through machine excavation and requested a more sensitive excavation approach.

The use of controlled machine excavation in archaeological investigation is an accepted process and is considered to be both effective and safe in excavating archaeological deposits and helping to inform Aboriginal cultural heritage assessments. Research indicates that controlled machine excavation is a safe and effective method for archaeological test excavation.

In an effort to respond to your concerns we have made a change to our method. To take a precautionary approach, we will be excavating the first test pit in each landscape area by hand to record stratigraphy, prior to continuing with machine excavation.

We have consulted with the Office of Environment and Heritage (OEH) and discussed responses to comments such as yours about the use of machine excavation. OEH considers the combined use of hand and machine excavation as an appropriate method for this test excavation and represents a good compromise for the project.

Notwithstanding this compromise, we have put in place the following precautions to ensure machine excavation is archaeologically accurate and does not pose undue risk of damage to archaeological deposits:

- machines will be tyred and use a 1 m length smooth-edge mud bucket;
- machine operators will be experienced and monitored at all times during excavation by qualified field staff;
- clear boundaries for the excavation will be put in place;
- should features of high significance and stratigraphic deposits such as hearths be identified during machine excavation the machine excavation will stop and hand tools will be used; and
- standard stop work protocols will continue to apply in the event that human remains are uncovered.

We hope that this letter helps to allay any concerns you may have in regards to the test excavation method.

I would also like to reiterate our willingness to meet with all group members should they wish to provide cultural information about the study area.

If you have any further questions please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

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4 June 2015

Karia Bond
Chairperson
Badu

Re: Marulan South - response to test excavation method

Dear Karia,

Thank you for your recent response to the proposed test excavation method for the Marulan South Continued Operations Project dated 11 May 2015. We appreciate your time in commenting on our proposed methods.

We note that you have raised concerns about potential damage to artefacts through machine excavation and requested a more sensitive excavation approach.

The use of controlled machine excavation in archaeological investigation is an accepted process and is considered to be both effective and safe in excavating archaeological deposits and helping to inform Aboriginal cultural heritage assessments. Research indicates that controlled machine excavation is a safe and effective method for archaeological test excavation.

In an effort to respond to your concerns we have made a change to our method. To take a precautionary approach, we will be excavating the first test pit in each landscape area by hand to record stratigraphy, prior to continuing with machine excavation.

We have consulted with the Office of Environment and Heritage (OEH) and discussed responses to comments such as yours about the use of machine excavation. OEH considers the combined use of hand and machine excavation as an appropriate method for this test excavation and represents a good compromise for the project.

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- should features of high significance and stratigraphic deposits such as hearths be identified during machine excavation the machine excavation will stop and hand tools will be used; and
- standard stop work protocols will continue to apply in the event that human remains are uncovered.

We hope that this letter helps to allay any concerns you may have in regards to the test excavation method.

In regards to the use of dry sieving we believe it is an adequate method for sieving to identify artefacts during test excavations. Additionally, many of the areas we are proposing to excavate will be in areas not able to accommodate a water truck or tap to facilitate wet sieving. Should weather or soil conditions be too difficult to dry sieve there may be the possibility of using wet sieving, however our primary sieving method will remain dry sieving.

We hope that this letter helps to allay any concerns you may have in regards to the test excavation method.

If you have any further questions please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

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4 June 2015

Donna Dobson
Director
Koomuri Ngunawal Aboriginal Corporation

Re: Marulan South - response to test excavation method

Dear Donna,

Thank you for your recent response to the proposed test excavation method for the Marulan South Continued Operations Project dated 15 May 2015. We appreciate your time in commenting on our proposed methods.

We note that you have raised concerns about potential damage to artefacts through machine excavation and requested a more sensitive excavation approach.

The use of controlled machine excavation in archaeological investigation is an accepted process and is considered to be both effective and safe in excavating archaeological deposits and helping to inform Aboriginal cultural heritage assessments. Research indicates that controlled machine excavation is a safe and effective method for archaeological test excavation.

In an effort to respond to your concerns we have made a change to our method. To take a precautionary approach, we will be excavating the first test pit in each landscape area by hand to record stratigraphy, prior to continuing with machine excavation.

We have consulted with the Office of Environment and Heritage (OEH) and discussed responses to comments such as yours about the use of machine excavation. OEH considers the combined use of hand and machine excavation as an appropriate method for this test excavation and represents a good compromise for the project.

Notwithstanding this compromise, we have put in place the following precautions to ensure machine excavation is archaeologically accurate and does not pose undue risk of damage to archaeological deposits:

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- clear boundaries for the excavation will be put in place;

- should features of high significance and stratigraphic deposits such as hearths be identified during machine excavation the machine excavation will stop and hand tools will be used; and
- standard stop work protocols will continue to apply in the event that human remains are uncovered.

We hope that this letter helps to allay any concerns you may have in regards to the test excavation method.

If you have any further questions please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

EMGA Mitchell McLennan

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4 June 2015

Darleen Johnson
Director
Murra Bidgee Mullangari Aboriginal Corporation, Cultural Heritage
PO Box 246
Seven Hills NSW 2147

Re: Marulan South - response to test excavation method

Dear Darleen,

Thank you for your recent response to the proposed test excavation method for the Marulan South Continued Operations Project dated 6 May 2015. We appreciate your time in commenting on our proposed methods. We note that you have raised concerns about potential damage to artefacts through machine excavation and requested a more sensitive excavation approach.

The use of controlled machine excavation in archaeological investigation is an accepted process and is considered to be both effective and safe in excavating archaeological deposits and helping to inform Aboriginal cultural heritage assessments. Research indicates that controlled machine excavation is a safe and effective method for archaeological test excavation.

In an effort to respond to your concerns we have made a change to our method. To take a precautionary approach, we will be excavating the first test pit in each landscape area by hand to record stratigraphy, prior to continuing with machine excavation.

We have consulted with the Office of Environment and Heritage (OEH) and discussed responses to comments such as yours about the use of machine excavation. OEH considers the combined use of hand and machine excavation as an appropriate method for this test excavation and represents a good compromise for the project.

Notwithstanding this compromise, we have put in place the following precautions to ensure machine excavation is archaeologically accurate and does not pose undue risk of damage to archaeological deposits:

- machines will be tyred and use a 1 m length smooth-edge mud bucket;
- machine operators will be experienced and monitored at all times during excavation by qualified field staff;
- clear boundaries for the excavation will be put in place;
- should features of high significance and stratigraphic deposits such as hearths be identified during machine excavation the machine excavation will stop and hand tools will be used; and

- standard stop work protocols will continue to apply in the event that human remains are uncovered.

We hope that this letter helps to allay any concerns you may have in regards to the test excavation method.

If you have any further questions please don't hesitate to contact me.

Yours sincerely



Rebecca Newell
Archaeologist
[redacted]

A.4 Stage 4 – issue of draft ACHA and responses

This section contains the following documents:

- letter detailing draft ACHA review process;
- letter inviting RAPs to a consultation meeting regarding the draft ACHA;
- presentation slides and meeting minutes from the second consultation meeting on 11 December 2015;
- RAP feedback from draft ACHA report in 2015;
- evidence of continuous consultation during break in EIS; and
- a letter from EMM presenting the updated draft ACHA on 13 August 2018 for RAP comment and review.

27 November 2015

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Re: Marulan South Limestone Mine Continued Operations Project - Aboriginal heritage draft report review

Dear Registered party,

Please find enclosed the draft Aboriginal cultural heritage assessment report for the Marulan South Limestone Mine Continued Operations Project. This report will form part of the Environmental Impact Statement for the Project.

We invite written responses from your organisation on the draft report, particularly regarding:

- Aboriginal heritage values;
- the draft significance assessment;
- the draft management recommendations; and
- any additional relevant Aboriginal heritage matters.

Responses to all written comments received will be provided in the final report. Please return your written comments by **11 January 2016** to:

Rebecca Newell
Marulan South Limestone Mine Continued Operations Project
EMM Consulting
PO Box 21
St Leonards NSW 1590
Fax: 02 9493 9599
Phone: 02 9493 9500

Additionally, you are invited to a meeting to discuss the draft report, fieldwork results and management responses for the Project. The meeting is planned for **Thursday 10 December at 11am**. The meeting place is the Marulan South Limestone Mine administration building (map attached). The meeting will:

- 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 for time to give feedback and discuss the proposed management and mitigation strategies.

The meeting is expected to run for up to two hours. Light refreshments will be provided. **Payment will not be made for the meeting.** Please confirm your attendance at this meeting by **11 January 2016.**

If you have any further questions please don't hesitate to contact me on [redacted] at [redacted]

Yours sincerely



Rebecca Newell
Senior Archaeologist
[redacted]

Marulan South Limestone Mine Continued Operations Project

Consultation meeting 2 – draft report feedback 10 December 2015



Acknowledgment

Before we begin the proceedings I would like to acknowledge and pay respect to the traditional owners of the land on which we meet.

I invite a community-nominated person to offer a welcome to Country…



Agenda

- Introduction and aims (All)
- Project update (RW)
- Process to investigate cultural sit (KW)
- Survey results (RN)
- Test excavation results (RN)
- Summary and significance (RN)
- Impacts and management measures (RN)
- Questions (All)
- Close



Introductions

- Boral Property Group
  - Rod Wallace (Planning and Development Manager NSW/ATC)
  - Sharon Makin (Stakeholder and Environmental Advisor)
  - Vince Scarcella (Indigenous Affairs Manager)
- EMM
  - Rebecca Newell (Senior Archaeologist) is preparing the Aboriginal cultural heritage assessment
  - Pamela Chauvel (Archaeologist)
- Waters Consultancy
  - Kate Waters

Aims

- We are looking for your feedback on the draft report and to answer any questions you may have.
- We will acknowledge all feedback given today, however we will not be able to confirm responses to the feedback today.c
- All feedback and comments will be addressed in the final report.

Investigation of potential cultural site

Project description

- Rod Wallace to present

Survey



- 5 days (April 2015)
- 51 km
- 71 transects – 50 m wide

- 41 sites identified



Test excavation

- 13 days, 25 test pits, 10cm spits.
- Hand and machine excavation.
- All excavated soil dry or wet sieved (5 mm) depending on conditions.
- Recording included photographs, soil profile drawings, context sheets and site notes.
- 539 artefacts were collected, cleaned and catalogued in the lab. Most artefacts were flakes including 17 retouched artefacts (1 Bondi point) and 29 cores, extensively worked.

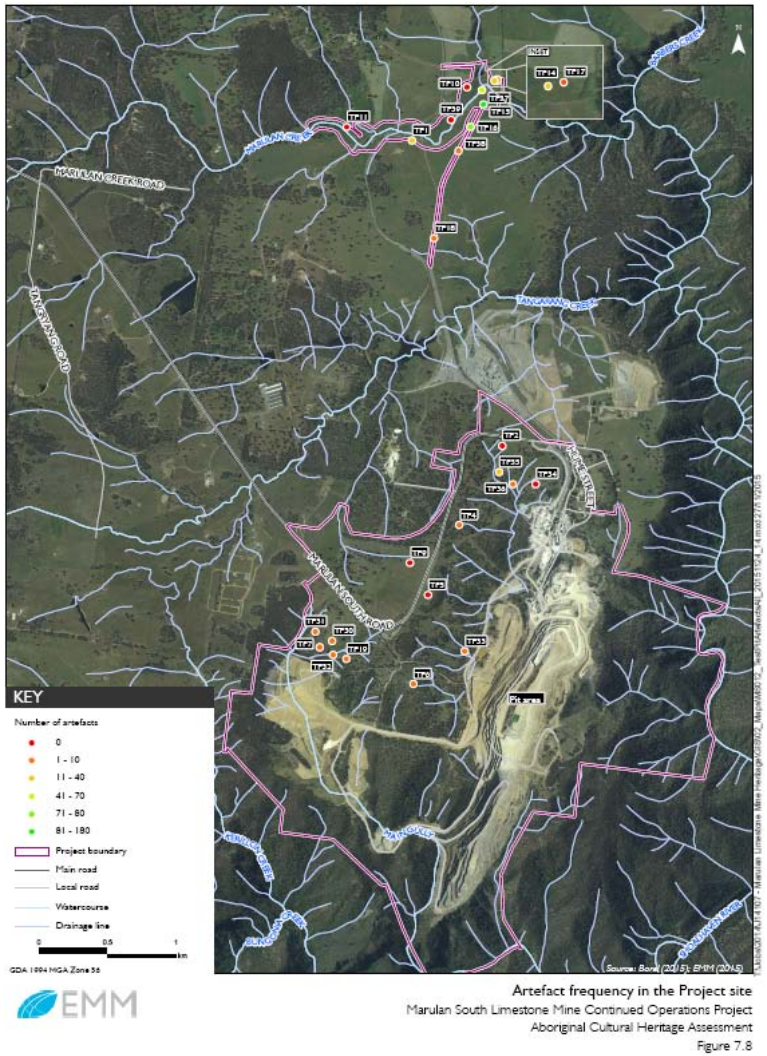
Test excavation







Test excavation – artefact densities



Artefact frequency in the Project site
Marulan South Limestone Mine Continued Operations Project
Aboriginal Cultural Heritage Assessment
Figure 7.8

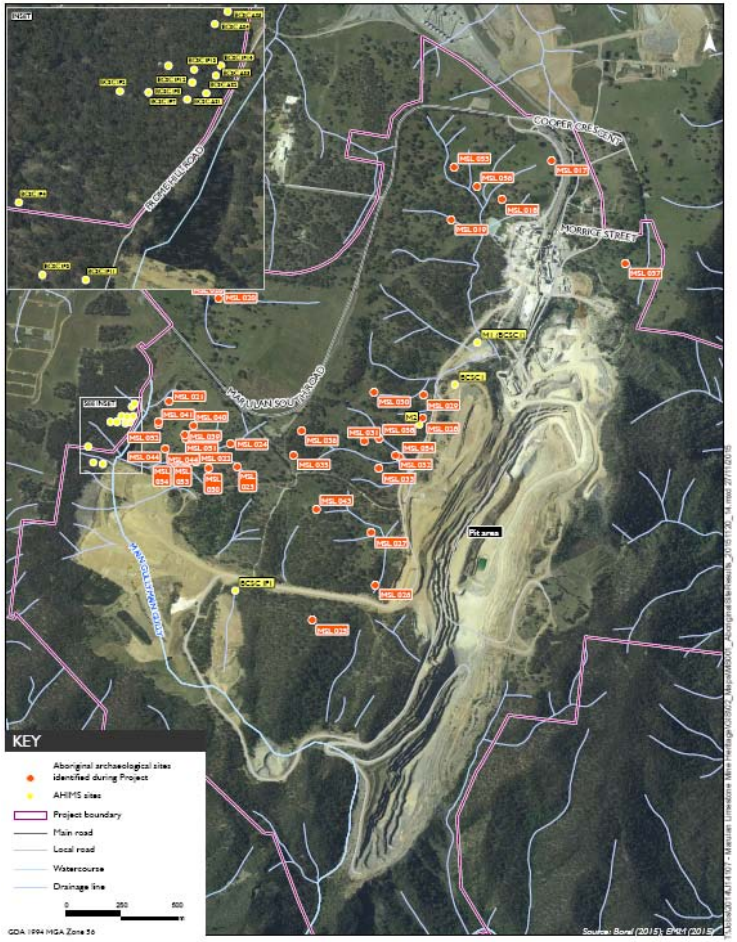
Aboriginal heritage sites – summary



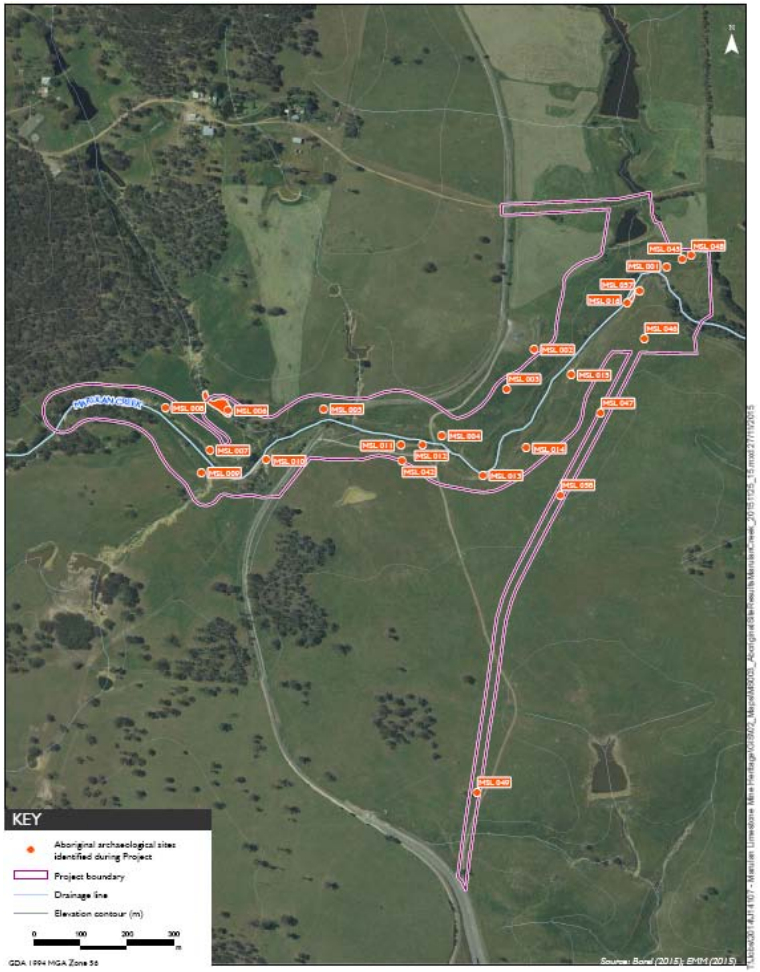


A total of 76 Aboriginal sites in or near the project area (including 46 identified during the field program and 18 sites previously identified).

Aboriginal heritage sites

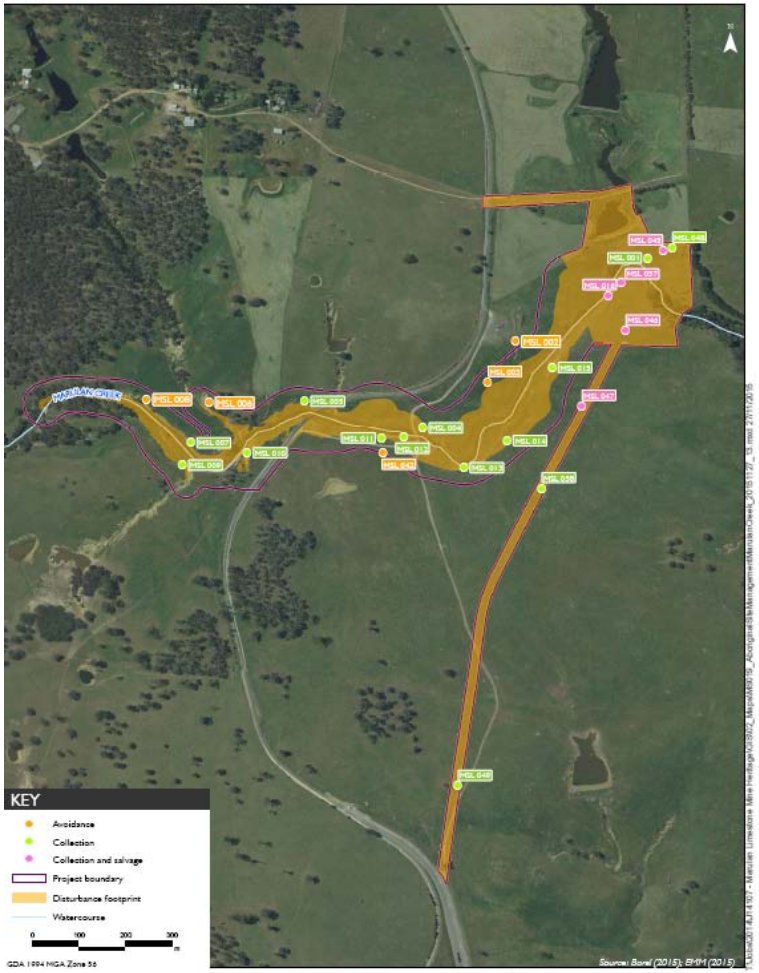


Aboriginal site results at main Project site
Marulan South Limestone Mine Continued Operations Project
Aboriginal Cultural Heritage Assessment
Figure 8.1

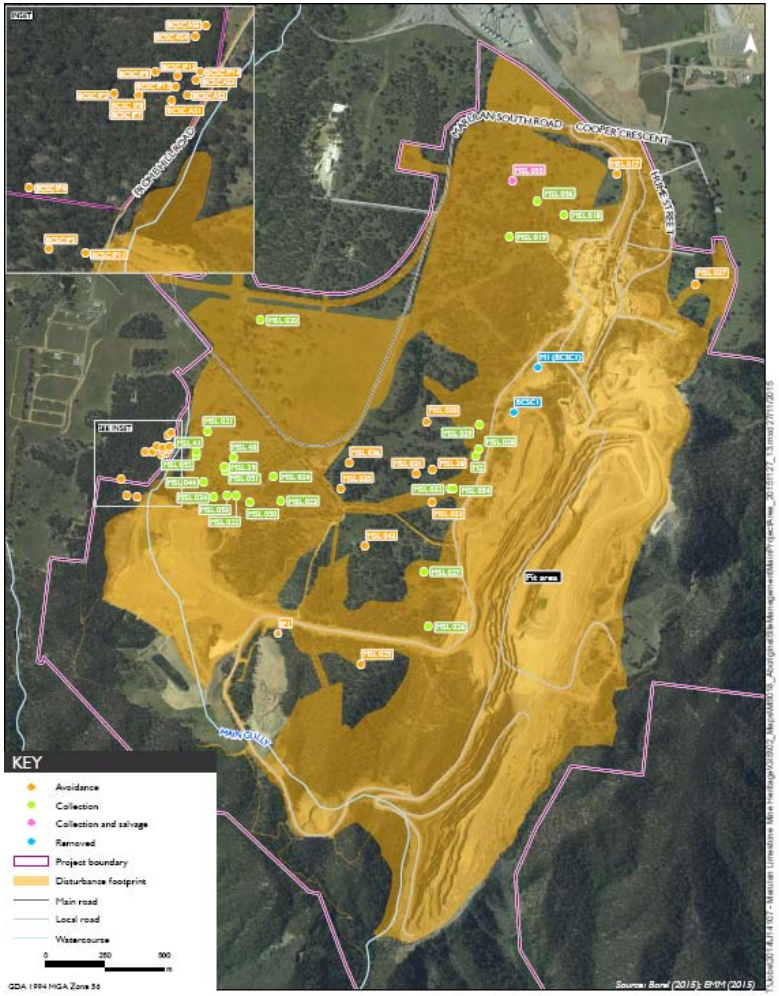


Aboriginal site results at Marulan Creek
Marulan South Limestone Mine Continued Operations Project
Aboriginal Cultural Heritage Assessment
Figure 8.2

Impacts and management



Aboriginal site management at Marulan Creek
Marulan South Limestone Mine Continued Operations Project
Aboriginal Cultural Heritage Assessment
Figure 11.2



Aboriginal site management at main Project site
Marulan South Limestone Mine Continued Operations Project
Aboriginal Cultural Heritage Assessment
Figure 11.1

Management strategies

- Avoidance - Aboriginal sites that remain within 100 m of the development will be fenced, and signage erected.

- Salvage – Proposed for five sites along Marulan Creek and one other. Involves shallow test pits and detailed artefact analysis.

- Collection - Sites in the disturbance footprint that will not be subject to further investigation or salvage excavation will be collected by members of the Aboriginal community and an archaeologist.

- No topsoil will be removed from the project site.

Questions?



Contacts

- Rebecca Newell



- EMGA Mitchell McLennan office:
  - 02 9493 9500 (general office number)
  - 02 9493 9599 (fax)
  - PO Box 21, St Leonards, NSW 1590
  - Suite 1, 20 Chandos St, St Leonards, NSW

Thank you for your time today



Memorandum

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11 December 2015

To
From Pamela Chauvel

Subject Marulan South Consultation Meeting Thursday 10th November

Dear Sir/Madam,

Meeting commenced at 10.25am

Present: 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)

Apologies: Sharon Makin, Steve Johnson, Darleen Johnson, Sharon Halls

Rebecca invited someone to do a welcome to country. Tyrone asked Glen to speak. Glen spoke about respect and tradition and how this is Ngunawal and Gundungurra country. He said that EMM had a duty of care to the traditional owners and expressed his concern that representatives from other groups had been involved in the project. Consequently, he is reluctant to share cultural knowledge because he doesn't want it appropriated by other groups.

Vince responded. He said that Boral wants to do the right thing but that Boral and EMM can't determine who speaks for country. OEH has made it clear that anyone who registers has to be included and that this is the legal/legislative position.

Glen gave a welcome to country in language.

10.45 Rebecca began presentation of the draft report and encouraged feedback from everyone and that all responses given at the meeting or in writing will be addressed in the final report.

