Boral Limited
Build something great ™

V4

Marulan South Limestone Mine Continued Operations
State Significant Development Application

ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Cement Limited | March 2019

Contents

V4

VOLUME 1

VOLUME 2

VOLUME 3

VOLUME 4

VOLUME 5

VOLUME 6

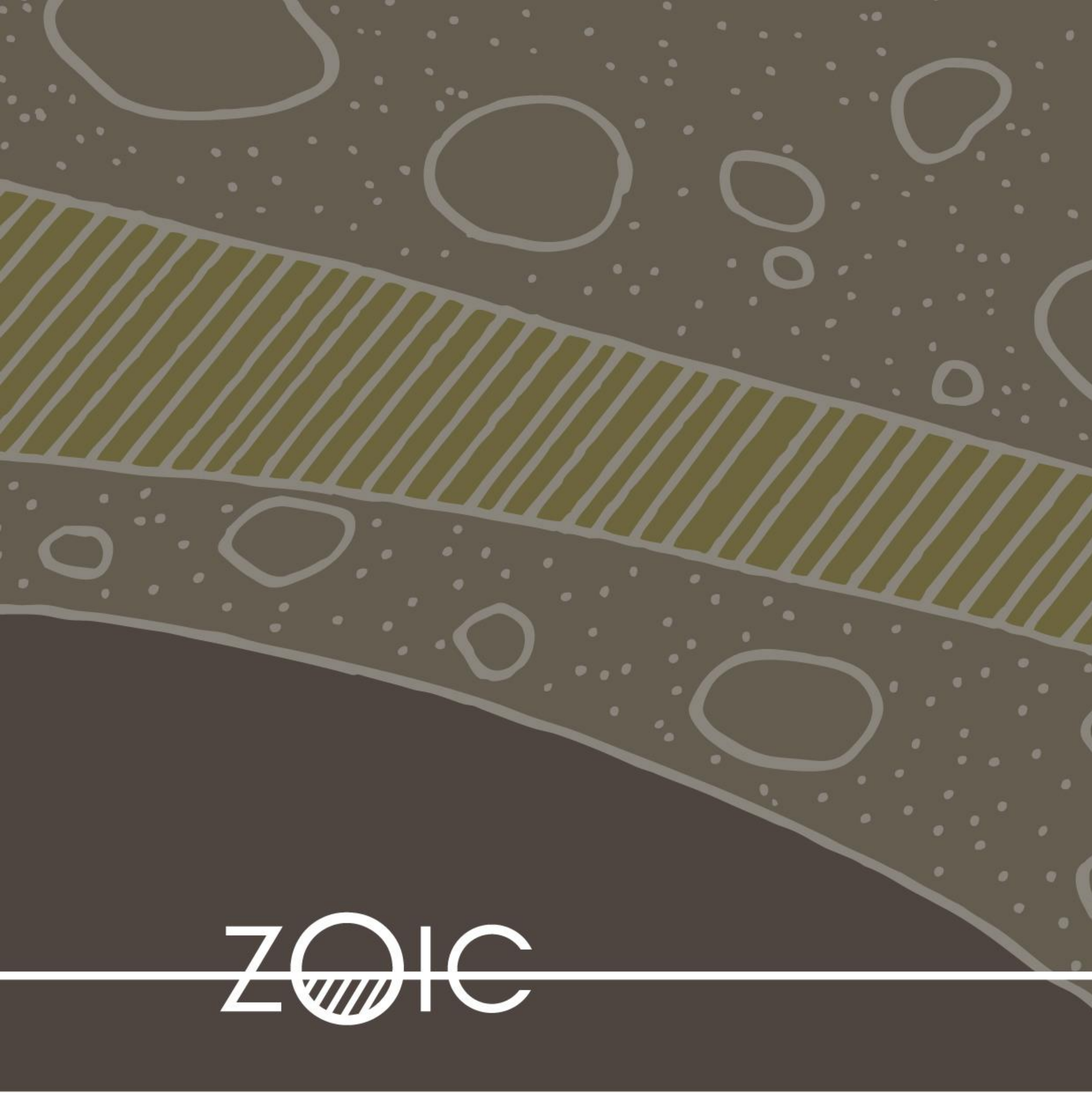
VOLUME 7

Appendix J

Phase 1 and 2 environmental site assessment

VOLUME 4

Appendix J	Phase 1 and 2 environmental site assessment
Appendix K	Biodiversity development assessment report
Appendix L	Aquatic ecology assessment



Phase 1 and 2 Environmental Site Assessment

Marulan South Limestone Mine Continued Operations
Marulan South, NSW

Prepared for Element Environment Pty Limited
on behalf of Boral Cement Limited

August 2018
14071

Quality Management

Document Distribution

Issue / Revision	Issue 1	Revision 1	Revision 2	Revision 3	Revision 4
Remarks	Draft for Comment	Draft for Comment	Draft for Comment	Draft for Comment	Final
Date	June 2015	April 2016	January 2018	June 2018	August 2018
Prepared by	Graeme Malpass	Graeme Malpass	Graeme Malpass	Graeme Malpass	Graeme Malpass
Signature					G Malpass
Approved by	Rebeka Hall	Rebeka Hall	Rebeka Hall	Rebeka Hall	Rebeka Hall
Signature					
Project number	14071	14071	14071	14071	14071
File Reference	Targeted ESA (draft)	ESA April 2016 (Final Draft)	ESA January 2018 (Final Draft)	ESA 26Jun18 (Rev 3 Draft)	ESA 20Aug18 (Rev 4 Final)
Distribution	Element Environment Boral Cement Limited Zoic Electronic File	Element Environment Boral Cement Limited Zoic Electronic File	Element Environment Boral Cement Limited Zoic Electronic File	Element Environment Boral Cement Limited Zoic Electronic File	Element Environment Boral Cement Limited Zoic Electronic File

This report was prepared in accordance with the scope of services set out in the contract between Zoic Environmental ty Ltd and ABN 23 154 745 525 and the Client

Glossary / Abbreviations

ACM: Asbestos Containing Material

AEC: Areas of Environmental Concern

AEMR: Annual Environmental Management Report

AGEC: Australasian Groundwater and Environmental Consultants

AGST: Above Ground Storage Tank

AHD: Australian Height Datum

Boral: Boral Cement Limited

BTEX: Monocyclic aromatic hydrocarbons including benzene, toluene, ethyl benzene and xylene

CLM Act: Contaminated Land Management Act 1997

CML: Consolidated Mining Lease

COC: Chain of Custody

COPC: Contaminants of Potential Concern

DP&E: The Department of Planning & Environment

DPI: NSW