Rod gave a summary of where the project is up to. There are 12 other detailed assessments happening concurrently which Boral are hoping to finalise early next year and submit to OEH for public exhibition/review. They are hoping for approval later next year.

Tyrone requested the groups be kept updated on the process and Rod confirmed that this would be the case. Rebecca stressed that confidentiality is assured and all sensitive material (eg. GPS points) would be removed from the final report. Groups will receive a fuller report.

Glen said that the reference to the women's site should not be included in the ACHA. He doesn't want other groups stealing the information. He suggested that a different term be used. Vince said that it could be omitted from the report completely and just a note saying "something has been taken out here".

Rebecca invited Kate to present on her investigation into this potential cultural site. Kate explained that she has been brought in to do an assessment of intangible heritage to bring back to OEH in accordance with the Burra Charter. As a starting point she will speak to stakeholders and ask them to identify knowledge holders that she

should speak to. She pointed out the difference between knowledge holders and stakeholders and acknowledged that it is a sensitive issue. However, legally she has to speak to everyone. She needs to find out who can speak for country, who has knowledge and who taught them this knowledge. Her methodology involves writing down what people tell her and showing it to them immediately for them to check. She then asks them to tell her what they are willing for her to include in the report (public record). All other information is kept confidential (she needs to keep it in case it goes to court but no one else will see it). Her reports are informed by what she has been told but only include that information which the knowledge holders agree may be included. They get to check the report before it goes out. She acknowledged that for knowledge holders, the process of deciding what cultural knowledge to share is very stressful and that it is a balance between sharing enough to protect but not giving away too much cultural knowledge. Her process will involve looking holistically at the whole cultural landscape in order to contextualise and understand the site under investigation. She will also look at documentary and other evidence.

Tyrone request that Kate talk to everyone first and then to him last. He also suggested Kate talk to his brother Don who is a cultural anthropologist.

Kate will speak to the RAPS after the meeting so they can give her the contact details of their nominations.

The issue of the large number of registered groups came up again. Rod said that he is willing to write a letter to OEH expressing concern about the large number of groups.

Tyrone and Glen said that their land rights claim is back on the table.

Rebecca continued with her presentations about the archaeological field work that was done.

Glen said that he believed that Peppertree and Marulan South are one big site, the same landform. Rebecca acknowledged the importance of understanding cultural landscapes and their intangible and spiritual importance. She pointed out that archaeologically, only Marulan Creek has high artefact densities similar to Peppertree and that across the rest of the Marulan South project area, the surface scatters are not reflective of subsurface deposits (which are of low density). Many of the proposed emplacements are on steep areas where there is little archaeological evidence.

Glen wanted more transects dug. From his experience of camping with his people, he believes that camping took place further back from water sources (200-500 metres) and that protection and food sources were the key considerations when people chose where to camp. People would not want to be in exposed areas or close to boundaries.

Rebecca asked Glen if he would be happy for this information to go in the ACHA background information and whether he identified these places during the survey. Glen confirmed that he had but chose not to mention it at the time. It was discussed that Kate's report would discuss the important cultural context of the landscape in more detail. Rebecca also suggested that as surface collection and salvage will be done as part of the management strategy, this could be an opportunity to explore the bigger picture. She asked Glen where he would like the transects dug.

Tyrone wants grader scrapes and monitoring of areas that will be affected. He referenced the methodology used at Bungandore which is also grazing country like Marulan South. He would like to drive around the project area and check for areas that still need to be investigated. He would like to know exactly where the women's site is.

Rebecca said that the emplacements and haul roads will be located on areas that were not archaeologically sensitive and that monitoring and grader scrapes are not warranted. Also, in many areas there is very little topsoil (less than 10%) and grader scrapes would not be helpful. However, surface collection and salvage will be done where needed. Rod said Boral have been investigating the best methods of rehabilitating the land and that scraping top soil and then replacing it has not been successful in the past as nothing will grow on it, besides thistles. Consequently, they will use shale and, apart from a narrow area of stripping on the edge of the pit area, they won't be doing grader scrapes.

Rebecca asked if there were any comments in regard to the proposed management strategies.

Glen said there were burials on the project area that haven't been found yet. Vince said that mechanisms are in place to deal with this if they are found (during test pitting or mine activity) however, if there are ways the graves could be avoided, that would be best. Glen confirmed that the burial sites won't be impacted. He referred to the existence of initiation and healing sites in the project area. Vince urged Glen to let Boral know so that these sites can be avoided and stressed that Boral's approach is to be culturally sensitive and to incorporate cultural information into the management strategy.

Tyrone complimented Boral on their working relationship with him and thanked Vince and Rod for their partnership with him. He also hopes to continue a professional working relationship with EMM. However, he wants it acknowledged that he works for Boral, not the archaeologists who are also contracted by Boral. He wants a mutual sharing of knowledge.

Rebecca called for any final comments about the report.

Tyrone requested that something be included about education. He suggested workshop packages to interpret culture and implement initiative to include the next generation. This could involve a combination of scientific and cultural knowledge. Rebecca said that both Peppertree and Marulan South have this potential and that EMM would like the information to be understandable, for the stories to come through and be disseminated more widely than simply grey literature.

Tammy asked who Kate will take to the women's site with her. She would like to be involved and learn more. Kate said she will go with the knowledge holders and that they will decide who else can come.

Vince closed by acknowledging Glen's initial comments and reiterating the limitations of what they can do and the frustrating nature of this.

The meeting ended at 12.40pm.

Pamela Kottaras

From: Ngunawal Heritage Aboriginal Corporation [redacted]
Sent: Sunday, 10 January 2016 4:36 PM
To: Pamela Kottaras
Subject: Marulan South Limestone Mine Continued Operations Project Draft

Hi Pamela

In general ,the Ngunawal Heritage Aboriginal Corporation believe the Management measures proposed are adequate, but at a minimum level.
We are pleased that a total of 32 sites will be preserved and protected and the remaining sites that are not subject to further investigation will be collected.
We agree with the salvage excavation at sites MSL016,MSL045,MSL046,MSL047,MSL055 and MSL057.
We recommend that MSL048 be added to the salvage excavation and the monitoring of top soil stripping in all areas likely to contain high density's of stone artefacts, especially around Marulan Creek. Although the monitoring of topsoil stripping is not popular with most Archaeologists it proves accurate in locating and salvaging subsurface stone artefacts, as has been the case at Peppertree Quarry, which has similar landforms to that of the Limestone Mine.
These recommendations are from a cultural perspective, not scientific.

Kind Regards

Graeme Dobson
Sites Officer

Pamela Chauvel

From: [redacted] on behalf of Glen Freeman
[redacted]
Sent: Saturday, 9 January 2016 10:55 AM
To: Pamela Chauvel
Subject: RE: Marulan South Limestone Mine Draft ACHA - review/comments due by Monday

Dear Consultant,

At the meeting in regards to this project between the Boral reps the RAPS and the EMM consultants i feel i made myself quite clear
as to what my recommendations were and to the fact that the Ngunawal know this place IE; Marulan, Blue Circle, Pepper Tree as one
whole Site and therefore the same monitoring plan as the one in existence on Pepper Tree be applied to the Marulan South Limestone
Mine. In all other matters pertaining to this project we at KNAC/GNHAC have no issues.

Regards,
For and on the behalf of KNAC/GNHAC
Glen Freeman Director/Contact for the above.

From: [redacted]
To: [redacted]
Date: Fri, 8 Jan 2016 09:09:23 +1100
Subject: Marulan South Limestone Mine Draft ACHA - review/comments due by Monday

Dear Registered Party,

Please be advised that the due date for all written comments regarding the draft Aboriginal cultural heritage assessment report for the Marulan South Limestone Mine Continued Operations Project is **Monday 11 January 2016.**

Kind regards,
Pamela Chauvel
Archaeologist

Sydney, Newcastle and Brisbane.

EMM

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Please note that EMGA Mitchell McLennan Pty Limited has changed its name to EMM Consulting Pty Limited (simply refer to us as EMM). Email and website addresses have been changed to reflect this. All other details including ABN, bank details etc remain unchanged.



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Pamela Kottaras

From: steve johnson [redacted]
Sent: Monday, 11 January 2016 9:44 AM
To: Pamela Chauvel; Pamela Kottaras
Subject: RE: Marulan South Limestone Mine Draft ACHA - review/comments due by Monday

Hi Pamela
We have reviewed the AHCA draft for the Marulan South Limestone Mine looks fine no additional comments or requests from us,if you require our response in letter form please let me know.

Kind Regards
Steve Johnson
AHCO

CORROBOREE ABORIGINAL CORPORATION
Preserving Aboriginal Culture & Heritage



[redacted]

From: Pamela Chauvel [redacted]
Sent: Friday, 8 January 2016 9:09 AM
To: Pamela Kottaras [redacted]
Subject: Marulan South Limestone Mine Draft ACHA - review/comments due by Monday

Dear Registered Party,

Please be advised that the due date for all written comments regarding the draft Aboriginal cultural heritage assessment report for the Marulan South Limestone Mine Continued Operations Project is **Monday 11 January 2016.**

Kind regards,
Pamela Chauvel
Archaeologist

Sydney, Newcastle and Brisbane.

EMM

Ground Floor, Suite 01
20 Chandos Street

St Leonards NSW 2065

PO Box 21
St Leonards NSW 1590
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Please note that EMGA Mitchell McLennan Pty Limited has changed its name to EMM Consulting Pty Limited (simply refer to us as EMM). Email and website addresses have been changed to reflect this. All other details including ABN, bank details etc remain unchanged.



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BURU NGUNAWAL ABORIGINAL CORPORATION
ABN : 24 059 704 833

11 January 2016

EMGA Mitchell McLennan
PO Box 21
St Leonards NSW 1590

Attention: Pamela Chauvel

Marulan South Limestone Mine Draft Aboriginal Cultural Heritage Assessment Review/Comments

Thank you for providing a copy of the above report pertaining to the results of surveys and i9nvestigation works undertaken at the Marulan South Limestone Mine for which a request for input from Buru Ngunawal Aboriginal Corporation (BNAC) as the Traditional Custodian group that participated in the program was made.

Accordingly, BNAC wish to state that we consider all Aboriginal sites to be of significance to us as the Traditional Carers for this area. BNAC also consider all sites to be of value to us socially, culturally and spiritually.

It is a concern BNAC have with any Aboriginal Cultural Heritage Assessments that too much emphasis is placed on the scientific archaeological values. This in turn diminishes the cultural significance that we as Aboriginal people hold for both tangible and intangible objects/places within the natural cultural landscape.

The Australia ICOMOS Burra Charter 2013, defines cultural significance as follows:

"Cultural significance means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of values for different individuals or groups." (ICOMOS 2013).

This definition should motivate all archaeologists to develop a better understanding of the culture they are assessing. A more sensitive and understanding approach may encourage more dialogue between archaeologists and the Aboriginal peoples whose culture is being scrutinised.

Sub-section 9.2 highlights the lack of sensitivity for the Aboriginal person providing evidence of a spiritual place through a developed cultural connection that is on a level that makes it hard to explain the sensitivities when there is no compassion being displayed. It was not only this one person but other Aboriginal people present that also "felt" that connection. It is difficult to indicate a special place when all evidence of its presence has been removed due to European occupation and land use of the area and not to mention the operational activities of the Lime Mine. Evidence such as marker trees, stone markers or stone arrangements which have systematically been removed or disturbed beyond recognition.

The statement that *"a cultural heritage specialist has been engaged to complete an investigation into the significance and values associated with the cultural site"* also demonstrates that no value or trust is being placed on Aboriginal people who come forward and provide such advice. It seems that Aboriginal people are not believed and require the confirmation of a person that holds a piece of paper that says that they have the authority to rule on that advice. If they advise wrongly then a highly significant area of cultural sensitivity will could be lost forever.

We provide the following comment in response to the documentation provided, with particular reference to the Management Plan Section 11.

BNAC agrees with the Management Recommendations as proposed from a scientific archaeological viewpoint.

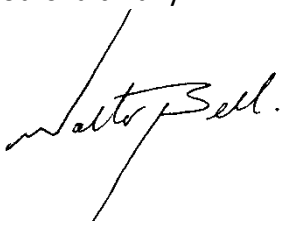
BNAC would also like to stress the importance of inclusion in this process to develop a better cultural understanding with the client and the compliance of these recommendations as interpretation of recommendations can differ from what is proposed. BNAC wish only to ensure impacts do not accidentally occur as past experience indicates that this can occur due to miscommunication.

BNAC would suggest that if there are to be any changes made to the recommendations as proposed that may impact on any of the sites detailed as non or partial impact that we be consulted immediately.

Thank you for the opportunity to provide comment and we look forward to working with you collaboratively on this project.

If you have any queries please contact me.

Yours faithfully



Wally Bell
Director/Chair

Pamela Chauvel

From: Wally Bell [redacted]
Sent: Monday, 11 January 2016 3:52 PM
To: Pamela Chauvel
Subject: RE: Marulan South Limestone Mine Draft ACHA - review/comments due by Monday
Attachments: Marulan South Limestone Mine Draft Aboriginal Cultural Heritage Assessment - Jan '16.docx

Dear Pamela,

Please find attached our comment on the above report.

Regards,

Wally Bell
Director/Chair
Mb: [redacted]

Buru Ngunawal Aboriginal Corporation
Traditional Custodian Group
[redacted]

From: Pamela Chauvel [redacted]
Sent: Friday, 8 January 2016 9:09 AM
To: Pamela Kottaras [redacted]
Subject: Marulan South Limestone Mine Draft ACHA - review/comments due by Monday

Dear Registered Party,

Please be advised that the due date for all written comments regarding the draft Aboriginal cultural heritage assessment report for the Marulan South Limestone Mine Continued Operations Project is **Monday 11 January 2016.**

Kind regards,
Pamela Chauvel
Archaeologist

Sydney, Newcastle and Brisbane.

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24 October 2016

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«First_Name»«Last_Name»
«Organisation»
«Address_1»
«Address_2»

Re: Boral Marulan South Limestone Mine Continued Operations project update

Dear Registered Aboriginal parties,

EMM Consulting Pty Ltd (EMM) on behalf of Boral Cement Limited (Boral) would like to update you/your organisation on the Marulan South Limestone Mine Continued Operations project (the project). This letter is notification of our commitment to provide ongoing consultation with the registered Aboriginal parties (RAPs) on this project.

During the preparation of the Environmental Impact Statement (EIS), Boral has undertaken further exploration and investigations of the limestone resource. This has identified further high grade limestone to the west and north of the proposed 30 year mine footprint, which was previously identified as overburden. Boral is therefore investigating the feasibility of mining this limestone resource, which may result in a change to the mine footprint.

It is highly unlikely that the revised mine footprint including the pit and overburden emplacements, would disturb areas that have not already been thoroughly surveyed and assessed as part of the project's Aboriginal cultural heritage assessment (ACHA) process undertaken to date. It is therefore unlikely that further site investigations will be required

All RAPs were sent the ACHA report for review in November last year and we have received comments back from four groups. Should any changes be made to the project, all RAPs will be provided with an updated ACHA report for your review and further comment. In the meantime, if you have any questions, please do not hesitate to contact me on the numbers and email below.

We appreciate your patience and will keep you informed of progress made in finalising the mine footprint and the revision of the ACHA.

Yours sincerely,

Pamela Kottaras
Heritage Services Manager

[redacted]

DRAFT

Pamela Kottaras

From: Wally Bell [redacted]
Sent: Thursday, 17 November 2016 9:34 AM
To: Pamela Kottaras
Subject: RE: J14107 Marulan South continuing consultation

Follow Up Flag: Follow up
Due By: Monday, 28 November 2016 9:00 AM
Flag Status: Completed

Hi Pamela,

Thanks for this update.

Could I request that you update your records to reflect a change in the postal address as per below.

Regards,

Wally Bell

Traditional Custodian Group
[redacted]

From: Pamela Kottaras [redacted]
Sent: Friday, 28 October 2016 9:27 AM
To: [redacted]
Subject: J14107 Marulan South continuing consultation

Dear Walter,

Attached is notification of continuing consultation for the Marulan South Limestone Mine Continued Operations project.

Please do not hesitate to contact me if you have any questions.

Kind regards,

Pamela

Pamela Kottaras | Associate - Heritage services manager

T 02 9493 9500 | [redacted] F 02 9493 9599

Ground Floor, Suite 01, 20 Chandos Street, St Leonards NSW 2065

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8 November 2017

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«First_Name» «Last_Name»
«Organisation»
«Address_1»
«Address_2»

Re: Boral Marulan South Limestone Mine Continued Operations project update

Dear Registered Aboriginal parties,

EMM Consulting Pty Ltd (EMM) on behalf of Boral Cement Limited (Boral) would like to update you/your organisation on the Marulan South Limestone Mine Continued Operations project (the project). This letter is notification of our commitment to provide ongoing consultation with the registered Aboriginal parties (RAPs) on this project.

Over the past year, Boral has been undertaking detailed exploration and further mine planning to identify the best way to extract the limestone resource. This mine planning process is nearing completion.

The revised mine footprint including the pit and overburden emplacements, would not disturb areas that have not already been thoroughly surveyed and assessed as part of the project's Aboriginal cultural heritage assessment (ACHA) process undertaken to date. It is therefore unlikely that further site investigations will be required.

Due to changes to the previously assessed mine plan, all RAPs will be provided with an updated ACHA report for your review and further comment. In the meantime, if you have any questions, please do not hesitate to contact me on the numbers and email below.

We appreciate your patience and will keep you informed of progress made in finalising the mine footprint and the revision of the ACHA.

Yours sincerely,

Pamela Kottaras
Heritage Services Manager



Pamela Kottaras

From: Pamela Kottaras
Sent: Friday, 9 December 2016 3:04 PM
To: 'Glen Freeman'; [redacted]
Cc: Ryan Desic
Subject: RE: J14107 Marulan South continuing consultation

Dear Glen,

Firstly let me apologise for taking so long to get back to you. The additional area proposed for mining is still in the process of being identified. The team will be notified as soon as the new area has been determined after which we will be able to assess if additional field survey is required. So far, the area under consideration has been previously surveyed by our team; this is why the letter updating you on the project (dated 28 October 2016) states that it is "unlikely that further site investigation will be required". At present, I cannot comment on the area that is being investigated as Boral's geologists are still assessing the quality and extent of the limestone and the exact boundary has not been determined. When a decision on the final footprint and disturbance area has been made, EMM will advise Boral on the requirement for additional survey and we will consult with the registered Aboriginal parties.

EMM and Boral appreciate your feedback so thank you for responding. I note that you request that we are careful with written and oral communication with other Ngunawal Clans people, as well as RAPs – can you please let me know if this letter is to be appended to the ACHA that will be publicly accessible or if you would like it to be restricted to Boral, EMM and the regulators?

Please give me a call if you wish to discuss further. Otherwise I, or someone from EMM, will be in touch when a decision about additional resource extraction area has been made.

Kind regards,

Pamela

Pamela Kottaras | Associate - Heritage services manager

T 02 9493 9500 | [redacted] 02 9493 9599

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From: Glen Freeman [redacted]
Sent: Tuesday, 15 November 2016 2:00 PM
To: Pamela Kottaras; [redacted]
Subject: Re: J14107 Marulan South continuing consultation

Dear Pamela,

Thank you for the recent update in regards to this project status, as stated in the proponents opinion there is no further need
of investigation for the mining process of this overburden, I must ask for clarification on the reasoning for this opinion.

Surely if the overburden is of an age that would of been mined before the processes of Aboriginal Cultural Heritage Management
was in place then this becomes a new project in regards to mining the limestone resources of the original mining operations, is
this so?

Having had years of experience in the mining industry, when old workings have been re examined for the purpose of re mining
due to advanced technologies their is the need for new infrastructure being put in place for this work to be carried out.

Will their be a need for new haul roads to be constructed? a conveyor system perhaps? will new dams have to be constructed?

Were these old overburden dumps monitored for artifacts previously?

The Whole of the Foot Print for all of the mining operations of Peppertree and Blue Circle is One Aboriginal Cultural Site, not
one , two or three or any number of separate Sites this whole Foot Print is a Highly Significant Cultural Site to our people.

What is it going to take for the proponents to admit this and enter into a more fair and just dialog and therefore actions that
will display a proper respect for this Sacred place and the people with Ancestral Connection to it, in particular Ngunawal (We The People)

This area is or should I say was our Ancestral Country under the Custodianship of the Barramarrangu- Eel Clan of the Ngunawal
who were one of the six Clan groups of our people, I cannot at this time share with you the full story of this place but needless
to say it is a Sacred Meeting Place for all of our Clans people as well as at least five other different groups of people from over
the mountains and across the plains and the coast from Marulan, as I have said this is Ngunawal Country and cannot say if the
others have any information in their Oral LORE as to the Significance of this place such as we do and I share this information with
you in trust.

As is in our LAW each of our Knowledge holders hold information in trust to be handed down orally to the next generations to
continue the process of passing sensitive information to be shared through the ages of time this is one of the intangible elements
of our LORE, so I ask you to please be careful with how you deal with this in any written and oral communication with other
Ngunawal Clans people, as well as RAP's for this project and in particular with the proponents of Pepper Tree and Blue Circle who

unfortunately I do not share trust in.

Please feel free to give me a call if you wish to discuss any aspect of this email to clarify any of it's content.

Kind Regards,

Glen Freeman Ngunawal Elder/Custodian.

Sent from Outlook

From: Pamela Kottaras [redacted]
Sent: Friday, 28 October 2016 9:40:59 AM
To: [redacted]
Subject: J14107 Marulan South continuing consultation

Dear Glen,
Attached is notification of continuing consultation for the Marulan South Limestone Mine Continued Operations project. I have also sent a letter addressed to Donna Dobson at Koomurri Ngunawal Aboriginal Corporation – please let me know if this isn't correct.
Please do not hesitate to contact me if you have any questions.
Kind regards,
Pamela

Pamela Kottaras | Associate - Heritage services manager
T 02 9493 9500 | [redacted] | **F** 02 9493 9599
Ground Floor, Suite 01, 20 Chandos Street, St Leonards NSW 2065
PO Box 21, St Leonards NSW 1590
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Ryan Desic

From: Ryan Desic
Sent: Monday, 13 August 2018 6:28 PM
Cc: PR17; Neville Hattingh; Pamela Kottaras
Subject: Marulan Limestone Mine SSD Project Draft ACHA for RAP review

Importance: High

Dear registered party,

Introduction

Thank you for continued participation in the Marulan Limestone Mine SSD Project (the project). As explained at intervals since the initial draft Aboriginal cultural heritage assessment (ACHA) for the project was distributed in November 2015, the project elements and project footprint have undergone some minor changes. Accordingly, the ACHA has been updated to reflect the most up to date impact assessment and management measures. Now that the changes have been incorporated into the ACHA, we are now up to the next stage of consultation for the project which is a review of the draft ACHA. Although registered parties have previously had 28 days to review the ACHA in 2015, we would like to offer another 28 day review period so that the updated report can be reviewed again in its entirety.

Notes for your review and comment

If you have specific comments for the document, please identify the section heading and page number so that we know specifically which part of the document to address. Our preference is for you to provide your comments in writing via email or letter.

When to respond by

If you wish to comment, please provide them within 28 days by **10 September 2018.** The review period is consistent with the *Aboriginal consultation requirements for proponents 2010* (DECCW 2010). If you are having trouble responding within this timeframe please let us know early so that we can consider alternative options.

Downloading the document

The document is available to download using the following link (press ctrl on your keyboard and click on it):

[redacted]

Closing

Please do not hesitate to contact me on my details below for any matters regarding the projects or if you have any difficulties in downloading or reading the documents.

Regards,

Ryan Desic | Senior Archaeologist

T 02 9493 9500 | [redacted] 02 9493 9599

Ground Floor, Suite 01, 20 Chandos Street, St Leonards NSW 2065

PO Box 21, St Leonards NSW 1590

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Appendix B

AHIMS search results and site cards

AHIMS Web Services (AWS)
Search Result

Your Ref Number : J14107 - Marulan 3

Client Service ID : 146358

EMGAMM-St Leonards (previously EMGA)

Ground Floor, Suite 01 20 Chandos Street
St Leonards New South Wales 2065

Attention: Rebecca Newell

Email: rnewell@emgamm.com

Date: 01 September 2014

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters, conducted by Rebecca Newell on 01 September 2014.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

112	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

PO BOX 1967 Hurstville NSW 2220
43 Bridge Street HURSTVILLE NSW 2220
Tel: (02)9585 6345 (02)9585 6471 Fax: (02)9585 6094

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14107 - Marulan 3

Client Service ID : 146358

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0102	Isolated Find 3	AGD	55	777420	6153370	Open site	Valid	Artefact : -	Isolated Find	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0101	Isolated Find 2	AGD	55	774550	6152900	Open site	Valid	Artefact : -	Isolated Find	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
52-4-0027	Dungeon Creek Quarry;	AGD	56	234810	6148750	Open site	Valid	Stone Quarry : -, Artefact : -	Quarry	
	Contact	**Recorders**	Mr.Doug Williams,Ms.Sue Feary					**Permits**		
52-4-0002	South Marulan;Caoura;	AGD	56	233778	6148430	Closed site	Valid	Grinding Groove : 1, Art (Pigment or Engraved) : -	Shelter with Art	
	Contact	**Recorders**	Kinsella					**Permits**		
51-6-0091	Marulan 6	AGD	55	774310	6153270	Open site	Valid	Artefact : -	Open Camp Site	3605,99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0059	Marulan Quarry 1	AGD	55	771860	6152890	Open site	Valid	Artefact : -	Open Camp Site	1995,99404
	Contact	**Recorders**	Peter Higgins,J Klavin,Kerry Navin					**Permits**		
51-6-0086	Marulan 1	AGD	55	774500	6153130	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0087	Marulan 2	AGD	55	774530	6153100	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0088	Marulan 3	AGD	55	774630	6153170	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0089	Marulan 4	AGD	55	774510	6153000	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0090	Marulan 5	AGD	55	774380	6153800	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0092	Marulan 7	AGD	55	774220	6153450	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0093	MF 1 - Winfarthing Road	AGD	55	765080	6151200	Open site	Valid	Artefact : -	Isolated Find	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0094	MF 3 - Narambulla Creek	AGD	55	765870	6151120	Open site	Valid	Artefact : -	Open Camp Site	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.

Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0095	MF 2 - Winfarthing Road	AGD	55	765190	6151120	Open site	Valid	Artefact : -	Isolated Find	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**	1607	
51-6-0096	MF 4 - Narambulla Creek	AGD	55	765950	6150620	Open site	Valid	Artefact : -	Open Camp Site	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0097	MF 5 - Narambulla Creek	AGD	55	765700	6150360	Open site	Valid	Artefact : -	Open Camp Site	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0098	MF 6 - Narambulla Creek	AGD	55	765590	6150170	Open site	Valid	Artefact : -	Isolated Find	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0103	Isolated Find 1	AGD	55	774500	6153170	Open site	Valid	Artefact : -	Isolated Find	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0104	Isolated Find 4	AGD	55	774550	6152900	Open site	Valid	Artefact : -	Isolated Find	
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0105	Marulan ER Site 1	AGD	55	774500	6153220	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Miss.Jackie Taylor					**Permits**		
51-6-0060	Marulan Quarry 2	AGD	55	772450	6153000	Open site	Valid	Artefact : -	Open Camp Site	1995,99404,100613,100615,100637,101183
	Contact	**Recorders**	Kerry Navin					**Permits**	2760,2761	
51-6-0242	MRN1	AGD	55	773179	6153116	Open site	Valid	Artefact : 3		
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0243	MRN2	AGD	55	773077	6153038	Open site	Valid	Artefact : 6		
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0244	MRN3	AGD	55	773043	6152939	Open site	Valid	Artefact : 8		
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0245	MRN4	AGD	55	772313	6152581	Open site	Valid	Artefact : 6		100614
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0246	MRN5	AGD	55	772404	6152969	Open site	Valid	Artefact : 6		100613,100615,100637,101183
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**	2760,2761	

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0249	MRN8	AGD	55	771061	6153668	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0250	MRN9	AGD	55	771252	6153592	Open site	Valid	Stone Arrangement : -		
	Contact Mr.Bill Hardie	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0251	MRN 10	AGD	55	771106	6153698	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0252	MRN 11	AGD	55	771093	6153692	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0254	MRN 13	AGD	55	771280	6153826	Open site	Valid	Artefact : 20		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0259	MRN18	AGD	55	772327	6153801	Open site	Valid	Artefact : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0262	MRN21	AGD	55	771559	6153669	Open site	Valid	Artefact : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0263	MRN22	AGD	55	771713	6153691	Open site	Valid	Artefact : 11		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0265	MRN24	AGD	55	771946	6153098	Open site	Valid	Artefact : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
48-4-0086	DP1056566 Lot 11/1	AGD	56	225675	6148350	Open site	Valid	Artefact : 12		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**	2536,2675,2676	
48-4-0087	DP1056566 Lot 11/2	AGD	56	226075	6148875	Open site	Valid	Artefact : 37		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**	2536,2675,2676	
48-4-0088	DP1056566 Lot 11/3	AGD	56	226000	6148750	Open site	Valid	Artefact : 3		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**	2536,2675,2676	
48-4-0089	DP1056566 Lot 12/1	AGD	56	225875	6147475	Open site	Valid	Artefact : 21		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**		
48-4-0090	DP1056566 Lot 12/2	AGD	56	225875	6147625	Open site	Valid	Artefact : 8		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**		
48-4-0091	DP1056566 Lot 12/3	AGD	56	225875	6147625	Open site	Valid	Artefact : 8		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**		

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
48-4-0092	DP1056566 Lot 12/IF1	AGD	56	225800	6147780	Open site	Valid	Artefact : 1		99346,99362
	Contact T Russell	**Recorders**	Mr.Doug Williams					**Permits**		
48-4-0093	DP1056566 Lot 12/IF2	AGD	56	225750	6147800	Open site	Valid	Artefact : 1		99346,99362
	Contact T Russell	**Recorders**	Mr.Doug Williams					**Permits**		
51-6-0378	LA 23	AGD	55	769978	6153907	Open site	Valid	Artefact : 2		99620
	Contact Searle	**Recorders**	Archaeological Heritage Surveys					**Permits**		
51-6-0381	LA 26	AGD	55	770030	6153824	Open site	Valid	Artefact : 1		99620
	Contact Searle	**Recorders**	Archaeological Heritage Surveys					**Permits**		
52-4-0143	MSQ 1	GDA	56	228406	6149690	Open site	Destroyed	Artefact : -		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0144	MSQ2	GDA	56	228292	6149943	Open site	Destroyed	Artefact : 3		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0145	MSQ3	GDA	56	228625	6149982	Open site	Destroyed	Artefact : 1		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0146	MSQ4	GDA	56	228608	6150001	Open site	Destroyed	Artefact : 1		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0147	MSQ5	GDA	56	228557	6149936	Open site	Destroyed	Artefact : 1		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0148	MSQ6	GDA	56	227050	6150950	Open site	Valid	Artefact : 2		
	Contact Searle	**Recorders**	Mr.Chris Lange					**Permits**		
52-4-0149	MSQ7	GDA	56	227735	6150380	Open site	Valid	Artefact : 2		
	Contact Searle	**Recorders**	Mr.Chris Lange					**Permits**		
52-4-0150	MSQ8	GDA	56	227353	6150223	Open site	Destroyed	Artefact : 9		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0151	MSQ9	GDA	56	227297	6150151	Open site	Destroyed	Artefact : 4		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0152	MSQ10	GDA	56	227252	6150208	Open site	Destroyed	Artefact : 2		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0153	MSQ11	GDA	56	227153	6150213	Open site	Destroyed	Artefact : 8		
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0154	MSQ12	GDA	56	227213	6150319	Open site	Destroyed	Artefact : 1		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0155	MSQ13	GDA	56	227153	6150213	Open site	Destroyed	Artefact : 4		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
52-4-0156	MSQ14	GDA	56	227414	6150203	Open site	Destroyed	Artefact : 1		103083
	Contact Searle	**Recorders** Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0157	MSQ15	GDA	56	227383	6150181	Open site	Destroyed	Artefact : 1		103083
	Contact Searle	**Recorders** Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0158	MSQ16	GDA	56	227447	6150191	Open site	Destroyed	Artefact : 2		103083
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0159	MSQ17	GDA	56	227198	6150283	Open site	Destroyed	Artefact : 3		103083
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0160	MSQ18	GDA	56	228576	6150429	Open site	Destroyed	Artefact : -		
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0161	BCSC1	GDA	56	227944	6148309	Open site	Destroyed	Artefact : -		100467
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont						**Permits**	2687,2976	
51-6-0428	Winfarthing Road - Isolated Find - WRIF1	AGD	55	765994	6150702	Open site	Valid	Artefact : 1		
	Contact T Russell	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0429	Winfarthing Road - WR2	AGD	55	765920	6150600	Open site	Valid	Artefact : -		
	Contact T Russell	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0430	Winfarthing Road - WR3	AGD	55	765672	6149673	Open site	Valid	Artefact : 3		
	Contact T Russell	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0422	Winfarthing Road - WR 1	GDA	55	765887	6150772	Open site	Valid	Artefact : 14		
	Contact Searle	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0467	Marulan T6 S1	AGD	55	772216	6152641	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0468	Marulan T6 S2	AGD	55	772010	6153579	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0469	Marulan T6 S4	AGD	55	772089	6153660	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0470	Marulan T6 S3	AGD	55	771997	6153599	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
52-4-0195	M1 (BCSC1)	AGD	56	227940	6148310	Open site	Destroyed	Artefact : -		100467,101390
	Contact	**Recorders** ERM Australia Pty Ltd-Pyrmont						**Permits**	2687,2976	
51-6-0638	MRN73	AGD	55	772847	6152659	Open site	Valid	Artefact : -		
	Contact	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0628	MRN67	AGD	55	772764	6152846	Open site	Valid	Artefact : -		101034
	Contact	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		

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51-6-0631	MRN70	AGD	55	772755	6152859	Open site	Valid	Artefact : -		101034
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0632	MRN71	AGD	55	772797	6152713	Open site	Valid	Artefact : -		101034
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0633	MRN72	AGD	55	772868	6152814	Open site	Valid	Artefact : -		
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0636	MRN76	AGD	55	771409	6153691	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
52-4-0246	M2	GDA	56	227783	6148128	Open site	Valid	Artefact : 3		
Contact		Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0264	Peppertree Burial 01 (stone arrangement)	GDA	56	227335	6150132	Open site	Valid	Stone Arrangement : 1		
Contact		Recorders	Godden Mackay Logan Heritage Consultants,Doctor.Tim Owen					Permits		
52-4-0265	Peppertree Scarred Tree 02	GDA	56	227874	6150107	Open site	Valid	Modified Tree (Carved or Scarred) : -		
Contact		Recorders	Godden Mackay Logan Heritage Consultants,Doctor.Tim Owen					Permits		
52-4-0266	BCSC AS1	AGD	56	226352	6147944	Open site	Valid	Artefact : 8		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0267	BCSC AS2	AGD	56	226371	6147950	Open site	Valid	Artefact : 2		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0268	BCSC AS3	AGD	56	226381	6147968	Open site	Valid	Artefact : 2		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0269	BCSC AS4	AGD	56	226380	6148020	Open site	Valid	Artefact : 22		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0270	BCSC IF2	AGD	56	226284	6147952	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0271	BCSC IF3	AGD	56	226206	6147767	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0272	BCSC IF4	AGD	56	226182	6147840	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0273	BCSC IF7	AGD	56	226313	6147951	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0274	BCSC IF8	AGD	56	226313	6147951	Open site	Valid	Artefact : 1		

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	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0275	BCSC IF9	AGD	56	226333	6147978	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0276	BCSC IF11	GDA	56	226354	6147952	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0277	BCSC IF12	AGD	56	226357	6147961	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0278	BCSC IF13	AGD	56	226359	6147974	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0279	BCSC IF14	AGD	56	226386	6147978	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0291	MQ 19	GDA	56	227498	6150292	Open site	Valid	Artefact : 1		103083
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0292	MQ 20	GDA	56	227952	6150239	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0293	MQ 21	GDA	56	228103	6150306	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0294	MQ 22	GDA	56	228292	6149943	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0295	MQ 23	GDA	56	227565	6150191	Open site	Destroyed	Artefact : 1		103083
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0296	MQ 24	GDA	56	227864	6150067	Open site	Destroyed	Artefact : 1		103083
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0297	MQ 25	GDA	56	229040	6149327	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0298	MQ 26	GDA	56	228833	6149949	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0299	MQ 27	GDA	56	227770	6150502	Open site	Valid	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0300	MQ 28	GDA	56	228264	6150468	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0301	MQ 29	GDA	56	228330	6150417	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
51-6-0704	MRN85	GDA	55	771793	6152895	Open site	Valid	Artefact : 1		

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14107 - Marulan 3

Client Service ID : 146358

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0705	MRN82	GDA	55	772955	6153079	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0706	MRN83	GDA	55	771622	6153881	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0707	MRN84	GDA	55	772089	6153292	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		

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Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

New Recording ☒ Additional information ☐

SITE IDENTIFICATION

Site name	BCSC1	**NPWS Site Number**	52-4-0161
Owner/manager	Blue Circle Southern Cement		
Owner Address	Hume St, Marulan South 2579		

LOCATION

Location	Marulan South				
How to get to the site	Access is via Blue Circle Southern Cement mine				
1:250,000 map name	Mossvale			**NPWS map code**	
AMG Zone	56	**AMG Easting**	227944	**AMG Northing**	6148309
Method for grid reference	Hand-held GPS	**Map scale (if method = map)**		**Map name**	Goulburn
NPWS District				**NPWS Zone**	
Portion no.				**Parish**	Marulan

SITE DESCRIPTION

Site type(s)	Stone artefact scatter	**Site type code (NPWS use only)**	

Description of site and contents
CHECKLIST: eg. length, width, depth, height of site, shelter, deposit, structure, element eg. tree scar, grooves in rock.
DEPOSIT: colour, texture, estimated depth, stratigraphy, contents-shell, bone, stone, charcoal, density & distribution of these, stone types, artefact types.
ART: area of decorated surface, motifs, colours, wet./dry pigment, engraving technique, no. of figures, sizes, patination.
BURIALS: number & condition of bone, position, age, sex, associated artefacts.
TREES: number, alive, dead. likely age, scar shape, position, size, patterns, axe marks, regrowth.
QUARRIES: rock type, debris, recognisable artefacts, percentage quarried

Low density artefact scatter associated with a number of converging minor drainage lines. The artefacts were present in five broad areas. Site boundaries were defined by the study area and the scatter is likely to have extended over a much larger area but has been truncated by mining activity in the past. The majority of artefacts occur close to the drainage lines. The artefacts in each area are listed below.

Location 1(227944E 6148309N) - 3 quartz flakes, 4 silcrete flakes, 1 silcrete broken flake, 1 silcrete flaked piece and 1 FGS (mudstone) broken flake (other fragment).

Location 2 - 6 silcrete flakes, 2 silcrete broken flakes, 1 silcrete broken flake (other fragment), 1 quartz flake and 1 quartz broken flake (proximal fragment).

Location 3 - 3 silcrete flakes, 2 silcrete broken flakes (longitudinal cone split), 1 silcrete broken flake (other fragment) and 1 silcrete core (multidirectional).

Location 4 - 2 silcrete flakes, 1 silcrete broken flake (longitudinal cone split) and 1 silcrete core (multidirectional).

Location 5 (227783E 6148128N) - 3 silcrete flakes, 1 silcrete broken flake (proximal fragment), 1 silcrete broken flake (other fragment) and 1 FGS (chert) flaked piece

Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

SITE ENVIRONMENT

Land form	Drainage line	**Aspect**		**Slope**	
Mark position of the site					
Local rock type		**Land use/effect**	Mining		
Distance from drinking water	within 50 metres	**Source**	ephemeral drainage line		
Resource zone (eg. estuarine, river, forest)		**Vegetation**			
Edible plants		**Faunal resources** (include shellfish)			
Other exploitable resources (eg. ochre)					
Are there other sites in the locality	Yes	**Are they in the Sites Register**	Yes	**Other site types include**	Stone artefact scatters, rockshelters with art

SITE MANAGEMENT

Site condition	Very disturbed	The site has been disturbed by vehicle tracks, grading or heavy machinery and the construction of a haul road for the associated mine.	
Management recommendations	A Section 90 should be obtained and surface collection undertaken.		
Have artefacts been removed from site	No	**When**	
By whom		**Deposited at**	
Consent applied for	☒	**Consent issued**	☐
Date of issue		**Consent number**	

SITE INSPECTION AND RECORDING

Reason for investigation	Continuation of mining operations at Blue Circle Southern Cement Mine.		
Were local Aborigines contacted or present for the recording	☐ Not contacted ☒ Contacted and present ☐ Contacted but not present	**Names and addresses**	Justin Boney (Pejar LALC), Graeme Dobson (United Ngunawal), Tyronne Bell and Bronwyn Ireland-Bell (Buru Ngunawal Aboriginal Corporation) and Dean Delponte (Yurwanga Gundana)
Is the site important to local Aborigines	refer to report (named below)		
Verbal/written reference sources	Marulan South Continuation of Operations Aboriginal Cultural Heritage Assessment	**ASR report number(s)**	C- C-
Photographs taken	Yes	**No of Photos attached**	

Version: June 1998 Data entered by: Date entered:

Aboriginal Sites Register of NSW

52-4-0195.

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

New Recording ☐ Additional information ☐

SITE IDENTIFICATION

Site name	M1	**NPWS Site Number**	
Owner/manager	Blue Circle Southern Cement		
Owner Address			

LOCATION

Location	Marulan South				
How to get to the site	drive				
1:250,000 map name	Mossvale			**NPWS map code**	
AMG Zone	56	**AMG Easting**	227944	**AMG Northing**	6148309
Method for grid reference	Hand-held GPS	**Map scale (if method = map)**		**Map name**	
NPWS District				**NPWS Zone**	
Portion no.				**Parish**	Marulan

SITE DESCRIPTION

Site type(s)	Stone artefact scatter	**Site type code (NPWS use only)**	
Description of site and contents CHECKLIST: eg. length, width, depth, height of site, shelter, deposit, structure, element eg. tree scar, grooves in rock. DEPOSIT: colour, texture, estimated depth, stratigraphy, contents-shell, bone, stone, charcoal, density & distribution of these, stone types, artefact types. ART: area of decorated surface, motifs, colours, wet,/dry pigment, engraving technique, no. of figures, sizes, patination. BURIALS: number & condition of bone, position, age, sex, associated artefacts. TREES: number, alive, dead. likely age, scar shape, position, size, patterns, axe marks, regrowth. QUARRIES: rock type, debris, recognisable artefacts, percentage quarried	Small artefact scatter located on SE bank of a minor drainage line. Five artefacts were found within an area of 10 metres by five metres disturbed by construcjton of a vehicle track/cutting across the drainage line. The area is cleared and much of the surrounding area is disturbed by mining/quarrying activites. Gully erosion and dumped material also occur. Visbility on the site/track was approximately 70 percent and on surrounding area approximatley 10 percent. Artefacts: Flake Quartz 50 mm Flake Quartz 15 mm Flake Silcrete 30 mm Flake Sicrete 30 mm Broken flake Silcrete 25 mm.		

Version: June 1998	Data entered by:	Date entered:

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Standard Site Recording Form

	Attach photographs and sketches, eg. plan & section of shelter. **Do NOT dig, disturb or damage site or contents.**

Version: June 1998	Data entered by:	Date entered:

Aboriginal Sites Register of NSW

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Standard Site Recording Form

SITE ENVIRONMENT

Land form		**Aspect**		**Slope**	
Mark position of the site					
Local rock type		**Land use/effect**			
Distance from drinking water		**Source**			
Resource zone (eg. estuarine, river, forest)		**Vegetation**			
Edible plants		**Faunal resources** (include shellfish)			
Other exploitable resources (eg. ochre)					
Are there other sites in the locality		**Are they in the Sites Register**		**Other site types include**	

SITE MANAGEMENT

Site condition			
Management recommendations			
Have artefacts been removed from site		**When**	
By whom		**Deposited at**	
Consent applied for	☐	**Consent issued**	☐
Date of issue		**Consent number**	

SITE INSPECTION AND RECORDING

Reason for investigation					
Were local Aborigines contacted or present for the recording	☐ Not contacted ☐ Contacted and present ☐ Contacted but not present	**Names and addresses**			
Is the site important to local Aborigines					
Verbal/written reference sources			**ASR report number(s)**	C- C-	
Photographs taken			**No of Photos attached**		
Site recorded by			**Date of recording**		
Address/institution	Environmental Resources Management Australia Pty Ltd (ERM), Building C 33 Saunders Street Pyrmont NSW 2009				

Version: June 1998	Data entered by:	Date entered:

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AHIMS Web Services (AWS)

f/PO Number : J14107 Marulan Sth update

Client Service ID : 329804

Note: This Excel report shows the sites found in AHIMS on the 23/02/2018. If this date is not the same as the original date of the Search Results letter obtained during the Basic Search, then the search results might be different. The PDF version of this report will always coincide with the Basic Search Results letter.

Site ID	Site name	Datum	Zone	Easting	Northing	Context	Site status	Primary contact	Site features	Site types	Recorders	Reports	Permits	Longitude GDA94	Latitude GDA94
52-4-0195	M1 (BCSC1)	AGD	56	227940	6148310	Open site	Destroyed		Artefact : -		ERM Australia Pty Ltd- !	100467,101390	2687,2976	150.03	-34.77
52-4-0264	Peppertree Burial 01 (s	GDA	56	227335	6150132	Open site	Valid		Stone Arrangement : 1		GML Heritage Pty Ltd +	103137		150.02	-34.75
52-4-0265	Peppertree Scarred Tre	GDA	56	227874	6150107	Open site	Valid		Modified Tree (Carved or Scarred) : -		GML Heritage Pty Ltd +	103137		150.03	-34.75
52-4-0266	BCSC AS1	AGD	56	226352	6147944	Open site	Valid		Artefact : 8		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0267	BCSC AS2	AGD	56	226371	6147950	Open site	Valid		Artefact : 2		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0268	BCSC AS3	AGD	56	226381	6147968	Open site	Valid		Artefact : 2		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0269	BCSC AS4	AGD	56	226380	6148020	Open site	Valid		Artefact : 22		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0270	BCSC IF2	AGD	56	226284	6147952	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0271	BCSC IF3	AGD	56	226206	6147767	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0272	BCSC IF4	AGD	56	226182	6147840	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0273	BCSC IF7	AGD	56	226313	6147951	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0274	BCSC IF8	AGD	56	226313	6147951	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0275	BCSC IF9	AGD	56	226333	6147978	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0276	BCSC IF11	GDA	56	226354	6147952	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0277	BCSC IF12	AGD	56	226357	6147961	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0278	BCSC IF13	AGD	56	226359	6147974	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0279	BCSC IF14	AGD	56	226386	6147978	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0263	BCSC IF 1	GDA	56	226967	6147161	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.02	-34.78
48-4-0086	DP1056566 Lot 11/1	AGD	56	225675	6148350	Open site	Valid	T Russell	Artefact : 12		Mr.Doug Williams	99346,99362	2536,2675,2676	150.00	-34.77
48-4-0087	DP1056566 Lot 11/2	AGD	56	226075	6148875	Open site	Valid	T Russell	Artefact : 37		Mr.Doug Williams	99346,99362	2536,2675,2676	150.01	-34.76
48-4-0088	DP1056566 Lot 11/3	AGD	56	226000	6148750	Open site	Valid	T Russell	Artefact : 3		Mr.Doug Williams	99346,99362	2536,2675,2676	150.01	-34.76
48-4-0089	DP1056566 Lot 12/1	AGD	56	225875	6147475	Open site	Valid	T Russell	Artefact : 21		Mr.Doug Williams	99346,99362		150.01	-34.78
48-4-0090	DP1056566 Lot 12/2	AGD	56	225875	6147625	Open site	Valid	T Russell	Artefact : 8		Mr.Doug Williams	99346,99362		150.01	-34.78
48-4-0091	DP1056566 Lot 12/3	AGD	56	225875	6147625	Open site	Valid	T Russell	Artefact : 8		Mr.Doug Williams	99346,99362		150.01	-34.78
48-4-0092	DP1056566 Lot 12/IF1	AGD	56	225800	6147780	Open site	Valid	T Russell	Artefact : 1		Mr.Doug Williams	99346,99362		150.00	-34.77
48-4-0093	DP1056566 Lot 12/IF2	AGD	56	225750	6147800	Open site	Valid	T Russell	Artefact : 1		Mr.Doug Williams	99346,99362		150.00	-34.77
52-4-0246	M2	GDA	56	227783	6148128	Open site	Valid		Artefact : 3		ERM Australia Pty Ltd-	Sydney CBD		150.03	-34.77
52-4-0291	MQ 19	GDA	56	227498	6150292	Open site	Valid		Artefact : 1		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0292	MQ 20	GDA	56	227952	6150239	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0293	MQ 21	GDA	56	228103	6150306	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0294	MQ 22	GDA	56	228292	6149943	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.76
52-4-0295	MQ 23	GDA	56	227565	6150191	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0296	MQ 24	GDA	56	227864	6150067	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103083,103137		150.03	-34.76
52-4-0297	MQ 25	GDA	56	229040	6149327	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.04	-34.76
52-4-0298	MQ 26	GDA	56	228833	6149949	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.04	-34.76
52-4-0299	MQ 27	GDA	56	227770	6150502	Open site	Valid		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0300	MQ 28	GDA	56	228264	6150468	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0301	MQ 29	GDA	56	228330	6150417	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0143	MSQ 1	GDA	56	228406	6149690	Open site	Destroyed	Searle	Artefact : -		Mr.Chris Lange,ERM Au	103137		150.03	-34.76
52-4-0144	MSQ2	GDA	56	228292	6149943	Open site	Destroyed	Searle	Artefact : 3		Mr.Chris Lange,ERM Au	103137		150.03	-34.76
52-4-0145	MSQ3	GDA	56	228625	6149982	Open site	Destroyed	Searle	Artefact : 1		Mr.Chris Lange,ERM Au	103137		150.04	-34.76
52-4-0146	MSQ4	GDA	56	228608	6150001	Open site	Destroyed	Searle	Artefact : 1		Mr.Chris Lange,ERM Au	103137		150.04	-34.76
52-4-0147	MSQ5	GDA	56	228557	6149936	Open site	Destroyed	Searle	Artefact : 1		Mr.Chris Lange,ERM Au	103137		150.03	-34.76
52-4-0148	MSQ6	GDA	56	227050	6150950	Open site	Valid	Searle	Artefact : 2		Mr.Chris Lange	103137		150.02	-34.75
52-4-0149	MSQ7	GDA	56	227735	6150380	Open site	Valid	Searle	Artefact : 2		Mr.Chris Lange	103137		150.03	-34.75
52-4-0150	MSQ8	GDA	56	227353	6150223	Open site	Destroyed	Searle	Artefact : 9		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0151	MSQ9	GDA	56	227297	6150151	Open site	Destroyed	Searle	Artefact : 4		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0152	MSQ10	GDA	56	227252	6150208	Open site	Destroyed	Searle	Artefact : 2		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0153	MSQ11	GDA	56	227153	6150213	Open site	Destroyed	Searle	Artefact : 8		Mr.Neville Baker,ERM A	103137		150.02	-34.75
52-4-0154	MSQ12	GDA	56	227213	6150319	Open site	Destroyed	Searle	Artefact : 1		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0155	MSQ13	GDA	56	227153	6150213	Open site	Destroyed	Searle	Artefact : 4		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0156	MSQ14	GDA	56	227414	6150203	Open site	Destroyed	Searle	Artefact : 1		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0157	MSQ15	GDA	56	227383	6150181	Open site	Destroyed	Searle	Artefact : 1		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0158	MSQ16	GDA	56	227447	6150191	Open site	Destroyed	Searle	Artefact : 2		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0159	MSQ17	GDA	56	227198	6150283	Open site	Destroyed	Searle	Artefact : 3		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0160	MSQ18	GDA	56	228576	6150429	Open site	Destroyed	Searle	Artefact : -		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0161	BCSC1	GDA	56	227944	6148309	Open site	Destroyed	Searle	Artefact : -		ERM Australia Pty Ltd- !	100467	2687,2976	150.03	-34.77
52-4-0571	MSL010	GDA	56	227014	6151710	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.02	-34.74
52-4-0572	MSL011	GDA	56	227303	6151742	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.02	-34.74
52-4-0573	MSL012	GDA	56	227351	6151743	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.02	-34.74
52-4-0574	BCSC AS 5	GDA	56	226394	6148034	Open site	Valid		Artefact : 1		O'Sullivan			150.01	-34.77
52-4-0517	MQ120	GDA	56	228983	6148847	Open site	Valid		Modified Tree (Carved or Scarred) : -		Mrs.Rebecca Newell			150.04	-34.77
52-4-0575	MSL047	GDA	56	227733	6151810	Open site	Valid		Artefact : 1		Mrs.Rebecca Newell,EMM Consulting			150.03	-34.74
52-4-0576	MSL051	GDA	56	226726	6148062	Open site	Valid		Artefact : 1		Mrs.Rebecca Newell,EMM Consulting			150.01	-34.77
52-4-0527	MSL013	GDA	56	227480	6151678	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.02	-34.74
52-4-0528	MSL014	GDA	56	227573	6151736	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.02	-34.74
52-4-0529	MSL015	GDA	56	227670	6151893	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.03	-34.74
52-4-0530	MSL016	GDA	56	227790	6152047	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.03	-34.74
52-4-0531	MSL017	GDA	56	228378	6149319	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),	Mrs.Rebecca Newell		150.03	-34.76

52-4-0532	MSL018	GDA	56	228156	6149143	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0533	MSL019	GDA	56	227926	6149051	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0534	MSL020	GDA	56	226874	6148700	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0535	MSL021	GDA	56	226651	6148231	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0536	MSL022	GDA	56	226773	6147960	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0537	MSL023	GDA	56	226960	6147938	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0538	MSL024	GDA	56	226929	6148039	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0539	MSL025	GDA	56	227298	6147245	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0540	MSL026	GDA	56	227583	6147404	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0541	MSL027	GDA	56	227564	6147638	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0542	MSL028	GDA	56	227796	6148156	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.77
52-4-0543	MSL029	GDA	56	227799	6148259	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.77
52-4-0544	MSL030	GDA	56	227576	6148273	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0545	MSL031	GDA	56	227532	6148053	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0546	MSL032	GDA	56	227675	6147990	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0547	MSL033	GDA	56	227599	6147928	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0548	MSL034	GDA	56	226677	6147956	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0549	MSL035	GDA	56	227214	6147991	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0550	MSL036	GDA	56	227250	6148100	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0551	MSL037	GDA	56	228711	6148854	Open site	Valid	Modified Tree (Carved or Scarred) : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.04	-34.77
52-4-0552	MSL038	GDA	56	227600	6148067	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0553	MSL039	GDA	56	226722	6148080	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0554	MSL040	GDA	56	226761	6148124	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0555	MSL041	GDA	56	226604	6148142	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0556	MSL042	GDA	56	227306	6151708	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0557	MSL043	GDA	56	227316	6147747	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0558	MSL044	GDA	56	226634	6148017	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0559	MSL045	GDA	56	227908	6152143	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0560	MSL046	GDA	56	227827	6151971	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0561	MSL048	GDA	56	227927	6152149	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0562	MSL049	GDA	56	227467	6150995	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.75
52-4-0563	MSL050	GDA	56	226829	6147930	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0564	MSL052	GDA	56	226604	6148129	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0565	MSL053	GDA	56	226733	6147960	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0566	MSL054	GDA	56	227689	6147985	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0567	MSL055	GDA	56	227939	6149291	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0568	MSL056	GDA	56	228042	6149204	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0569	MSL057	GDA	56	227817	6152074	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0570	MSL058	GDA	56	227647	6151634	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0518	MSL001	GDA	56	227874	6152125	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0519	MSL002	GDA	56	227590	6151948	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0520	MSL003	GDA	56	227531	6151862	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0521	MSL004	GDA	56	227391	6151763	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0522	MSL005	GDA	56	227138	6151821	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0523	MSL006	GDA	56	226932	6151817	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0524	MSL007	GDA	56	226894	6151731	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0525	MSL008	GDA	56	226798	6151823	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0526	MSL009	GDA	56	226875	6151683	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74

Report generated by AHIMS Web Service on 23/02/2018 for Pamela Chauvel for the following area at Datum :GDA, Zone : 56, Eastings : 224977 - 230200, Northings : 6146607 - 6152672 with a Buffer of 200 meters. Additional Info : Aboriginal heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 117

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Appendix C

Survey and excavation personnel

Table C.1 Survey personnel

Participants	
Ryan Desic	Adam Patterson
Rebecca Newell	Karen Denny
Deidre Patterson	Steve Johnson
Justin Boney	Duncan Falk
Tyronne Bell	Glen Freeman
Deidre Patterson	Kayleen Busk
Leeroy Boota	Shaun Carroll
Lee Patterson	Ryan Johnson
Izahaya Clay	Tammy Muscat

Table C.2 Excavation personnel

Participants	
Rebecca Newell	Newton Carriage
Pamela Kottaras	Karen Denny
Ryan Desic	Steve Johnson
Pamela Chauvel	Duncan Falk
Nick Svede	Newton Bond
Irek Golka	Kieran McNally
Grant Thompson	Georgette Lord
Justin Boney	Tina O'Sullivan
Glen Freeman	Shaun Carroll
Leeroy Boota	Ryan Johnson
Graeme Dobson	Tyronne Bell

Appendix D

Survey data

Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m²)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m²)	Area available for detection (m²)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Comments
T1	13/04/2015	Pedestrian survey	Low Hills	Watercourse	1	900	127	50	6350	20	60	0.2	0.6	3810	762	12	Marualn	Marulan Granite Batholith	Granite, silcrete	30	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A transect through a drainage depression, in flat paddock. The area is cut by a vehicle track and has a moderate level of disturbance. Marulan creek lies to the north. Vegetation consists of pature grasses and weeds. One large tree, not scarred.
T2	13/04/2015	Pedestrian survey	Low Hills	Ridgeline	10	10	4590	50	229500	20	60	0.2	0.6	137700	27540	12	Marualn	Marulan Granite Batholith	Granite, silcrete	20	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	The transect followed a flat hill crest in paddocks, generally exposures are areas of erosion through cattle tracks and resting places. Vegetation is pasture grasses and weeds, no trees or shrubs along transect. Follows the route of the proposed haul road.
T3	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	10	13235.4	50	661770	40	60	0.4	0.6	397062	158824.8	24	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A transect along Marulan Creek following the slope. Due to the large group the transect crossed the gentle slope landform adjacent to the creek. This included the lower mid and upper slope landforms. Vegetation was pasture grass and weeds, with very few trees or shrubs. Erosion along the transect was a result of machine works including channel creation and from wind and water erosion as well as some cattle tracks.
T4	13/04/2015	Pedestrian survey	Low Hills	Watercourse	1	10	458.1	20	9162	40	70	0.4	0.7	6413.4	2565.36	28	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A transect along a drainage depression, a tributary of Marulan Creek. Large areas of erosion have been created through creek bank slip and possibly flooding. Background scatter of granite and other gravels
T5	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	10	460	50	23000	40	70	0.4	0.7	16100	6440	28	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A transect along Marulan Creek following the slope. Due to the large group the transect crossed the gentle slope landform adjacent to the creek. This included the lower mid and upper slope landforms. Vegetation was pasture grass and weeds, with very few trees or shrubs. Erosion along the transect was a result of machine works including channel creation and from wind and water erosion as well as some cattle tracks.
T6	13/04/2015	Pedestrian survey	Low Hills	Spur	N/A	5	151	30	4530	30	70	0.3	0.7	3171	951.3	21	Marualn	Marulan Granite Batholith	Granite, silcrete	5	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect along the upper hill crest overlooking Marulan Creek. A vehicle track cut through the majority of the transect. Pasture and weed grasses throughout. Large trees framed the creek section of the transect
T7	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	1	10	10	100	10	50	0.1	0.5	50	5	5	Marualn	Marulan Granite Batholith	Granite, silcrete	5	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect through Marulan Creek. Marshy area with water flowing through and very high creek banks on either side from erosion.
T8	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	5	1954	50	97700	40	80	0.4	0.8	78160	31264	32	Marualn	Marulan Granite Batholith	Granite, silcrete	5	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A transect along Marulan Creek following the slope. Due to the large group the transect crossed the gentle slope landform adjacent to the creek. This included the lower mid and upper slope landforms. Vegetation was pasture grass and weeds, with very few trees or shrubs. Erosion along the transect was a result of machine works including channel creation and from wind and water erosion as well as some cattle tracks.
T9	13/04/2015	Pedestrian survey	Low Hills	Spur	N/A	10	132	50	6600	20	70	0.2	0.7	4620	924	14	Marualn	Marulan Granite Batholith	Granite, silcrete	20	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	The transect followed a flat hill crest in paddocks, generally exposures are areas of erosion through cattle tracks and resting places. Vegetation is pasture grasses and weeds, no trees or shrubs along transect. Follows the route of the proposed haul road.
T10	14/04/2015	Pedestrian survey	Low Hills	Undulating plain	5	290	734	50	36700	10	10	0.1	0.1	3670	367	1	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	This transect was over a small paddock covered in long grass with very low visibility. Very few trees scattered through. Evidence of a small ephemeral drainage line. Vegetation is high pasture grass. The transect is on a flat hillcrest landform. Appears that the area was a large crest overlooking Tangarang Creek in the northg
T11	14/04/2015	Pedestrian survey	Low Hills	Spur	10	300	875	50	43750	10	5	0.1	0.05	2187.5	218.75	0.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	This transect was over a small paddock covered in long grass with very low visibility. Very few trees scattered through. Evidence of a small ephemeral drainage line. Vegetation is high pasture grass. The transect is on a flat hillcrest landform. Appears that the area was a large crest overlooking Tangarang Creek in the northg
T12	14/04/2015	Pedestrian survey	Low Hills	Watercourse	4	350	331	50	16550	10	5	0.1	0.05	827.5	82.75	0.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	The transect covered a small ephemeral drainage line on a flat crest landform. Vegetation was very high pasture grass and visibility was very low.
T13	14/04/2015	Pedestrian survey	Low Hills	Spur	5	500	702	50	35100	10	40	0.1	0.4	14040	1404	4	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	The transect covered a hillcrest landform. The area was charcteised by many rolling open low hills and the transect was large enough to cover some of the slopes associated with the hillcrest.
T14	14/04/2015	Pedestrian survey	Low Hills	Watercourse	3	500	210	50	10500	20	60	0.2	0.6	6300	1260	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A transect following two drainage depressions also encompassing the banks of the depressions. No water in any. The vegetation was pasture grasses very high making visibility very low.
T15	14/04/2015	Pedestrian survey	Low Hills	Hill slope	10	500	283	50	14150	30	60	0.3	0.6	8490	2547	18	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Hillcrest transect. Vegetation cover was high, with pasture grasses and some trees.
T16	14/04/2015	Pedestrian survey	Low Hills	Watercourse	2	500	470	50	23500	20	60	0.2	0.6	14100	2820	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect following two drainage depressions. A number of mature trees and pasture and weed grasess dominate the transect. Many large outcrops of granite throughout
T17	14/04/2015	Pedestrian survey	Low Hills	Spur	4	800	180	20	3600	40	80	0.4	0.8	2880	1152	32	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks possibly quarry activities	Grassed paddock	Transect on hillcrest, trees and leaft litter. Many gravels as cover, the area has been highly disturbed, it could be a hill maunfactured as a result of the quarry activities.
T18	14/04/2015	Pedestrian survey	Low Hills	Hill slope	5	800	136	50	6800	10	70	0.1	0.7	4760	476	7	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect on a hillslope showing mid and lower slop characteristics towards an ephermeral watercourse. Vegetation cover is thick pasture grasses and weeds.

Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m²)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m²)	Area available for detection (m²)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Comments
T19	14/04/2015	Pedestrian survey	Low Hills	Watercourse	2	800	75	20	1500	10	60	0.1	0.6	900	90	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Drainage depression transect, crosses two
T20	14/04/2015	Pedestrian survey	Low Hills	Hill slope	40	800	150	50	7500	20	70	0.2	0.7	5250	1050	14	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect on lower hillslop leading to large flat hillcrest. Vegetation was thick with many large bloulders of granite spread throughout the transect.
T21	14/04/2015	Pedestrian survey	Low Hills	Spur	50	815	274	50	13700	10	70	0.1	0.7	9590	959	7	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect on flat crest landform asdjacent to drainage line.
T22	14/04/2015	Pedestrian survey	Low Hills	Spur	30	830	510	50	25500	20	60	0.2	0.6	15300	3060	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect onbank of ephemeral creek bank following slope landform Like a spur
T23	14/04/2015	Pedestrian survey	Low Hills	Watercourse	2	900	693	50	34650	30	60	0.3	0.6	20790	6237	18	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Transect onbank of ephemeral creek bank following flat landform
T24	14/04/2015	Pedestrian survey	Low Hills	Hill slope	3	1000	495	50	24750	10	60	0.1	0.6	14850	1485	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Following hillslope lower mid and upper to finish on the crest of a ridge landform. Vegetation is thick pasture grass and weeds with some granite outcropping evident.
T25	14/04/2015	Pedestrian survey	Ridge	Ridgeline	5	1000	388	50	19400	10	60	0.1	0.6	11640	1164	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Ridgecrest landform following the line of a flat ridge adjacent to Marulan South Road. Vegetation cover is high with pasture grasses and weeds throughout.
T26	14/04/2015	Pedestrian survey	Low Hills	Hill slope	30	1000	251	50	12550	10	60	0.1	0.6	7530	753	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Hill slope landform between two drainage depressions
T27	14/04/2015	Pedestrian survey	Ridge	Ridgeline	40	1000	196	50	9800	10	60	0.1	0.6	5880	588	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Ridgecrest landform following the line of a flat ridge adjacent to Marulan South Road. Vegetation cover is high with pasture grasses and weeds throughout.
T28	14/04/2015	Pedestrian	Ridge	Hill slope	20	1500	423	50	21150	10	60	0.1	0.6	12690	1269	6	Marualn	Marulan Granite	Granite, silcrete	10	Grass/imported and	Vehicle, wind and	Grassed	Hill slope landform between two drainage
T29	14/04/2015	Pedestrian survey	Ridge	Hill slope	10	1500	518	50	25900	20	60	0.2	0.6	15540	3108	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Hill slope landform between two drainage depressions, quite steep landform
T30	14/04/2015	Pedestrian survey	Ridge	Ridgeline	30	1500	311	50	15550	10	60	0.1	0.6	9330	933	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Ridgecrest landform following the line of a flat ridge adjacent to Marulan South Road. Vegetation cover is high with pasture grasses and weeds throughout.
T31	15/04/2015	Pedestrian survey	Low Hills	Plain	80	800	314	50	15700	20	60	0.2	0.6	9420	1884	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Plain landform used for cattle and sheep grazing. Paddock and weed grass cover was high and an epheral stream was 80m away.
T32	15/04/2015	Pedestrian survey	Low Hills	Watercourse	2	800	97	50	4850	5	60	0.05	0.6	2910	145.5	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Drainage depression transect in low hills landform pattern. Vegetation was high and there was no water in the drainage depression.
T33	15/04/2015	Pedestrian survey	Low Hills	Hill slope	10	850	82	50	4100	5	60	0.05	0.6	2460	123	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	mid upper and lower hillslope in paddocks. Vegetation grass cover was very high and visibility was very low.
T34	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	340	50	17000	5	50	0.05	0.5	8500	425	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility. A large imported gravel track has been created at the northern end of the transect. Farm tracks are also present throughout the transect.
T35	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	373	50	18650	5	50	0.05	0.5	9325	466.25	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility. A large imported gravel track has been created at the northern end of the transect. Farm tracks are also present throughout the transect.
T36	15/04/2015	Pedestrian survey	Low Hills	Hill slope	10	850	71	68	4828	5	60	0.05	0.6	2896.8	144.84	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	mid upper and lower hillslope in paddocks. Vegetation grass cover was very high and visibility was very low.
T37	15/04/2015	Pedestrian survey	Low Hills	Watercourse	2	800	68	50	3400	5	60	0.05	0.6	2040	102	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Drainage depression transect in low hills landform pattern. Vegetation was high and there was no water in the drainage depression.
T38	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	542	50	27100	5	50	0.05	0.5	13550	677.5	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
T39	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	352	50	17600	5	50	0.05	0.5	8800	440	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility. It contains a scattering of small trees and shrubs. Evidence of termite damage in exposures
T40	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	707	50	35350	5	50	0.05	0.5	17675	883.75	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
T41	15/04/2015	Pedestrian survey	Low Hills	Watercourse	50	800	543	50	27150	5	50	0.05	0.5	13575	678.75	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A drainage depression grazing paddocks with very high grass cover and very low visibility.
T42	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	707	50	35350	20	50	0.2	0.5	17675	3535	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
T43	15/04/2015	Pedestrian survey	Low Hills	Watercourse	3	900	129	50	6450	30	50	0.3	0.5	3225	967.5	15	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A drainage depression grazing paddocks with very high grass cover and very low visibility. Large dam has been created at the start of the transect.
T44	15/04/2015	Pedestrian survey	Low Hills	Plain	10	900	429	50	21450	20	30	0.2	0.3	6435	1287	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
T45	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	900	650	50	32500	20	60	0.2	0.6	19500	3900	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A drainage depression through grazing paddocks. The drainage depression has been subject to extensive disturbance through machine excavation of the depression, the dumping of car parts and other materials and animal movement.
T46	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	729	50	36450	50	80	0.5	0.8	29160	14580	40	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
T47	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	729	50	36450	50	80	0.5	0.8	29160	14580	40	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.

Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m²)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m²)	Area available for detection (m²)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Comments
T48	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	900	650	50	32500	30	60	0.3	0.6	19500	5850	18	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A drainage depression through grazing paddocks.
T49	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	729	50	36450	40	80	0.4	0.8	29160	11664	32	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
T50	15/04/2015	Pedestrian survey	Low Hills	Spur	10	1000	343	50	17150	40	80	0.4	0.8	13720	5488	32	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A ridge crest landform overlooking a number of drainage depressions. Vegetation was leaf litter and pasture grasses. Visibility was good.
T51	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	1000	500	50	25000	20	70	0.2	0.7	17500	3500	14	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A treansect crossing a hill slope and drainage depressions. Vegetation cover is pasture grasses, weeds and leaf litter from eucalypt trees in the vicinity. No mature trees identified.
T52	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	266	50	13300	10	60	0.1	0.6	7980	798	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
T53	15/04/2015	Pedestrian survey	Low Hills	Spur	10	1000	262	50	13100	20	50	0.2	0.5	6550	1310	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steep crest following a drainage line, vegetation was thick and terrain was difficult. Large number of boulders and granite outrcrops visible.
T54	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	1000	255	50	12750	30	70	0.3	0.7	8925	2677.5	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steel drainage depression with two large dams located in each area.
T55	15/04/2015	Pedestrian survey	Low Hills	Spur	15	1500	232	50	11600	30	70	0.3	0.7	8120	2436	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steep crest following a drainage line, vegetation was thick and terrain was difficult. Large number of boulders and granite outrcrops visible.
T56	15/04/2015	Pedestrian survey	Low Hills	Spur	15	1500	316	50	15800	30	70	0.3	0.7	11060	3318	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steep crest following a drainage line, vegetation was thick and terrain was difficult. Large number of boulders and granite outrcrops visible.
T57	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	200	2000	950	50	47500	10	60	0.1	0.6	28500	2850	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steep ridgeline near the Bungonia George with very high vegetation cover, including thick trees and ground vegetation. Many granite boulders of varying sizes
T58	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	200	2000	451	50	22550	10	60	0.1	0.6	13530	1353	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steep ridgeline near the Bungonia George with very high vegetation cover, including thick trees and ground vegetation. Many granite boulders of varying sizes
T59	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	200	2000	334	50	16700	10	60	0.1	0.6	10020	1002	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A steep ridgeline near the Bungonia George with very high vegetation cover, including thick trees and ground vegetation. Many granite boulders of varying sizes. Followed a vehicle track with dumped car located alongside.
T60	16/04/2015	Pedestrian survey	Low Hills	Spur	200	2000	698	50	34900	10	60	0.1	0.6	20940	2094	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A moderately inclined crest over looking a number of drainage lines.
T61	16/04/2015	Pedestrian survey	Low Hills	Watercourse	1	2000	443	50	22150	30	70	0.3	0.7	15505	4651.5	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	Following a number of drainage depressions and a possible remnant creek line as they move up into more inclined areas. Very steep and difficult to naviage terrrain.
T62	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	10	2000	426	50	21300	30	70	0.3	0.7	14910	4473	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A moderately inclined crest over looking a number of drainage lines.
T63	16/04/2015	Pedestrian survey	Low Hills	Watercourse	10	2000	564	50	28200	30	70	0.3	0.7	19740	5922	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A drainage depression finishing in a large dam adjacent to the mine haul road. Vegetation was pasture grass and exposure and visibility were moderate.
T64	16/04/2015	Vehicel	Low Hills	Ridgeline	10	1000	997	10	9970	10	40	0.1	0.4	3988	398.8	4	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A vehicle transect on the crest of a ridge. It is in an area of previous dumping for the quarry and is a highly modified environment. The slope to the south is very steep and goes into the gorge. Vegetation renewal has occured and gravels, soil and sand have been introduced.
T65	17/04/2015	Pedestrian survey	Low Hills	Watercourse	20	20	1091	50	54550	10	40	0.1	0.4	21820	2182	4	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A creek bank overlooking a section of the now removed unnamed creek flowing through the quarry area. Vegetation was high with leaf litter and grass cover. The other side of the bank was also traversed.
T66	17/04/2015	Pedestrian survey	Low Hills	Spur	10	30	921	50	46050	20	50	0.2	0.5	23025	4605	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A spur crest between a number of drainage lines, gentle aspect with many flat sections as it climbs to the main redgeline in the area.
T67	17/04/2015	Pedestrian survey	Low Hills	Spur	10	30	565	50	28250	20	50	0.2	0.5	14125	2825	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A spur crest between a number of drainage lines, gentle aspect with many flat sections as it climbs to the main redgeline in the area.
T68	17/04/2015	Pedestrian survey	Low Hills	Spur	10	30	1313	50	65650	20	50	0.2	0.5	32825	6565	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	A spur crest between a number of drainage lines, gentle aspect with many flat sections as it climbs to the main redgeline in the area.
T69	17/04/2015	Pedestrian survey	Low Hills	Ridgeline	50	1000	619	50	30950	20	50	0.2	0.5	15475	3095	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	The gentle crest of a rdige in the surrounding area. Possibly the easiest route through the area. Vegetation was high and visibility was low
T70	17/04/2015	Pedestrian survey	Low Hills	Watercourse	10	10	692	50	34600	20	30	0.2	0.3	10380	2076	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	the bank of a creek running towards the Bungong George. Disturbed through erosion, farm tracks, and the use of concerete and dumping at the end of transect
T71	17/04/2015	Pedestrian survey	Low Hills	Watercourse	10	10	692	50	34600	10	30	0.1	0.3	10380	1038	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	the bank of a creek running towards the Bungong George. Disturbed through erosion, farm tracks, and the use of concerete and dumping at the end of transect

Appendix E

Test excavation data

Test pit	Square	Level	Type	Implement	Raw material	Length	Weight	Colour	Comment
TP15	SOUTH	Spit 1: 0-10cm	Retouched flake	Retouched	Silcrete	75	29.35	Grey	Retouched on dorsal face along two margins, distal end
TP15	SOUTH	Spit 1: 0-10cm	Core		Silcrete	40	11.36	Grey	Flake that has been turned into a core - negative scars on ventral surface. 10% cortex on
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	29	3.69	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Longitudinal split		Silcrete	28	2.62	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	30	3.72	Grey	Possible retouch on ventral face
TP15	SOUTH	Spit 1: 0-10cm	Proximal flake		Silcrete	32	8.61	Grey	Some cortext (15%), reddish
TP15	SOUTH	Spit 1: 0-10cm	Flake		Quartz	49	9.36	Grey	Grey and red, cortex (40%)
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	23	0	Grey	Split diagonally from platform across to the margin, feather
TP15	SOUTH	Spit 1: 0-10cm	Flake		Quartz	33	8.02	White	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	23	1.68	Grey	Outrepasse termination
TP15	SOUTH	Spit 1: 0-10cm	Flake		Quartz	29	5.25	White	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	28	2.03	Grey	Cortex (10%)
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	32	5.22	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	26	145	Grey	Step termination
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	26	0.7	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	27	0.39	Grey	Long and narrow
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	25	2.16	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	28	1.22	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	26	1.31	Brown	Step termination
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	25	1.7	Dark green	Long and narrow flake
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	22	0.53	Grey	Long and narrow flake
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	21	0.49	Brown	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	16	0.53	Brown	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	20	0.52	Brown	multicoloured
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	20	43	Black	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	20	0.19	Dark green	Long and narrow
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	16	0.51	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	16	0.59	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	18	0.33	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	18	0.69	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	14	0.13	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	13	0.23	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	11	0.2	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	10	0.15	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	10	0.1	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	10	0.13	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	15	0.3	Brown	
TP15	SOUTH	Spit 1: 0-10cm	Proximal flake		Silcrete	15	0.72	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Proximal flake		Silcrete	18	0.75	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Proximal flake		Silcrete	15	0.32	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Proximal flake		Silcrete	14	0.73	Brown	
TP15	SOUTH	Spit 1: 0-10cm	Medial Flake		Silcrete	21	3.42	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Medial Flake		Silcrete	15	0.37	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Medial Flake		Quartz	15	0.43	White	
TP15	SOUTH	Spit 1: 0-10cm	Medial Flake		Quartz	11	0.13	White	
TP15	SOUTH	Spit 1: 0-10cm	Medial Flake		Silcrete	11	0.22	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Medial Flake		Silcrete	10	0.16	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	7	0.05	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Core		Silcrete	27	4.68	Brown	
TP15	SOUTH	Spit 1: 0-10cm	Retouched flake	Bondi Point	Silcrete	20	0.36	Grey	Retouched along one lateral margin to make a point
TP15	SOUTH	Spit 1: 0-10cm	Retouched flake	Retouched	Silcrete	21	0.78	Grey	Retouched on the platform onto the dorsal surface.
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	26	4.06	Brown	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	21	1.11	Brown	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	18	0.64	Grey	Possible retouch on one margin
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	20	1.06	Grey	Possibly a complete flake, some
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	15	0.51	Grey	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	18	0.37	Grey	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	16	0.24	Grey	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	17	0.55	Grey	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Quartz	18	0.3	White	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	10	0.1	Grey	
TP15	SOUTH	Spit 1: 0-10cm	xFlaked piece		Quartz	8	0.08	White	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	21	1.55	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	26	1.84	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	23	1.44	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	23	1.62	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	16	0.15	Brown	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	15	0.22	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	11	0.2	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	14	0.09	Grey	
TP15	SOUTH	Spit 1: 0-10cm	Distal Flake		Quartz	9	0.15	White	
TP15	SOUTH	Spit 2: 10-20cm	Core		Quartz	36	53	Milky	Greenish yellow milky quartz. Reworked on several facets
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	31	6	Grey	Small area of cortex on proximal end. Half 'T' shape
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	24	2	Grey	Triangular shape, feather
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	42	14	Grey	Short , wide flake with wide
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	27	1	Grey	Single dorsal ridge, feather
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	8	0.4	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.4	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.4	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.5	Brown	Pinkish stone with red streaks,
TP15	SOUTH	Spit 2: 10-20cm	Flake		Quartz	8	0.3	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	9	0.3	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	15	1	Grey	Thin flake, step termination
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	15	0.9	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	8	0.3	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	17	1	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Proximal flake		Silcrete	38	9	Brown	Dark reddish brown stone. Two
TP15	SOUTH	Spit 2: 10-20cm	Medial Flake		Silcrete	18	2	Brown	Parallel ridges down the centre of the distal side
TP15	SOUTH	Spit 2: 10-20cm	Medial Flake		Silcrete	13	0.3	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Medial Flake		Quartz	19	4	Crystal	Flat flake, no distinct ridges.
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	17	1	Milky	white

TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	12	0.5	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	12	0.2	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	16	0.4	Milky	white
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	16	3	Brown	Reddish brown. Possible retocuh on distal end
TP15	SOUTH	Spit 2: 10-20cm	xFlaked piece		Silcrete	15	0.2	Grey	
TP15	SOUTH	Spit 2: 10-20cm	xFlaked piece		Silcrete	10	0.2	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.5	Grey	approx 10% cortex
TP15	SOUTH	Spit 2: 10-20cm	Flake		Quartz	8	0.1	Milky	white
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	13	0.5	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	10	0.2	Grey	
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	4	0.1	Crystal	
TP15	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	10	0.4	Brown	reddish brown
TP15	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	20	1	Grey	Flat flake, two ridges
TP15	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	20	1	Brown	
TP15	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	12	1	Grey	Short, wide flake with faceted
TP15	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	13	0.4	Grey	grey stone with reddish brown
TP15	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	7	0.1	Grey	
TP15	SOUTH	Spit 3: 20-30cm	Medial Flake		Quartz	11	0.1	Milky	white
TP15	SOUTH	Spit 3: 20-30cm	Medial Flake		Silcrete	10	0.1	Brown	reddish brown
TP15	SOUTH	Spit 3: 20-30cm	Distal Flake		silcrete	18	0.1	Grey	long, narrow flake, single ridge.
TP15	SOUTH	Spit 3: 20-30cm	Distal Flake		Silcrete	9	0.1	Grey	
TP15	SOUTH	Spit 3: 20-30cm	Distal Flake		Silcrete	10	0.1	Grey	thin flake, <1mm
TP15	SOUTH	Spit 3: 20-30cm	xFlaked piece		Silcrete	31	3	Brown	
TP15	CENTRE	Spit 1: 0-10cm	Core		Silcrete	23	15	Grey	several negative scars, one edge has been worked with a series of short chips ending in step
TP15	CENTRE	Spit 1: 0-10cm	Core		Silcrete	23	3	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Medial Flake		Silcrete	13	0.1	Grey	long, narrow flake
TP15	CENTRE	Spit 1: 0-10cm	Distal Flake		Silcrete	17	0.2	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Distal Flake		Quartz	18	0.1	Milky	white
TP15	CENTRE	Spit 1: 0-10cm	Distal Flake		Silcrete	14	0.1	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Distal Flake		Quartz	11	0.1	Milky	white
TP15	CENTRE	Spit 1: 0-10cm	Flake		Quartz	20	2	Milky	white
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	37	2	Grey	Long, narrow flake. Two ridges.
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	20	1	Grey	grey and reddish brown
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	36	16	Brown	Possible working of platform.Two deep grooves
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	24	3	Brown	
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	25	2	Brown	outrepasse termination
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	26	1	Grey	Long, narrow flake, single ridge.
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	13	0.3	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	11	0.1	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	9	0.1	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	13	0.1	Grey	very thin flake - 1mm
TP15	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	9	0.1	Grey	
TP15	CENTRE	Spit 1: 0-10cm	Flake		Quartz	9	0.1	Milky	white
TP15	CENTRE	Spit 1: 0-10cm	Flake		Quartz	8	0.1	Milky	white
TP15	CENTRE	Spit 1: 0-10cm	Flake		Quartz	8	0.1	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Core		Silcrete	38	16	Grey	Varigated material brownish, grey and dark grey.
TP15	NORTH	Spit 1: 0-10cm	Flake		Silcrete	12	0.3	Brown	
TP15	NORTH	Spit 1: 0-10cm	Flake		Silcrete	16	0.1	Brown	Long, narrow flake, single ridge
TP15	NORTH	Spit 1: 0-10cm	Flake		Silcrete	14	0.1	Grey	Long, narrow flake, single ridge
TP15	NORTH	Spit 1: 0-10cm	Flake		Quartz	17	3	Milky	light grey
TP15	NORTH	Spit 1: 0-10cm	Flake		Quartz	19	1	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Flake		Quartz	12	0.1	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Flake		Quartz	20	0.4	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Flake		Quartz	11	0.1	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Flake		Quartz	8	0.1	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Medial Flake		Quartz	9	0.1	Milky	white
TP15	NORTH	Spit 1: 0-10cm	Distal Flake		Quartz	15	1	Milky	white. Possible battering on distal end from bipolar flaking
TP15	NORTH	Spit 1: 0-10cm	Distal Flake		Quartz	7	0.1	Crystal	white
TP15	NORTH	Spit 1: 0-10cm	Longitudinal split		Silcrete	26	3	Brown	reddish brown
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	20	2	Grey	feather termination
TP15	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	17	0.5	Grey	Flat flake, thin.
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	17	1	Grey	varigated, grey and reddish brown, step termination
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.1	Brown	dark reddish brown
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	13	1	Grey	dark grey
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	31	1	Brown	Reddish brown. Long, narrow flake with single ridge.
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	13	0.5	Brown	Pale greyish brown
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	13	0.3	Brown	reddish brown
TP15	NORTH	Spit 2: 10-20cm	Flake		Quartz	20	2	Milky	white
TP15	NORTH	Spit 2: 10-20cm	Flake		Quartz	20	1	Milky	white
TP15	NORTH	Spit 2: 10-20cm	Flake		Quartz	10	0.1	Milky	white
TP15	NORTH	Spit 2: 10-20cm	Flake		Quartz	13	0.1	Milky	white
TP15	NORTH	Spit 2: 10-20cm	flake		Quartz	32	10	Milky	smoky.
TP15	NORTH	Spit 2: 10-20cm	Flake		Silcrete	22	0.5	Grey	Long, narrow flattish flake.
TP15	NORTH	Spit 2: 10-20cm	Medial Flake		Quartz	14	1	milky	Smoky quartz
TP15	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	13	0.4	Brown	
TP15	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	9	0.2	Grey	
TP15	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	14	0.2	Grey	Dark grey
TP15	NORTH	Spit 2: 10-20cm	xFlaked piece		Silcrete	9	0.1	Grey	
TP15	NORTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	26	2	Crystal	pinkish
TP15	NORTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	16	1	Milky	White
TP15	CENTRE	Spit 3: 20-30cm	Flake		Quartz	21	0.4	Milky	
TP15	CENTRE	Spit 3: 20-30cm	Distal Flake		Quartz	20	2	Milky	white
TP15	CENTRE	Spit 3: 20-30cm	Distal Flake		Silcrete	8	0.1	Grey	
TP1	SOUTH	Spit 3: 20-30cm	Flake		Quartz	11	0.2	Milky	white
TP1	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	11	0.2	Brown	reddish brown
TP1	SOUTH	Spit 3: 20-30cm	Core		Quartz	20	7	Milky	white, rotated core.
TP1	SOUTH	Spit 3: 20-30cm	Distal Flake		Silcrete	12	0.2	Grey	
TP1	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	13	0.3	Brown	Reddish brown, flat flake with no Reddish brown. Flat flake, thin
TP1	CENTRE	Spit 2: 10-20cm	Flake		Quartz	15	3	Milky	white
TP1	CENTRE	Spit 2: 10-20cm	Flake		Quartz	19	1	Milky	white
TP1	CENTRE	Spit 2: 10-20cm	xFlaked piece		Silcrete	11	0.2	Brown	

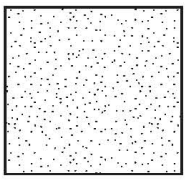
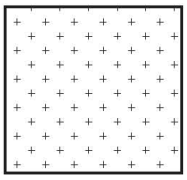
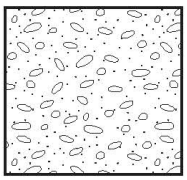
TP1	CENTRE	Spit 2: 10-20cm	xFlaked piece		Silcrete	12	1	Brown	
TP1	CENTRE	Spit 3: 20-30cm	Flake		Quartz	26	2	Milky	Cortex - 50% of dorsal surface
TP1	CENTRE	Spit 3: 20-30cm	Flake		Quartz	14	0.3	Crystal	
TP1	CENTRE	Spit 3: 20-30cm	Core		Quartz	26	12	Milky	30% cortex
TP1	CENTRE	Spit 3: 20-30cm	Core		Quartz	32	10	Milky	15% cortex. Flat piece, approx 8mm thick. Edges worked from
TP1	NORTH	Spit 1: 0-10cm	Flake		Quartz	13	2	Milky	
TP1	NORTH	Spit 1: 0-10cm	Flake		Quartz	27	3	Milky	
TP1	NORTH	Spit 1: 0-10cm	Flake		Quartz	10	0.4	Milky	
TP1	NORTH	Spit 1: 0-10cm	Distal Flake		Silcrete	12	1	Grey	
TP1	NORTH	Spit 2: 10-20cm	Flake		Quartz	14	0.2	Milky	white
TP1	NORTH	Spit 2: 10-20cm	Flake		Silcrete	17	4	Brown	
TP1	NORTH	Spit 2: 10-20cm	Flake		Quartz	20	1	Crystal	
TP1	NORTH	Spit 2: 10-20cm	Distal Flake		Quartz	11	1	Milky	smoky quartz
TP1	NORTH	Spit 2: 10-20cm	Core		Silcrete	30	8	Grey	Two scars from the same edge, one wide and feathered, the
TP1	NORTH	Spit 3: 20-30cm	Flake		Quartz	9	0.5	Milky	white
TP1	NORTH	Spit 3: 20-30cm	Flake		Quartz	9	0.25	Milky	white
TP1	NORTH	Spit 3: 20-30cm	Core		Silcrete	37	42	Grey	Negative scars on several faces
TP1	NORTH	Spit 3: 20-30cm	Core		Volcanic	83	253	Brown	Series of scars taken from largest face, other scars ending
TP1	NORTH	Spit 3: 20-30cm	Flake		Quartz	12	0.3	Milky	white
TP1	NORTH	Spit 3: 20-30cm	Flake		Quartz	12	21	Milky	smoky
TP1	NORTH	Spit 3: 20-30cm	Flake		Quartz	23	3	Milky	smoky
TP1	NORTH	Spit 3: 20-30cm	Flake		Quartz	16	0.7	Milky	smoky
TP1	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	14	1	Milky	smoky
TP1	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	7	0.3	Milky	smoky
TP1	NORTH	Spit 3: 20-30cm	xFlaked piece		Quartz	7	0.3	Milky	white
TP1	NORTH	Spit 3: 20-30cm	xFlaked piece		Quartz	10	0.2	Milky	white
TP6	SOUTH	Spit 1: 0-10cm	Proximal flake		Quartz	8	0.3	Milky	
TP6	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	11	0.08	Brown	
TP6	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	6	0.09	Brown	
TP6	NORTH	Spit 1: 0-10cm	Flake		Silcrete	19	0.6	Brown	
TP6	NORTH	Spit 1: 0-10cm	Distal Flake		Silcrete	14	0.7	Brown	
TP6	NORTH	Spit 1: 0-10cm	Distal Flake		Silcrete	30	3	Brown	near complete
TP6	NORTH	Spit 1: 0-10cm	Distal Flake		Silcrete	5	0.07	Brown	
TP6	NORTH	Spit 1: 0-10cm	xFlaked piece		Silcrete	27	1.7	Brown	50% cortex
TP7	NORTH	Spit 1: 0-10cm	Flake		Silcrete	18	0.8	Grey	
TP14	SOUTH	Spit 1: 0-10cm	Retouched flake	Retouched	Silcrete	39	4.23	Brown	Retouched onto dorsal surface along proximal end of one
TP14	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	13	0.7	Brown	Wide flake, step termination
TP14	SOUTH	Spit 1: 0-10cm	Flake		Chert	10	0.6	Brown	Ventral surface - black, dorsal surface - yellowish brown. 20%
TP14	SOUTH	Spit 2: 10-20cm	Core		Silcrete	89	178	Brown	
TP14	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	11	0.4	Brown	thin flake, feather termination
TP14	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	28	0.65	Brown	platform missing
TP14	SOUTH	Spit 2: 10-20cm	Medial Flake		Silcrete	8	0.5	Brown	
TP14	SOUTH	Spit 2: 10-20cm	Medial Flake		Silcrete	5	0.12	Brown	
TP14	SOUTH	Spit 2: 10-20cm	Medial Flake		Silcrete	6	0.17	Brown	
TP14	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	9	0.52	Brown	
TP14	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	10	0.45	Brown	
TP14	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	7	0.2	Milky	white
TP14	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	15	0.37	Brown	
TP14	CENTRE	Spit 2: 10-20cm	Distal Flake		Silcrete	18	0.23	Brown	long narrow flat flake
TP14	CENTRE	Spit 2: 10-20cm	Distal Flake		Silcrete	14	0.62	Brown	hinge termination
TP14	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	11	0.2	Brown	hinge termination
TP14	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	12	0.37	Brown	step termination
TP14	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	6	0.19	Brown	feather termination, cortex on 70% of dorsal side
TP14	CENTRE	Spit 2: 10-20cm	xFlaked piece		Silcrete	7	0.06	Brown	
TP14	CENTRE	Spit 2: 10-20cm	xFlaked piece		Quartz	6	0.42	Milky	white
TP14	NORTH	Spit 1: 0-10cm	Flake		Silcrete	17	0.82	Brown	
TP14	NORTH	Spit 1: 0-10cm	Flake		Silcrete	15	0.66	Brown	
TP14	NORTH	Spit 1: 0-10cm	Flake		Silcrete	21	0.66	Brown	near complete, long narrow
TP14	NORTH	Spit 1: 0-10cm	Core		Quartz	22	11	Milky	white
TP14	NORTH	Spit 2: 10-20cm	Retouched flake	Retouched	Silcrete	32	4	Brown	Small area of retouch on proximal end of one lateral
TP14	NORTH	Spit 2: 10-20cm	Flake		Silcrete	22	4	Brown	long narrow flake with two
TP14	NORTH	Spit 2: 10-20cm	Flake		Chert	9	0.45	Grey	Short, wide flake, step termination, dark grey.
TP14	NORTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	5	0.05	Brown	
TP14	NORTH	Spit 2: 10-20cm	Flake		Quartz	10	0.17	Crystal	
TP14	NORTH	Spit 2: 10-20cm	Flake		Quartz	6	0.15	Crystal	
TP14	NORTH	Spit 2: 10-20cm	Flake		Quartz	7	0.25	Crystal	
TP14	NORTH	Spit 2: 10-20cm	Flake		Quartz	7	0.23	Milky	Cortex on dorsal surface
TP16	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	11	0.53	Crystal	step termination
TP16	SOUTH	Spit 1: 0-10cm	Flake		Quartz	15	0.48	Milky	
TP16	SOUTH	Spit 1: 0-10cm	Medial Flake		Quartz	4	5	Milky	
TP16	SOUTH	Spit 1: 0-10cm	Distal Flake		Quartz	6	0.13	Crystal	
TP16	SOUTH	Spit 1: 0-10cm	Distal Flake		Silcrete	9	0.35	Grey	
TP16	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	14	0.83	Grey	Faceted platform, feather termination. Cortex - 20% of
TP16	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	15	0.35	Brown	
TP16	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.47	Grey	step termination
TP16	SOUTH	Spit 2: 10-20cm	Flake		Quartz	17	0.87	Milky	white
TP16	SOUTH	Spit 2: 10-20cm	Flake		Quartz	22	1.32	Milky	pinkish white
TP16	SOUTH	Spit 2: 10-20cm	Core		Silcrete	30	6.8	Grey	Rotated core, 20% cortex
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	29	1.75	Grey	Dorsal surface - 50% cortex
TP16	SOUTH	Spit 2: 10-20cm	Retouched flake	Retouched	Silcrete	20	7.23	Brown	reddish brown. Cortex on platform and 50% dorsal surface. Small retouch scars on
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	19	2.85	Milky	smoky quartz
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	6	0.19	Milky	white
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	6	0.22	Milky	white
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	10	0.21	Milky	white
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	6	0.12	Milky	white
TP16	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	12	0.65	Milky	white
TP16	SOUTH	Spit 3: 20-30cm	Flake		Quartz	9	0.08	Milky	pinky white
TP16	SOUTH	Spit 3: 20-30cm	Flake		Quartz	11	0.2	Milky	white
TP16	SOUTH	Spit 3: 20-30cm	Flake		Quartz	14	0.97	Crystal	
TP16	SOUTH	Spit 3: 20-30cm	Flake		Quartz	22	1.19	Crystal	

TP16	SOUTH	Spit 4: 30-40cm	xFlaked piece		Quartz	20	0.54	Milky	smoky
TP16	CENTRE	Spit 3: 20-30cm	Flake		Quartz	10	0.56	Milky	
TP16	CENTRE	Spit 3: 20-30cm	Flake		Quartz	10	0.41	Milky	
TP16	CENTRE	Spit 3: 20-30cm	Flake		Silcrete	17	0.23	Brown	Long, narrow, thin flake
TP16	CENTRE	Spit 3: 20-30cm	Medial Flake		Quartz	11	0.32	Milky	white
TP16	CENTRE	Spit 3: 20-30cm	Distal Flake		Quartz	6	0.09	Milky	white
TP16	CENTRE	Spit 3: 20-30cm	Distal Flake		Quartz	7	0.13	Milky	white
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	40	11.64	Brown	outrepasse termination
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	32	5.04	Grey	
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	18	0.76	Brown	
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	14	0.65	Brown	
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	18	1.09	Brown	
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	12	3.86	Brown	Short, wide, thick flake
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	20	1.04	Brown	
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	23	0.84	Brown	Thin flake, 60% cortex on dorsal
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	13	0.43	Brown	Thin, wide flake
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	14	0.61	Brown	Thin, wide flake
TP16	CENTRE	Spit 4: 30-40cm	Flake		Quartz	13	0.16	Crystal	
TP16	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	9	0.15	Brown	
TP16	CENTRE	Spit 4: 30-40cm	Distal Flake		Silcrete	11	0.35	Brown	Feather termination, triangular
TP16	CENTRE	Spit 4: 30-40cm	Distal Flake		Silcrete	14	0.87	Brown	
TP16	CENTRE	Spit 4: 30-40cm	xFlaked piece		Silcrete	13	2.66	Brown	
TP16	CENTRE	Spit 4: 30-40cm	Distal Flake		Quartz	20	2.5	Milky	smoky quartz
TP16	CENTRE	Spit 4: 30-40cm	Distal Flake		Quartz	10	1.39	Crystal	
TP16	NORTH	Spit 2: 10-20cm	Core		Silcrete	37	28.36	Brown	rotated core
TP16	NORTH	Spit 2: 10-20cm	Flake		Silcrete	39	8.61	Brown	thick flake
TP16	NORTH	Spit 2: 10-20cm	Flake		Silcrete	19	0.97	Brown	faceted platform, feather temination, pointed tip
TP16	NORTH	Spit 2: 10-20cm	Flake		Silcrete	17	0.51	Brown	
TP16	NORTH	Spit 2: 10-20cm	Flake		Silcrete	13	0.28	Brown	
TP16	NORTH	Spit 2: 10-20cm	Retouched flake	Retouched	Silcrete	25	2.24	Brown	2-3 small flakes removed from
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	11	1.14	Brown	
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	8	0.21	Brown	
TP16	NORTH	Spit 2: 10-20cm	Flake		Silcrete	9	0.84	Brown	
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Quartz	9	0.67	Milky	smoky
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Quartz	11	0.81	Crystal	
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Quartz	11	0.96	Milky	
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Quartz	8	0.45	Milky	
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	8	0.25	Grey	
TP16	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	20	1.12	Brown	
TP16	NORTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	24	0.92	Brown	50% cortex on dorsal side
TP16	NORTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	20	0.71	Brown	
TP16	NORTH	Spit 4: 30-40cm	Core		Silcrete	31	19.22	Grey	
TP16	NORTH	Spit 4: 30-40cm	Flake		Silcrete	31	3.12	Grey	thin flake
TP16	NORTH	Spit 4: 30-40cm	Flake		Silcrete	17	0.73	Grey	step termination
TP16	NORTH	Spit 4: 30-40cm	Flake		Silcrete	16	1.58	Brown	hinge termination
TP16	NORTH	Spit 4: 30-40cm	Flake		Silcrete	9	0.15	Brown	hinge termination
TP16	NORTH	Spit 4: 30-40cm	Flake		Silcrete	9	0.24	Brown	
TP16	NORTH	Spit 4: 30-40cm	Distal Flake		Quartz	7	0.19	Crystal	
TP17	SOUTH	Spit 1: 0-10cm	xFlaked piece		Quartz	6	0.08	Milky	white
TP17	SOUTH	Spit 1: 0-10cm	Flake		zQuartzite	8	0.21	Grey	
TP17	SOUTH	Spit 2: 10-20cm	Core		Silcrete	34	26.64	Grey	rotated core
TP17	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	31	18.23	Brown	Cortex on one lateral margin and some of distal end
TP17	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	20	1.11	Brown	pinkish brown stone, faceted
TP17	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	11	1.09	Brown	pinkish brown stone,
TP17	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	8	0.35	Brown	pinkish brown stone,
TP17	SOUTH	Spit 2: 10-20cm	Medial Flake		Silcrete	14	0.46	Brown	pinkish brown stone,
TP17	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	12	0.36	Grey	pinkish brown stone,
TP17	SOUTH	Spit 2: 10-20cm	Flake		Quartz	10	0.18	Milky	white
TP17	SOUTH	Spit 2: 10-20cm	Flake		Quartz	25	6.02	Milky	white
TP17	SOUTH	Spit 3: 20-30cm	Flake		Quartz	36	4.74	Crystal	
TP17	SOUTH	Spit 3: 20-30cm	Flake		Quartz	10	0.38	Milky	white
TP17	SOUTH	Spit 3: 20-30cm	Distal Flake		Quartz	13	1.25	Milky	white
TP17	SOUTH	Spit 3: 20-30cm	Distal Flake		Quartz	7	0.06	Milky	white
TP17	SOUTH	Spit 3: 20-30cm	Flake		Quartz	19	5.76	Milky	white
TP17	SOUTH	Spit 3: 20-30cm	Flake		Quartz	9	0.15	Milky	white
TP17	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	9	0.06	Brown	
TP17	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	18	0.5	Brown	
TP17	SOUTH	Spit 3: 20-30cm	xFlaked piece		Silcrete	11	0.15	Brown	
TP17	SOUTH	Spit 3: 20-30cm	xFlaked piece		Silcrete	7	0.16	Brown	
TP17	SOUTH	Spit 3: 20-30cm	xFlaked piece		Silcrete	8	0.11	Grey	
TP17	SOUTH	Spit 4: 30-40cm	Distal Flake		Quartz	15	0.6	Crystal	
TP17	SOUTH	Spit 4: 30-40cm	Flake		Quartz	34	9.69	Milky	pinkish
TP17	SOUTH	Spit 4: 30-40cm	Flake		Quartz	22	5.01	Milky	white
TP17	SOUTH	Spit 4: 30-40cm	Flake		Quartz	12	1.67	Milky	white
TP17	SOUTH	Spit 4: 30-40cm	Flake		Quartz	10	0.37	Milky	white
TP17	SOUTH	Spit 4: 30-40cm	Flake		Quartz	12	0.66	Milky	white
TP17	SOUTH	Spit 4: 30-40cm	Flake		Quartz	8	0.51	Crystal	
TP17	SOUTH	Spit 5: 40-50cm	Distal Flake		Quartz	13	1.13	Milky	outrepasse termination
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	18	0.63	Milky	white
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	11	0.28	Milky	smoky
TP17	CENTRE	Spit 2: 10-20cm	Distal Flake		Silcrete	17	0.54	Grey	grey and reddish brown, feather
TP17	CENTRE	Spit 2: 10-20cm	Proximal flake		Silcrete	16	0.42	Grey	single distal ridge.
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	15	1.56	Milky	white
TP17	CENTRE	Spit 2: 10-20cm	Distal Flake		Silcrete	9	1.41	Grey	step termination, wide, short
TP17	CENTRE	Spit 2: 10-20cm	xFlaked piece		Silcrete	17	1.2	Grey	negative scars on what seems to be the ventral surface.
TP17	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	22	5.79	Grey	Very coarse grained silcrete, different to other artefacts
TP17	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	16	0.46	Grey	thin flake, feather termination
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	13	0.48	Milky	
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	20	2.25	Milky	
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	22	4.75	Milky	
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	22	1.66	Milky	smoky
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	14	0.54	Milky	feather termination
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	6	0.08	Crystal	
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	6	0.06	Milky	
TP17	CENTRE	Spit 2: 10-20cm	Flake		Chert	17	0.75	Brown	Thin flake with clear waves of
TP17	CENTRE	Spit 2: 10-20cm	Distal Flake		Quartz	7	0.48	Milky	
TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	13	0.61	Milky	

TP17	CENTRE	Spit 2: 10-20cm	Flake		Quartz	12	0.23	Milky	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	24	2.04	Brown	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	6	0.1	Crystal	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	21	4.4	Milky	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	21	3.59	Milky	smoky
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	12	1.7	Milky	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	20	1.38	Milky	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	17	0.55	Milky	
TP17	CENTRE	Spit 4: 30-40cm	Medial Flake		Quartz	11	2.05	Milky	
TP17	CENTRE	Spit 4: 30-40cm	Flake		Quartz	5	0.01	Crystal	
TP17	NORTH	Spit 1: 0-10cm	Flake		Quartz	5	0.01	Crystal	
TP17	NORTH	Spit 2: 10-20cm	Flake		Quartz	6	0.07	Crystal	
TP17	NORTH	Spit 3: 20-30cm	Flake		Quartz	15	2.33	Crystal	feather termination
TP17	NORTH	Spit 3: 20-30cm	Flake		Quartz	11	1.06	Milky	feather termination
TP17	NORTH	Spit 3: 20-30cm	Flake		Quartz	11	0.39	Milky	step termination
TP17	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	13	0.61	Milky	
TP17	NORTH	Spit 3: 20-30cm	Flake		Quartz	11	0.51	Milky	feather termination
TP17	NORTH	Spit 3: 20-30cm	Flake		Quartz	10	0.38	Milky	smoky
TP17	NORTH	Spit 3: 20-30cm	Flake		Silcrete	6	0.08	Grey	
TP17	NORTH	Spit 3: 20-30cm	Flake		Quartz	8	0.48	Milky	smoky
TP17	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	5	0.01	Milky	smoky
TP17	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	6	0.08	Milky	smoky
TP17	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	31	18.86	Milky	10% Cortex
TP17	NORTH	Spit 4: 30-40cm	Flake		Quartz	17	1.2	Milky	
TP17	NORTH	Spit 4: 30-40cm	Flake		Quartz	16	1.06	Milky	
TP17	NORTH	Spit 4: 30-40cm	Flake		Silcrete	17	0.77	Grey	
TP17	NORTH	Spit 4: 30-40cm	Flake		Silcrete	16	1.22	Brown	Reddish brown
TP17	NORTH	Spit 4: 30-40cm	Flake		Quartz	8	0.43	Crystal	smoky
TP17	NORTH	Spit 4: 30-40cm	Distal Flake		Silcrete	9	0.93	Brown	
TP17	NORTH	Spit 4: 30-40cm	Distal Flake		Silcrete	26	1.91	Grey	
TP17	NORTH	Spit 4: 30-40cm	xFlaked piece		Quartz	12	1.08	Milky	
TP17	NORTH	Spit 4: 30-40cm	xFlaked piece		Silcrete	14	2.08	Brown	
TP17	NORTH	Spit 5: 40-50cm	Flake		Quartz	12	0.72	Crystal	
TP17	NORTH	Spit 5: 40-50cm	Flake		Quartz	22	10.32	Milky	
TP17	NORTH	Spit 5: 40-50cm	Core		Silcrete	12	1.78	Grey	small scars around rim of platform as well as earlier,
TP18	CENTRE	Spit 2: 10-20cm	Flake		Quartz	9	0.24	Crystal	smoky
TP19	SOUTH	Spit 1: 0-10cm	Retouched flake	Retouched	Silcrete	20	0.78	Grey	Distal flake. Clear waves of compression. Retouch onto ventral surface on both lateral margins and onto dorsal surface
TP19	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	20	2.43	Brown	step termination
TP30	SOUTH	Spit 1: 0-10cm	Retouched flake	Retouched	Silcrete	48	5.79	Brown	Central ridge on dorsal surface, notch taken from distal end of lateral marginas well as small cips on same margin towards
TP30	SOUTH	Spit 1: 0-10cm	Longitudinal split		Chert	28	3.11	Grey	waves of compression, feather
TP31	SOUTH	Spit 3: 20-30cm	Retouched flake	Retouched	Silcrete	25	2.29	Grey	Hinge termination. Retouch on distal end onto distal surface. One small flake taken from
TP31	CENTRE	Spit 1: 0-10cm	Retouched flake	Retouched	Silcrete	34	20.4	Grey	Extensively retouched flake on lateral and distal margins. Larger wide flakes taken from ventral surface as well as smaller chips
TP32	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	18	0.56	Grey	
TP32	SOUTH	Spit 1: 0-10cm	Distal Flake		Volcanic	14	1.35	Brown	
TP32	SOUTH	Spit 1: 0-10cm	Flake		Quartz	16	1.09	Milky	
TP32	NORTH	Spit 1: 0-10cm	Retouched flake	Retouched	Quartz	25	5.04	Milky	Substantial flake taken from proximal end of one lateral margin onto ventral surface. Small chips taken along both
TP33	SOUTH	Spit 1: 0-10cm	Distal Flake		Quartz	10	0.82	Milky	feather termination
TP33	SOUTH	Spit 1: 0-10cm	Flake		Quartz	12	0.74	Milky	
TP33	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	8	0.17	Grey	thin flake
TP33	CENTRE	Spit 1: 0-10cm	Flake		Silcrete	16	0.74	Grey	coarse stone
TP33	CENTRE	Spit 2: 10-20cm	Flake		Quartz	9	0.2	Milky	
TP35	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	18	0.36	Grey	
TP35	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	16	1.81	Brown	
TP35	SOUTH	Spit 2: 10-20cm	Flake		Silcrete	17	0.63	Brown	Thin flake, ending in a point, feather termination
TP35	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	38	6.76	Grey	
TP35	SOUTH	Spit 2: 10-20cm	Distal Flake		Silcrete	17	2.17	Brown	
TP35	SOUTH	Spit 2: 10-20cm	Distal Flake		Quartz	21	7.87	Milky	
TP35	SOUTH	Spit 2: 10-20cm	Retouched flake	Retouched	Silcrete	18	0.52	Grey	Missing platform. At least three deep flakes taken from lateral margin towards the distal point,
TP35	SOUTH	Spit 2: 10-20cm	xFlaked piece		Silcrete	12	1.33	Brown	
TP35	SOUTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	22	0.84	Brown	distal flake
TP35	SOUTH	Spit 2: 10-20cm	Core		Silcrete	19	3.94	Brown	40% cortex
TP35	SOUTH	Spit 2: 10-20cm	Core		Silcrete	23	5.28	Brown	
TP35	SOUTH	Spit 3: 20-30cm	Retouched flake	Retouched	Silcrete	22	3.66	Brown	Flakes taken from both ventral and dorsal surfaces at proximal end, before platform removed
TP35	SOUTH	Spit 3: 20-30cm	Core		Silcrete	17	2.81	Brown	10% cortex.
TP35	SOUTH	Spit 3: 20-30cm	Core		Silcrete	17	1.46	Brown	Thin piece, only negative scars visible. 40% cortex.
TP35	SOUTH	Spit 3: 20-30cm	Core		Quartz	26	7.66	Milky	
TP35	SOUTH	Spit 3: 20-30cm	Flake		Quartz	13	2.56	Milky	coarse stone
TP35	SOUTH	Spit 4: 30-40cm	xFlaked piece		Silcrete	8	0.28	Brown	
TP35	SOUTH	Spit 4: 30-40cm	Flake		Silcrete	10	0.69	Brown	Feather termination, dorsal
TP35	CENTRE	Spit 1: 0-10cm	Flake		Quartz	13	0.33	Crystal	
TP35	CENTRE	Spit 2: 10-20cm	Flake		Quartz	11	0.16	Milky	
TP35	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	14	0.94	Brown	feather termination
TP35	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	25	1.53	Brown	
TP35	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	10	1.45	Brown	
TP35	CENTRE	Spit 2: 10-20cm	Flake		Chert	20	1.33	Grey	Possible flake that has been reworked - only negative scars
TP35	CENTRE	Spit 3: 20-30cm	Flake		Silcrete	20	0.16	Brown	1mm thick
TP35	CENTRE	Spit 3: 20-30cm	Flake		Silcrete	13	0.09	Brown	1mm thick
TP35	CENTRE	Spit 3: 20-30cm	Longitudinal split		Quartz	19	0.6	Crystal	
TP35	CENTRE	Spit 4: 30-40cm	Medial Flake		Silcrete	9	0.08	Crystal	

TP35	CENTRE	Spit 4: 30-40cm	Flake		Quartz	7	0.13	Milky	smoky
TP35	NORTH	Spit 2: 10-20cm	Flake		Silcrete	10	0.5	Brown	step termination
TP35	NORTH	Spit 2: 10-20cm	Longitudinal split		Silcrete	10	0.13	Brown	
TP35	NORTH	Spit 2: 10-20cm	Flake		Silcrete	13	1.18	Brown	
TP35	NORTH	Spit 2: 10-20cm	Flake		Silcrete	10	0.6	Brown	
TP35	NORTH	Spit 2: 10-20cm	Distal Flake		Silcrete	5	0.09	Brown	
TP35	NORTH	Spit 3: 20-30cm	Flake		Quartz	13	0.31	Crystal	
TP35	NORTH	Spit 3: 20-30cm	Flake		Silcrete	12	0.85	Brown	
TP35	NORTH	Spit 3: 20-30cm	Medial Flake		Silcrete	24	1.84	Brown	
TP35	NORTH	Spit 3: 20-30cm	Distal Flake		Quartz	9	0.88	Milky	
TP35	NORTH	Spit 3: 20-30cm	Core		Silcrete	23	4.67	Milky	
TP35	NORTH	Spit 4: 30-40cm	Longitudinal split		Silcrete	18	0.7	Brown	
TP36	CENTRE	Spit 2: 10-20cm	Flake		Quartz	15	1.21	Crystal	
TP36	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	24	1.68	Grey	
TP36	CENTRE	Spit 3: 20-30cm	Flake		Quartz	31	2.85	Milky	smoky, dorsal surface is cortex.
TP36	CENTRE	Spit 3: 20-30cm	Flake		Silcrete	36	7.56	Grey	
TP36	CENTRE	Spit 3: 20-30cm	Distal Flake		Silcrete	7	0.21	Grey	
TP36	CENTRE	Spit 3: 20-30cm	Distal Flake		Silcrete	14	3.34	Grey	
TP36	NORTH	Spit 1: 0-10cm	Flake		Silcrete	12	0.15	Grey	
TP36	NORTH	Spit 1: 0-10cm	Flake		Quartz	17	0.6	Crystal	smoky
TP37	SOUTH	Spit 1: 0-10cm	Flake		Quartz	25	10.73	Crystal	smoky
TP37	SOUTH	Spit 1: 0-10cm	Flake		Quartz	27	4.79	Milky	white
TP37	SOUTH	Spit 1: 0-10cm	Flake		Silcrete	12	0.32	Grey	
TP37	SOUTH	Spit 1: 0-10cm	Core		Silcrete	30	11.51	Brown	
TP37	SOUTH	Spit 2: 10-20cm	Flake		Quartz	16	0.43	Milky	white
TP37	SOUTH	Spit 2: 10-20cm	Medial Flake		Quartz	9	0.36	Milky	white
TP37	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	10	0.28	Grey	2mm thick, short, wide flake, feather termination
TP37	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	13	0.13	Grey	thin flake, step termination
TP37	SOUTH	Spit 3: 20-30cm	Flake		Silcrete	7	0.11	Grey	thin flake,
TP37	SOUTH	Spit 4: 30-40cm	Core		Silcrete	38	58.94	Grey	Rotated core, several different platforms used. Step terminations from steep
TP37	SOUTH	Spit 4: 30-40cm	Flake		Silcrete	12	0.4	Brown	
TP37	SOUTH	Spit 4: 30-40cm	Medial Flake		Silcrete	6	0.07	Brown	
TP37	SOUTH	Spit 5: 40-50cm	Flake		Silcrete	14	0.53	Brown	thin, flat flake.
TP37	SOUTH	Spit 5: 40-50cm	Flake		Silcrete	8	0.14	Brown	thin, flat flake.
TP37	SOUTH	Spit 5: 40-50cm	Flake		Silcrete	21	2.75	Grey	thin, flat flake.
TP37	SOUTH	Spit 5: 40-50cm	Flake		Quartz	18	0.97	Crystal	
TP37	SOUTH	Spit 5: 40-50cm	Flake		Silcrete	26	2.58	Grey	coarse stone
TP37	SOUTH	Spit 6: 50-60cm	Flake		Quartz	34	14.08	Grey	coarse yellowish stone. 40%
TP37	SOUTH	Spit 6: 50-60cm	Flake		Volcanic	24	2.21	Grey	coarse stone, step termination.
TP37	SOUTH	Spit 6: 50-60cm	Flake		Quartz	12	0.63	Milky	
TP37	SOUTH	Spit 7: 60-70cm	Flake		Silcrete	12	0.13	Grey	
TP37	SOUTH	Spit 7: 60-70cm	Flake		Quartz	11	0.24	milky	
TP37	SOUTH	Spit 7: 60-70cm	Longitudinal split		Silcrete	10	0.08	Brown	
TP37	CENTRE	Spit 1: 0-10cm	Flake		Quartz	9	0.33	Crystal	
TP37	CENTRE	Spit 1: 0-10cm	Flake		Quartz	36	15.69	Crystal	40% cortex
TP37	CENTRE	Spit 3: 20-30cm	Flake		Quartz	9	0.33	Milky	white
TP37	CENTRE	Spit 3: 20-30cm	Core		Quartz	52	100.14	Milky	50% cortex,
TP37	CENTRE	Spit 2: 10-20cm	Flake		Quartz	5	0.09	Milky	white
TP37	CENTRE	Spit 2: 10-20cm	Flake		Silcrete	8	0.06	Grey	Short, wide, flat flake, step
TP37	CENTRE	Spit 4: 30-40cm	Flake		Silcrete	21	0.39	Brown	Long, narrow, flat flake, two
TP37	CENTRE	Spit 4: 30-40cm	Distal Flake		Silcrete	6	0.12	Grey	feather termination
TP37	CENTRE	Spit 5: 40-50cm	Flake		Silcrete	31	6.32	Grey	step termination
TP37	CENTRE	Spit 5: 40-50cm	Flake		Silcrete	26	0.91	Grey	feather termination, single
TP37	CENTRE	Spit 5: 40-50cm	Retouched flake	Retouched	Silcrete	19	1.32	Grey	retouch at proximal end (platform missing) from ventral
TP37	CENTRE	Spit 5: 40-50cm	Flake		Quartz	9	0.19	Crystal	
TP37	CENTRE	Spit 5: 40-50cm	Flake		Quartz	11	0.2	Milky	
TP37	CENTRE	Spit 6: 50-60cm	Flake		Quartz	30	8.6	Milky	
TP37	CENTRE	Spit 6: 50-60cm	Flake		Silcrete	27	3.9	Grey	
TP37	CENTRE	Spit 6: 50-60cm	Core		Quartz	33	12.2	Milky	
TP37	CENTRE	Spit 6: 50-60cm	Flake		Silcrete	14	0.51	Brown	
TP37	CENTRE	Spit 6: 50-60cm	Distal Flake		Quartz	5	0.07	Milky	white
TP37	CENTRE	Spit 7: 60-70cm	Flake		Quartz	6	0.05	Milky	
TP37	CENTRE	Spit 7: 60-70cm	Flake		Silcrete	9	0.22	Brown	step terminaation
TP37	CENTRE	Spit 7: 60-70cm	Flake		Silcrete	8	0.24	Grey	feather termination
TP37	CENTRE	Spit 7: 60-70cm	Flake		Silcrete	6	0.08	Grey	Less than 1mm thick, feather
TP37	CENTRE	Spit 7: 60-70cm	xFlaked piece		Silcrete	7	0.16	Grey	
TP37	NORTH	Spit 1: 0-10cm	Flake		Quartz	10	0.44	Milky	
TP37	NORTH	Spit 1: 0-10cm	Longitudinal split		Quartz	17	3.15	Milky	45% cortex
TP37	NORTH	Spit 1: 0-10cm	Distal Flake		Quartz	13	1.33	Milky	
TP37	NORTH	Spit 2: 10-20cm	Proximal flake		Quartz	6	0.39	Milky	
TP37	NORTH	Spit 2: 10-20cm	Proximal flake		Quartz	13	0.53	Milky	smoky
TP37	NORTH	Spit 3: 20-30cm	Flake		Quartz	8	0.27	Crystal	
TP37	NORTH	Spit 5: 40-50cm	Flake		Quartz	10	0.06	Milky	
TP37	NORTH	Spit 5: 40-50cm	Flake		Quartz	41	11.18	Milky	Smoky. Seration along one lateral margin onto dorsal
TP37	NORTH	Spit 5: 40-50cm	Flake		Silcrete	31	2.12	Grey	distal end snapped off, single
TP37	NORTH	Spit 5: 40-50cm	Flake		Silcrete	6	0.01	Grey	
TP37	NORTH	Spit 5: 40-50cm	Flake		Silcrete	11	0.11	Grey	
TP37	NORTH	Spit 5: 40-50cm	xFlaked piece		Silcrete	8	0.28	Grey	
TP37	NORTH	Spit 5: 40-50cm	Distal Flake		Silcrete	10	0.12	Grey	
TP37	NORTH	Spit 5: 40-50cm	Distal Flake		Silcrete	11	0.16	Grey	step termination
TP37	NORTH	Spit 5: 40-50cm	Distal Flake		Silcrete	6	0.07	Grey	feather termination
TP37	NORTH	Spit 5: 40-50cm	Flake		Silcrete	6	0.12	Grey	short, wide flake, step
TP37	NORTH	Spit 5: 40-50cm	Distal Flake		Silcrete	11	0.16	Brown	
TP37	NORTH	Spit 5: 40-50cm	Proximal flake		Silcrete	10	0.48	Grey	
TP37	NORTH	Spit 6: 50-60cm	Distal Flake		Silcrete	9	0.01	Grey	
TP37	NORTH	Spit 7: 60-70cm	Flake		Silcrete	18	1.68	Brown	
TP37	NORTH	Spit 7: 60-70cm	Flake		Quartz	11	0.56	Milky	
TP37	NORTH	Spit 7: 60-70cm	Distal Flake		Silcrete	7	0.05	Grey	
TP38	SOUTH	Spit 3: 20-30cm	Distal Flake		Quartz	10	0.58	Milky	
TP38	CENTRE	Spit 3: 20-30cm	Flake		Quartz	33	14.98	Milky	
TP38	NORTH	Spit 3: 20-30cm	Retouched flake	Retouched	Silcrete	25	5.8	Grey	Retouch onto ventral surface along one lateral margin, evidence of battering on other

Table E.1 Key

	**Sandstone**
	**Charcoal**
	**Degraded sandstone**



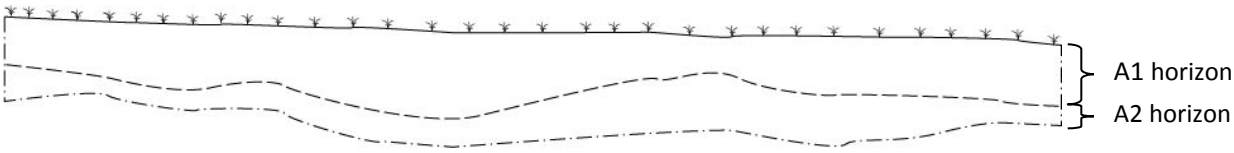


Figure E.1 Soil profile of TP1 (top elevation, base west elevation)

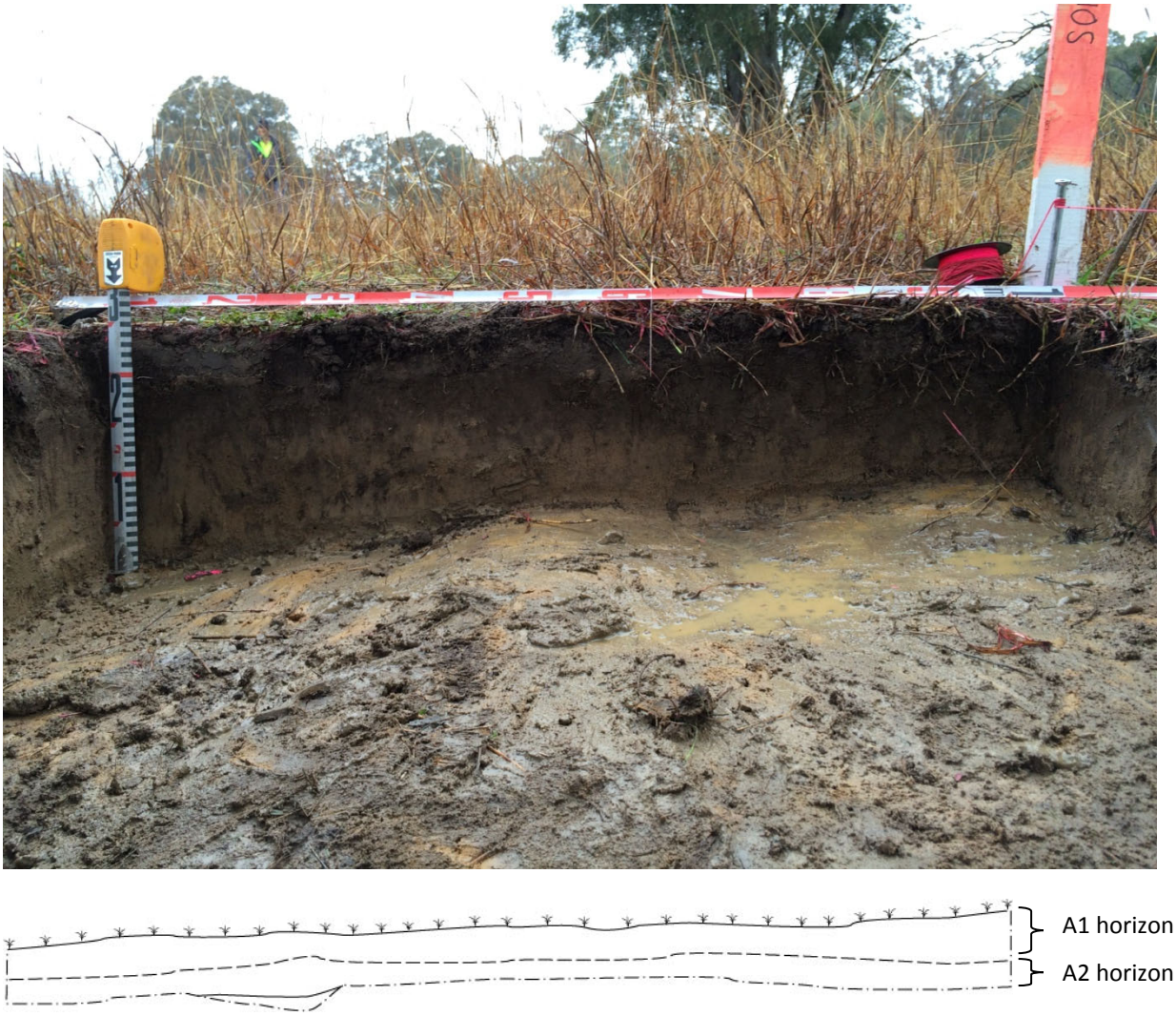
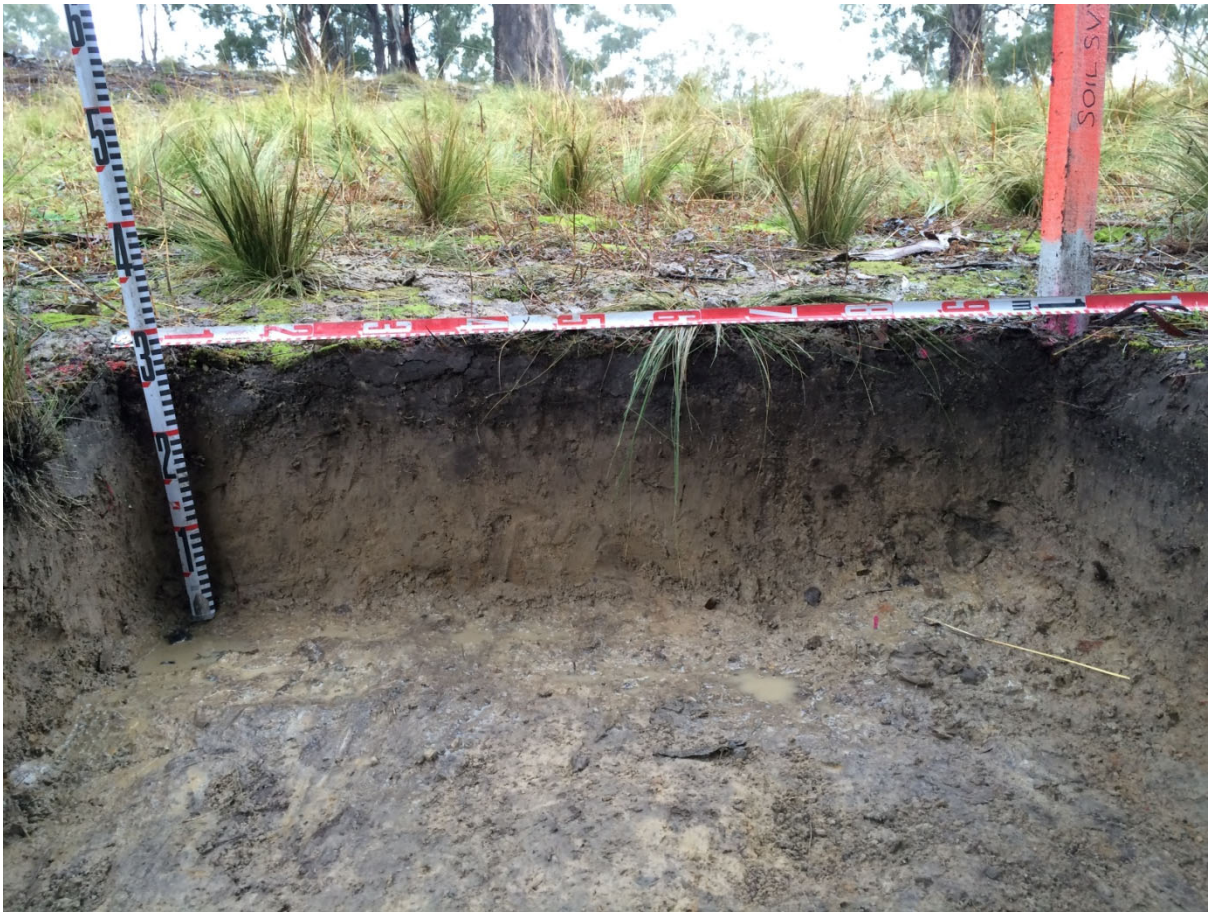


Figure E.2 Soil profile of TP2



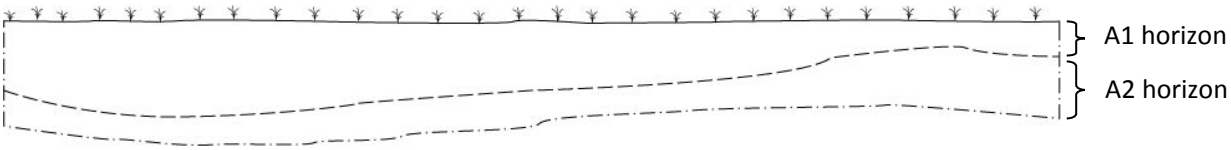


Figure E.3 Soil profile of TP4



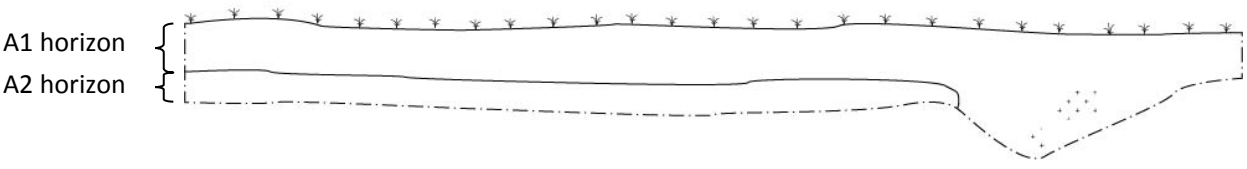


Figure E.4 Soil profile of TP5





Figure E.5 Soil profile of TP6



Figure E.6 TP7



Figure E.7 Soil profile of TP9



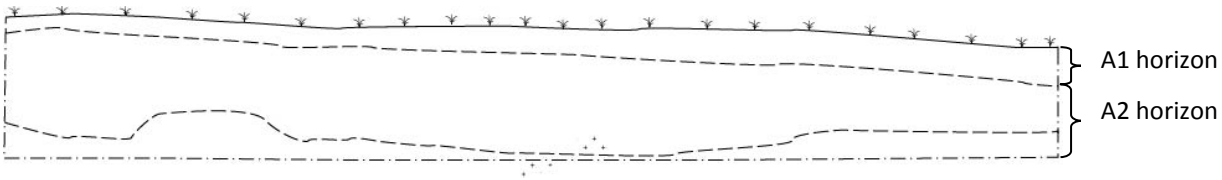


Figure E.8 Soil profile of TP10

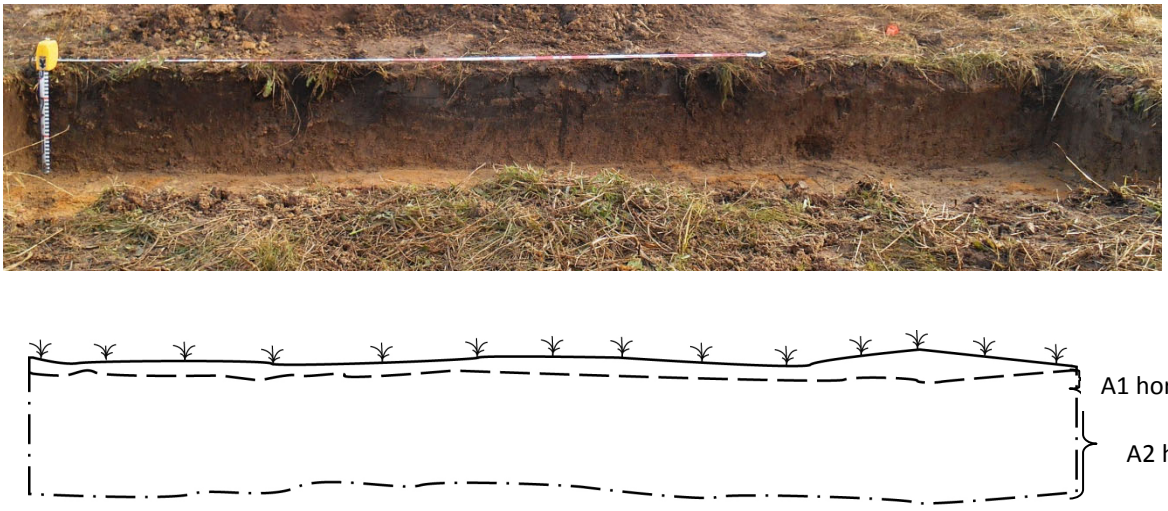


Figure E.9 Soil profile of TP11



Figure E.10 Soil profile of TP14

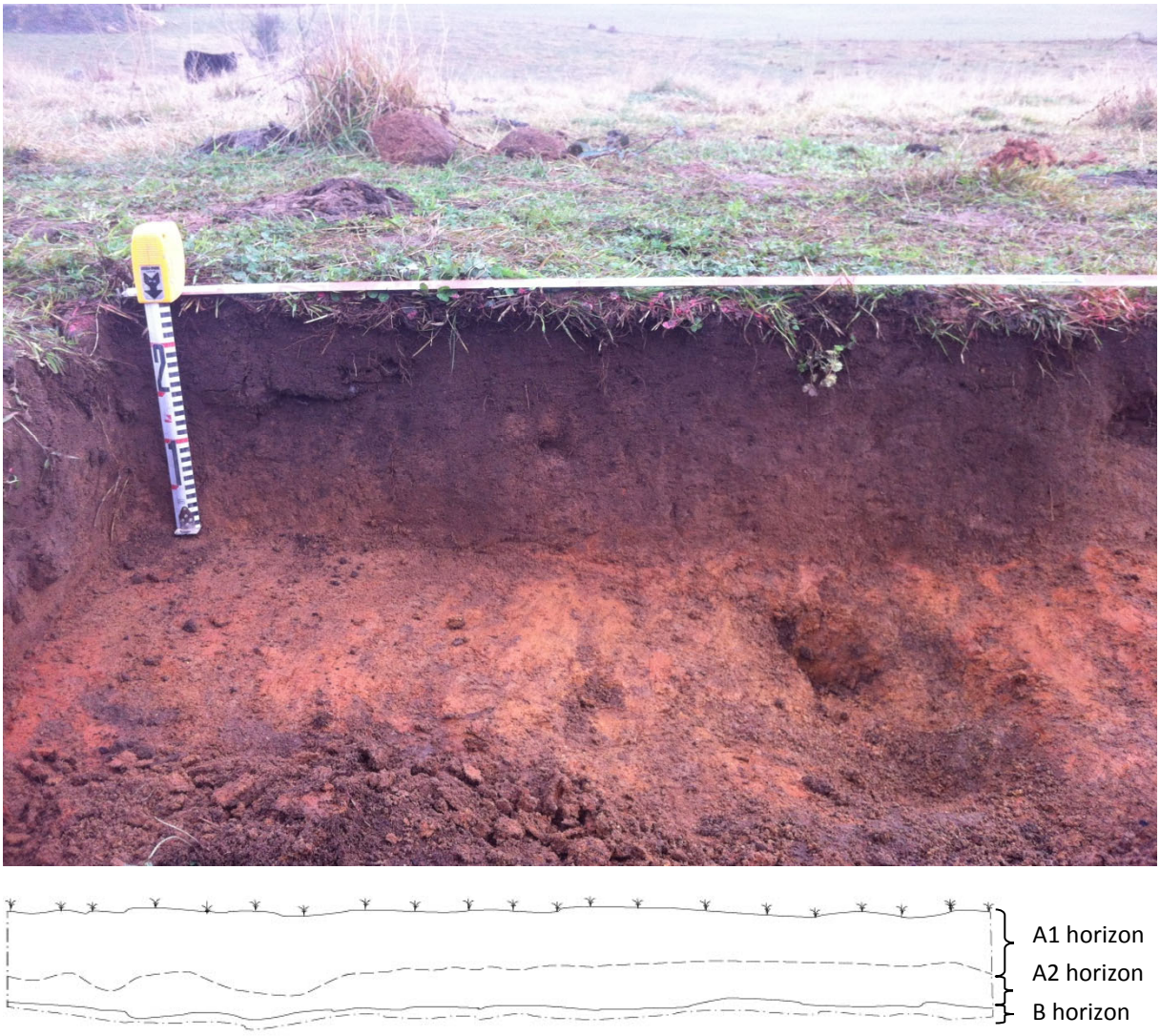


Figure E.11 Soil profile of TP15



Figure E.12 Soil profile of TP16

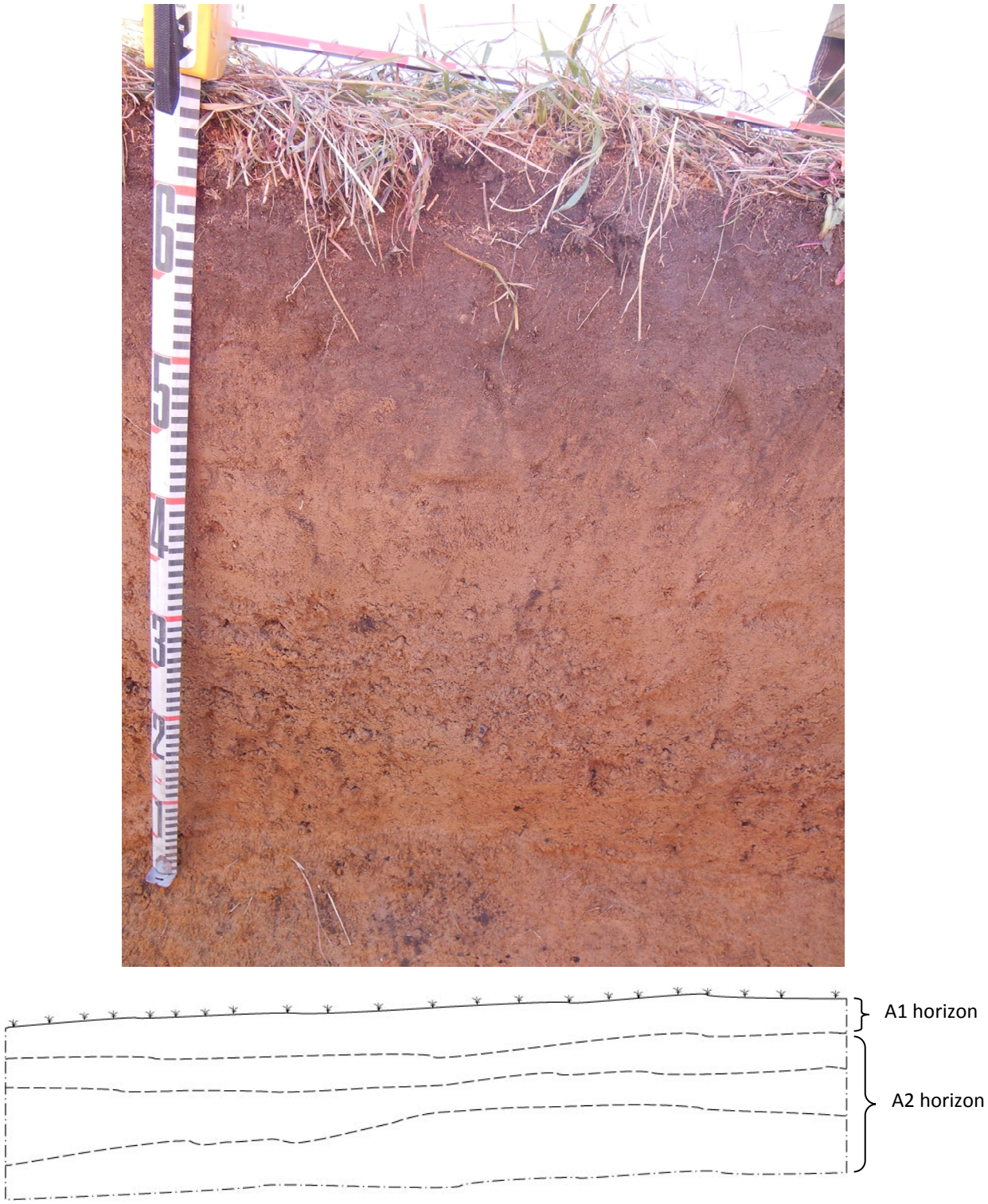


Figure E.13 Soil profile of TP17



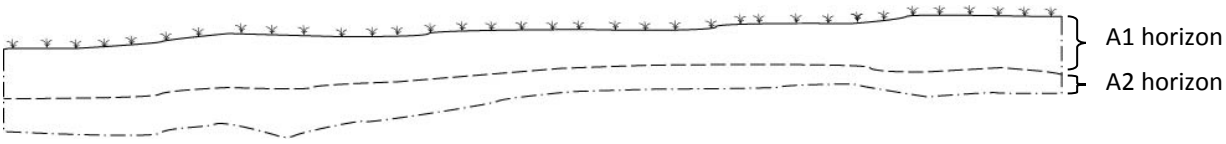


Figure E.14 Soil profile of TP18



Figure E.15 Soil profile of TP19



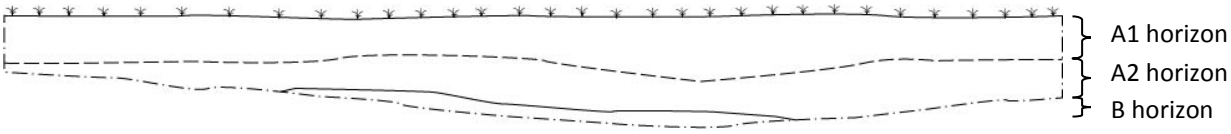


Figure E.16 Soil profile of TP30



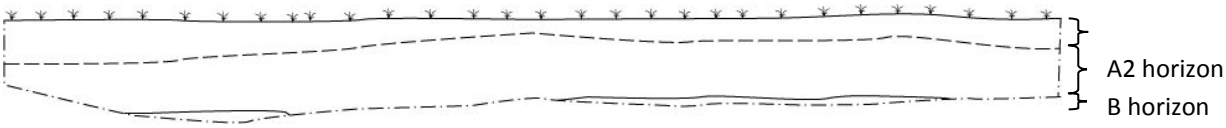


Figure E.17 Soil profile of TP31



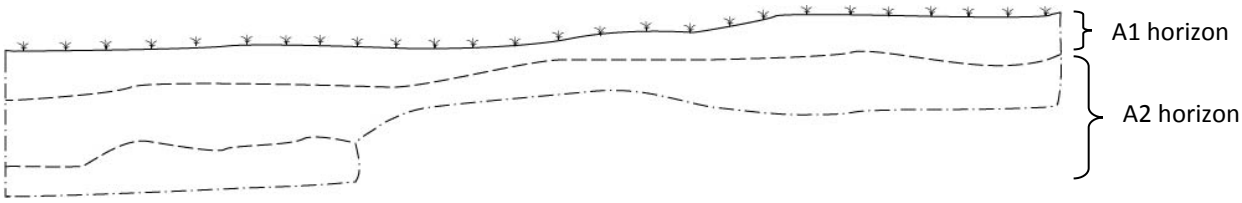


Figure E.18 Soil profile of TP32



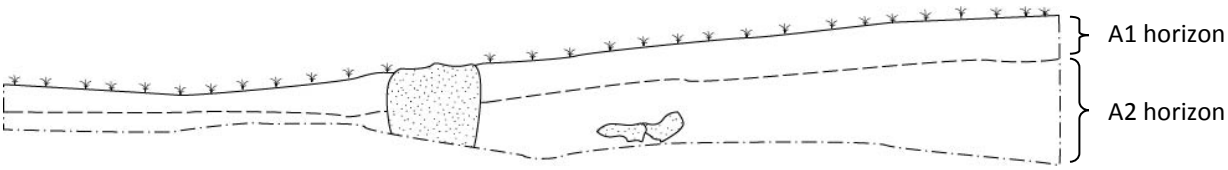


Figure E.19 Soil profile of TP33



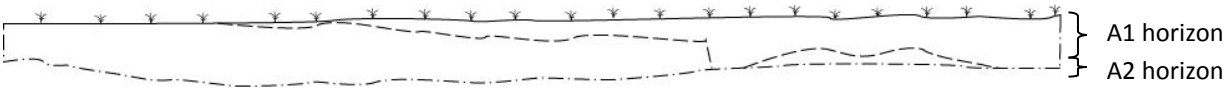


Figure E.20 Soil profile of TP34



Figure E.21 Soil profile of TP35



Figure E.22 Soil profile of TP36

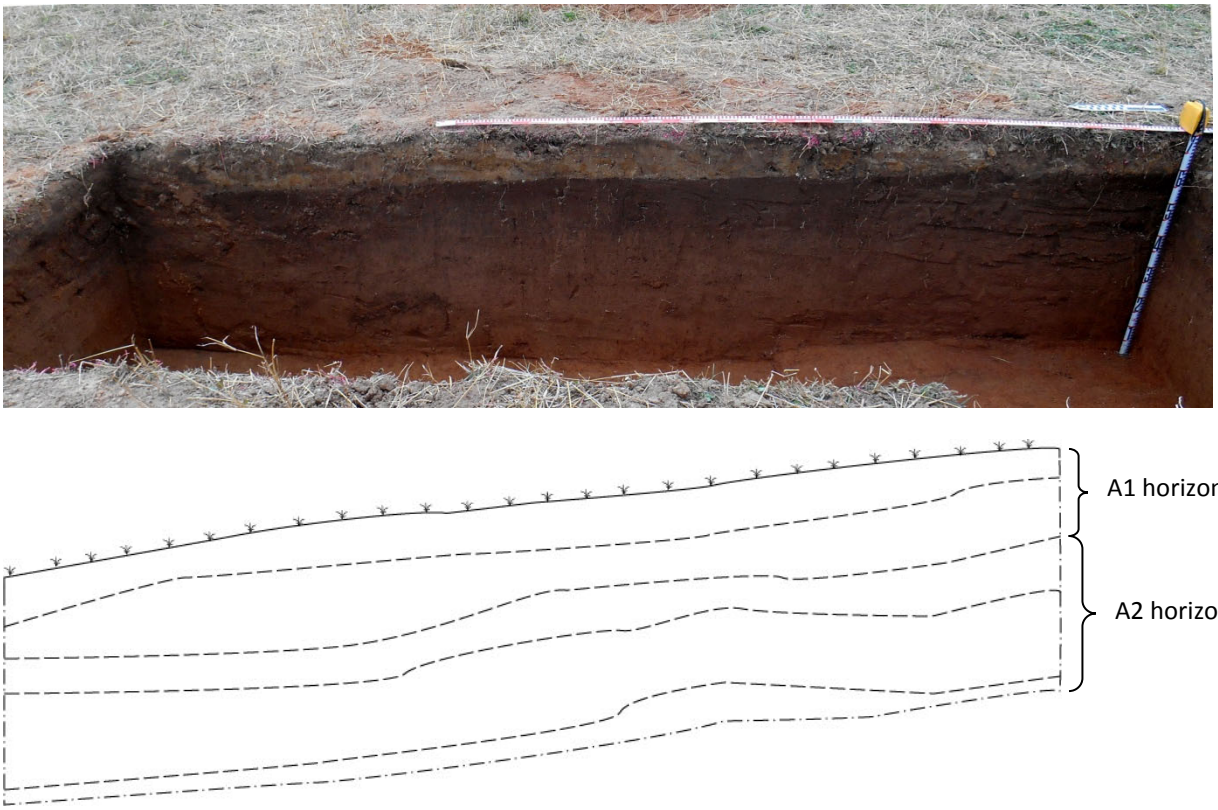


Figure E.23 Soil profile of TP37



Figure E.24 Soil profile of TP38



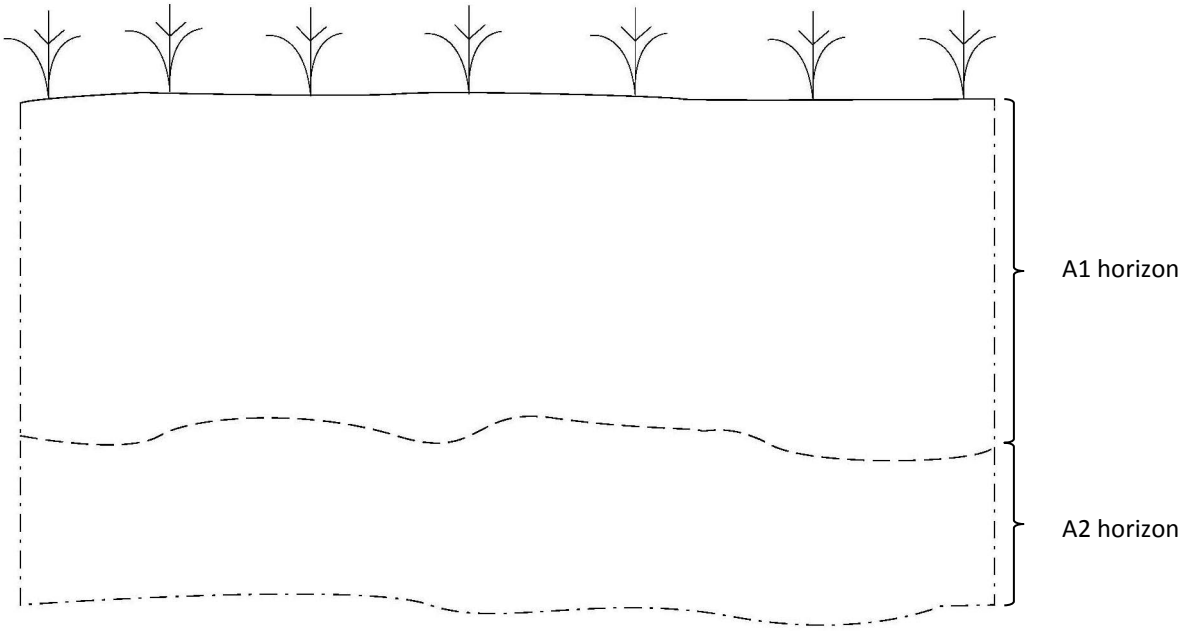


Figure E.25 Soil profile of TP39

Appendix F

Aboriginal site data

Site Name	Test pit	Zone	Easting	Northing	Date recorded	Transect No.	Site Type	Artefact count	Landform element	Soil landscape	Underlying geology	Exposure type	Landuse/ Vegetation	Exposure size (m2)	Exposure visibility %	Assemblage elements	Disturbance to deposit	Site length (m)	Site width (m)	Area (m^2)	Likley area of PAD (m^2)	Description
MSL 001		56 H	227875	6152125	13-Apr-15	T2	Artefact scatter	4	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	3	60	silcrete, quartz and chert	Minor: erosion	3	1	3	5	A group of four artefacts on a simple slope rise overlooking Marulan Creek. Minor disturbance from wind and water erosion. Possible 5m2 PAD area.
MSL 002		56 H	227591	6151948	13-Apr-15	T2	Artefact scatter	7	Watercourse	Marulan	Marulan Granite Batholith	machine	Grazing paddock	39	70	black silcrete, silcrete, quartz	Major: erosion through machine	10	1	10	10	A group of seven artefacts in a disturbed trench excavated by machine. The machine excavation has revealed the underlying soil profile including silty sand.
MSL 003		56 H	227531	6151862	13-Apr-15	T2	Isolated find	1	Undulating Plain	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	50	quartz	Minor: erosion	1	1	1	1	A quartz flake located in an erosion patch.
MSL 004		56 H	227392	6151763	13-Apr-15	T2	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	1	50	quartz	Minor: erosion	1	1	1	1	A single quartz flake located on an eroding bank of the creek in a rocky area, with silty sand soil.
MSL 005		56 H	227138	6151821	13-Apr-15	T2	Artefact scatter	3	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	2	60	quartz silcrete	Minor: erosion	2	1	2	10	three flakes - 2 silcrete and 1 quartz on an erosion spur 3m from Marulan Creek near drainage depressions.
MSL 006		56 H	226933	6151817	13-Apr-15	T2	Artefact scatter	24	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	100	80	mudstone, silcrete, quartz, red silcrete, quartzite	Major: erosion from creek	10	10	100	50	Large exposure of 24 artefacts along small drainage spur area of exposure approximately 10x20m along drainage line. Located on a spur overlooking the creek. Vegetation is pature grass and disturbance to the site is from erosion. Artefacts included flakes and cores of silcrete, mudstone, quartz and quartzite. Artefacts extend as far as exposure.
MSL 007		56 H	226894	6151731	13-Apr-15	T2	Artefact scatter	2	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	1	70	chalcedony	Major: erosion from creek	2	2	2	2	Three silcrete artefacts.
MSL 008		56 H	226798	6151823	13-Apr-15	T2	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	1	60	silcrete	Major: erosion from creek	1	1	1	1	A silcrete artefact on creek bank.
MSL 009		56 H	226875	6151683	13-Apr-15	T2	Artefact scatter	10	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	10	60	silcrete quartz	Major: erosion from creek	5	6	11		A group of silcrete artefacts eroding from the creek bank including two large cores, flakes and flaked pieces.
MSL 010		56 H	227014	6151710	13-Apr-15	T2	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Water	Grazing paddock	1	80	quartz	Major: erosion from creek	1	1	1	1	A quartz core on eroding creek bank.
MSL 011		56 H	227303	6151742	13-Apr-15	T3	Artefact scatter	2	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	3	70	quartzite and mudstone	Major: erosion from creek	3	1	3	1	A quartzite flake and a mudstone flaked puece eroding from Marulan Creek bank.
MSL 012		56 H	227351	6151743	13-Apr-15	T3	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	20	silcrete	Major: erosion from creek	1	1	1	1	A silcrete artefact on creek bank.
MSL 013		56 H	227480	6151678	13-Apr-15	T3	Artefact scatter	7	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	10	70	quartz, silcrete,	Major: erosion from creek	10	5	5	30	Three quartz flakes, 4silcrete flakes eroding from creek bank in exposure. Creek bank is steep in this section. Two of the silcrete flakes were black
MSL 014		56 H	227573	6151736	13-Apr-15	T3	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	60	quartz	Major: erosion from creek	1	1	1	1	A single quartz flake located on an eroding bank of the creek in a rocky area, with silty sand soil.
MSL 015		56 H	227670	6151893	13-Apr-15	T3	Artefact scatter	15	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	40	70	quartz, silcrete, mudstone,	Major: erosion from creek	20	10	2	30	A group of flakes and core s eroding from the creek bank.
MSL 016		56 H	227790	6152047	13-Apr-15	T3	Artefact scatter	30	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	100	90	quartz, silcrete, mudstone,	Major: erosion from creek	50	10	5	100	A group of silcrete and quartz flakes and cores eroding from the creek bank. There is also a visible seam of silcrete and large red silcrete bounders in the area.
MSL 017		56 H	228378	6149319	14-Apr-15	T13	Artefact scatter	2	Hill slope	Marulan	Marulan Granite Batholith	Fallen tree roots	Grazing paddock	1	60	quartz, silcrete	minor disturbance from tree falling	1	1	1	1	One silcrete and one quartz flake located in ground exposed by the falling of a large eucalyptus tree.
MSL 018		56 H	228156	6149143	14-Apr-15	T18	Artefact scatter	6	Spur	Marulan	Marulan Granite Batholith	Wind	Grazing paddock	30	70	quartz, chert, silcrete, quartzite	Minor: erosion from wind	10	2	20	30	Six artefacts mostly flakes, one with evidence of platform preparation possible cores. Area is approximatly 20m2 on a high point of hill overlooking quarry to the east. Material included quartz, silcrete, chert and quartzite.
MSL 019		56 H	227926	6149051	14-Apr-15	T22	Isolated find	1	Hill slope	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	40	50	mudstone	Major: erosion from creek	1	1	1	1	One mudstone core eroding from a creek bank on heavily disturbed context near the creek.
MSL 020		56 H	226874	6148700	15-Apr-15	T43	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	50	silcrete	Major: erosion from build and maintainence of dam wall	1	1	1	1	Single silcrete flake on a dam wall.
MSL 021		56 H	226651	6148231	15-Apr-15	T44	Artefact scatter	7	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	60	chert	Major: erosion from creek and machine excavation	30	20	10	40	A group of artefacts located on the bank of drainage depression. The area is very disturbed, possibly throught the creation of a bund, there is evidence of large erosional scars and earth movement. 7 artefacts in total including a chert core, silcrete flakes.
MSL 022		56 H	226773	6147960	15-Apr-15	T34	Artefact scatter	20	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	50	70	quartz, chert, silcrete, IMT, quartzite	Minor: erosion from wind	10	10	50	100	large site - 1 chert core, 3 chert flakes, 2 silcrete flakes, 1 broken chert flake, 1 silcrete flake, 1 proxima chert flake, 1 quartz flaked peiece, 1 chert flake 1 quuartz flaked piece, 1 silcrete flake, 1 medial chert flake, 3 silcrete flakes and 1 silcrete core.
MSL 023		56 H	226960	6147938	15-Apr-15	T49	Artefact scatter	12	Hill slope	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	20	60	silcrete,	Minor: erosion from wind	5	5	20	100	Silcrete core, multidirectional, silcrete flakes, grey black proximal silcrete flakes, silcrete flaked pieces, silcrete flakes x 3
MSL 024		56 H	226929	6148039	15-Apr-15	T46	Isolated find	1	Hill slope	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	20	50	silcrete	Minor: erosion from wind	1	1	1	1	One silcrete flake.
MSL 025		56 H	227298	6147245	16-Apr-15	T53	Isolated find	1	Ridgeline	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	10	70	quartz	Minor: erosion from wind	1	1	1	1	One quartz flake on a ridge overlooking the quarry. In a small clearning of trees.
MSL 026		56 H	227583	6147404	16-Apr-15	T63	Artefact scatter	5	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	30	50	silcrete	Minor: erosion from wind	20	5	50	50	on a spur near two drainage lines, a rise just above the watercourses. 4 silcrete flakes and 1 silcrete core. The area of exposure is approximately 20x5m down the spur area of site is basically the same. Some leaf litter reducing visibility.
MSL 027		56 H	227564	6147638	16-Apr-15	T63	Artefact scatter	2	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	30	60	chert, silcrete	Major: erosion from build and maintainence of dam wall	1	1	1	1	A chert core and silcrete core on the side of a dam wall in a heavily distrubed area. Visibility is low, ground cover is high.
MSL 028		56 H	227796	6148156	17-Apr-15	T65	Artefact scatter	4	Spur	Marulan	Marulan Granite Batholith	Wind	Grazing paddock	10	50	silcrete	Minor: erosion from wind	5	5	25		3 silcrete flakes in red and grey, a grey silcrete core on the edge of an undulating ridgeline overlooking an unnamed creek flowing into the quarry area. The area of exposure continues up the ridgeline.

MSL 029		56 H	227799	6148259	17-Apr-15	T66	Artefact scatter	3	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	5	50	quartz, silcrete	Moderate: erosion from wind, water and vehicle tracks	5	10	50		1 quartz flake and 2 silcrete flakes located on a spur crest, flat area of the landform. The area is slightly disturbed and an old vehicle track cuts through the centre of the crest, exposing the artefacts, there may be some PAD in area.
MSL 030		56 H	227576	6148273	17-Apr-15	T66	Artefact scatter	30	Spur	Marulan	Marulan Granite Batholith	Vehicle track	Grazing paddock	15	60	silcrete, quartz, mudstone	Major: from vehicle tracks	10	10	100	200	A large scatter of artefacts including tool types, and a possible silcrete scraper. Area of exposure due to car tredage, drainage line more gentle nearby, it is also near watercourses and may be the location of the better travelling routes.
MSL 031		56 H	227532	6148053	17-Apr-15	T67	Isolated find	1	Watercourse	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	60	quartz	Minor: erosion from wind	1	1	1	1	An isolated quartz flake in a drainage depression on rise overlooking creek
MSL 032		56 H	227675	6147990	17-Apr-15	T67	Artefact scatter	3	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	10	60	silcrete	Minor: erosion from wind	1	1	1	1	Three silcrete flakes on the lower end od a spur. The area has been disturbed with dig channels and disturbance and it is close to the mine haul road.
MSL 033		56 H	227599	6147928	17-Apr-15	T68	Artefact scatter	6	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	20	70	silcrete	Minor: erosion from wind	15	3	15	25	Located on a spur line between two drainage depressions. 3 flakes and 3 cores all in silcrete over an approxiamtely 15m2 area eroding near the treline. The area is a flat spur on an openundulating landform.
MSL 034		56 H	226677	6147956	17-Apr-15	T68	Artefact scatter	2	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	20	40	silcrete	Minor: erosion from wind	20	30		20	1 grey broken silcrete flake, one red silcrete flake.
MSL 035		56 H	227214	6147991	17-Apr-15	T68	Isolated find	1	Ridgeline	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	50	silcrete	Minor: erosion from wind	1	1	1	1	Silcrete flake, located on a gentle ridgeline in steady rain.
MSL 036		56 H	227250	6148100	17-Apr-15	T69	Artefact scatter	2	Ridgeline	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	50	silcrete	Minor: erosion from wind	1	1	1	1	Two silcrete flakes.
MSL 037		56 H	228711	6148854	17-Apr-15	T70	Not a scar tree		Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	1	1	tree	non	1	1	1	1	A scarred tree located overlooking a creek.
MSL 038		56 H	227600	6148067	30-Jun-15	T68	Artefact scatter	3	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	5	5	silcrete	Minor: erosion from wind	2	2	4	NIL	Two grey silcrete flakes and one core identified on hill crest exposure amongst rocky exposures.
MSL 039		56 H	226722	6148080	30-Jun-15	T46	Artefact scatter	8	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	5	5	silcrete	Minor: erosion from wind	2	2	4	NIL	Site comprises: 1 x quartz distal flake 1 x silcrete distal flake 6 x silcrete flakes
MSL 040		56 H	226761	6148124	30-Jun-15	T47	Artefact scatter	2	Spur	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	3	3	silcrete	Minor: erosion from wind	2	2	4	NIL	1 x grey silcrete flake identified on a broad flat spur crest overlooking an ephemeral drainage line.
MSL 041		56 H	226604	6148142	30-Jun-15	T45	Artefact scatter	3	Hill slope	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	5	2	silcrete	Minor: erosion from wind	2	2	4	NIL	2 x grey silcrete flake and 1 x grey silcrete medial flake identified on a gently inclined hill slope.
MSL 042	TP1	56 H	227306	6151708	30-Jun-15	Test excavation	Subsurface artefact deposit	34	Undulating Plain	Marulan	Marulan Granite Batholith	Wind and water	Grazing paddock	0	0	quartz silcrete and volcanic	Minor: erosion from wind	2	2	4	NIL	A range of silcrete and quartz flakes with one volcanic flake.
MSL 043	TP6	56 H	227316	6147747	30-Jun-15	Test excavation	Subsurface artefact deposit	8	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete, quartz	Minor: erosion from wind	3	1	3	NIL	Seven silcrete flakes and one quartz flake.
MSL 044	TP7	56 H	226634	6148017	30-Jun-15	Test excavation	Subsurface artefact deposit	1	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete	Minor: erosion from wind	3	1	3	NIL	One silcrete flake.
MSL 045	TP14	56 H	227908	6152143	30-Jun-15	Test excavation	Subsurface artefact deposit	32	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	quartz, silcrete and chert	Minor: erosion from wind	3	1	3	NIL	A group of chert, silcrete and quartz flakes and cores, including two retouched silcrete flakes.
MSL 046	TP15	56 H	227827	6151971	30-Jun-15	Test excavation	Subsurface artefact deposit	174	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	quartz, silcrete and chert	Minor: erosion from wind	3	1	3	NIL	A large group of chert, silcrete and quartz flakes and cores, including two retouched silcrete flakes and one bondi point.
MSL 047	TP16	56 H	227733	6151810	30-Jun-15	Test excavation	Subsurface artefact deposit	71	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	quartz, silcrete and chert	Minor: erosion from wind	3	1	3	NIL	A group of silcrete and quartz flakes and cores.
MSL 048	TP17	56 H	227927	6152149	30-Jun-15	Test excavation	Subsurface artefact deposit	84	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	quartz, silcrete and quartzite	Minor: erosion from wind	3	1	3	NIL	A group of silcrete quartz and quartzite flakes.
MSL 049	TP18	56 H	227467	6150995	30-Jun-15	Test excavation	Subsurface artefact deposit	1	Undulating Plain	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	quartz	Minor: erosion from wind	3	1	3	NIL	one quartz flake.
MSL 050	TP19	56 H	226829	6147930	30-Jun-15	Test excavation	Subsurface artefact deposit	2	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete	Minor: erosion from wind	3	1	3	NIL	Two silcrete flakes, one with retouch.
MSL 051	TP30	56 H	226726	6148062	30-Jun-15	Test excavation	Subsurface artefact deposit	2	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete and chert	Minor: erosion from wind	3	1	3	NIL	A silcrete flake with evidence of retouch and a chert flake.
MSL 052	TP31	56 H	226604	6148129	30-Jun-15	Test excavation	Subsurface artefact deposit	2	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete	Minor: erosion from wind	3	1	3	NIL	Two retouched silcrete flakes.
MSL 053	TP32	56 H	226733	6147960	30-Jun-15	Test excavation	Subsurface artefact deposit	4	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete, volcanic and quartz	Minor: erosion from wind	3	1	3	NIL	Two quartz flakes, a silcrete flake and a volcanic flaked piece.
MSL 054	TP33	56 H	227689	6147985	30-Jun-15	Test excavation	Subsurface artefact deposit	5	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete and quartz	Minor: erosion from wind	3	1	3	NIL	Two silcrete flakes and three quartz flakes.
MSL 055	TP35	56 H	227939	6149291	30-Jun-15	Test excavation	Subsurface artefact deposit	40	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete and quartz	Minor: erosion from wind	3	1	3	NIL	A group of silcrete and quartz flakes.
MSL 056	TP36	56 H	228042	6149204	30-Jun-15	Test excavation	Subsurface artefact deposit	8	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete and quartz	Minor: erosion from wind	3	1	3	NIL	Three quartz flakes and five silcrete flakes.
MSL 057	TP37	56 H	227817	6152074	30-Jun-15	Test excavation	Subsurface artefact deposit	68	Spur	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete and quartz	Minor: erosion from wind	3	1	3	NIL	A group of quartz and silcrete flakes.
MSL 058	TP38	56 H	227647	6151634	30-Jun-15	Test excavation	Subsurface artefact deposit	8	Undulating Plain	Marulan	Marulan Granite Batholith	Test excavation	Grazing paddock	0	0	silcrete and quartz	Minor: erosion from wind	3	1	3	NIL	Three quartz flakes and five silcrete flakes.
M1 (BCSC1)/BSC1		56 H	228044	6148500	N/A	N/A	Artefact scatter	?	Drainage line	Marulan	N/A	survey	cleared / mining	N/A	N/A	silcrete and quartz	Major: vehicle track/cutting across drainage line	10	5	50	N/A	Small artefact scatter - 2 quartz flakes. 2 silcrete flakes and 1 broken silcrete flake.
M2		56 H	227783	6148128	N/A	N/A	Artefact scatter	3	N/A	Marulan	N/A	survey	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BCSC AS1		56 H	226456	6148134	N/A	N/A	Artefact scatter	8	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete and quartz	Major: road construction and tracks	N/A	N/A	N/A	N/A	One brown silcrete distal flake One grey silcrete grey multiplatform core One red brown silcrete multiplatform core with 30% cortex Two white quartz flakes One black silcrete angular fragment One light grey silcrete angular fragment One grey silcrete medial flake piece
BCSC AS2		56 H	226475	6148140	N/A	N/A	Artefact scatter	2	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete and quartz	Major: road construction and tracks	N/A	N/A	N/A	N/A	One white quartz flake piece One grey silcrete flake piece Artefacts are not comolete flakes.
BCSC AS3		56 H	226485	6148158	N/A	N/A	Artefact scatter	2	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete and quartz	Major: road construction and tracks	N/A	N/A	N/A	N/A	One grey silcrete flake One pink quartz flake Artefacts have a platform and bulb of percussion. The silcrete flake is a primary flake with a weathered dorsal surface. The quartz flake has four scars on the dorsal surface.

BCSC AS4		56 H	226484	6148210	N/A	N/A	Artefact scatter	22	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete, chert and chalcedony	Major: road construction and tracks	N/A	N/A	N/A	N/A	The artefact scatter consisting of 22 artefacts and one river cobble in association with the artefacts. One river cobble silcrete heat treated Four silcrete flake pink grey Two silcrete flake cream One silcrete flake light grey Four silcrete flake grey Three silcrete flake red. One chert flake One silcrete flake light green One chalcedonay Three angular fragments One red core single platform.
BCSC AS5		56 H	226394	6148034	N/A	N/A	Artefact scatter	10	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete, quartz and quartzite	Major: road construction and tracks	N/A	N/A	N/A	N/A	An artefact scatter of ten pieces. Two quartz flakes One angular fragment with quartz veins One blue grey silcrete core single platform One silcrete flake grey One silcrete core grey multi platform with 25% cortex One quartzite core brown multi platform One silcrtet flake brown One silcrete medial flake cream One silcrete flake piece
BCSC IF1		56 H	226951	6147378	N/A	N/A	Isolated find	1	Ridgeline	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Grey Silcrete Core. Artefact has six negative scars and two positive scars with 0% cortex. The core was not in situ and was located amongst erosional soils and shale rock
BCSC IF2		56 H	226388	6148142	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations,	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Red Brown Silcrete Flake. Artefact has two distinct scars on the dorsal side with a step termination on the bottom right edge.
BCSC IF3		56 H	226310	6147957	N/A	N/A	Isolated find	1	Mid-slope	Marulan	limestone	Survey	limestone mining operations,	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Red Silcrete Flake piece Artefact has no platform or bulb of percussion. Artefact does resemble a negative ventral flake scar
BCSC IF4		56 H	226286	6148030	N/A	N/A	Isolated find		Mid-slope	Marulan	limestone	Survey	limestone mining operations,	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Grey Silcrete Flake. Artefact has platform and percussion point, with four scars on dorsal surface.
BCSC IF7		56 H	226417	6148141	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One grey brown Red Silcrete flake Artefact has eight scars with no obvious bulbs or platform.
BCSC IF8		56 H	226417	6148141	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Red Silcrete Core A reduced core with eight ventral scars and bulb and percussion platforms.
BCSC IF9		56 H	226437	6148168	N/A	N/A	Isolated find		Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Grey Silcrete Flake piece Artefact has three knapping scars and one natural surface (1% cortex).
BCSC IF11		56 H	226354	6147952	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations,	N/A	N/A	quartzite and silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One grey green quartzite Flake. Artefact is a reddish silcrete . A primary flake that has a weathered ventral surface.
BCSC IF12		56 H	226461	6148151	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	silcrete	Major: road construction and tracks	N/A	N/A	N/A	N/A	One Red Brown Silcrete Flake piece Artefact has possible scar surfaces. No bulb or platform present
BCSC IF13		56 H	226463	6148164	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	quartz	Major: road construction and tracks	N/A	N/A	N/A	N/A	One white quartz Flake. Artefact has a bulb of percussion and three scars on the dorsal surface
BCSC IF14		56 H	226490	6148168	N/A	N/A	Isolated find	1	Lower slope	Marulan	limestone	Survey	limestone mining operations	N/A	N/A	quartzite	Major: road construction and tracks	N/A	N/A	N/A	N/A	One grey green quartzite Flake. Artefact has four scars on the dorsal side with a platform and bulb of percussion.

Appendix G

Cultural site assessment – Restricted Information

Omitted due to confidential information









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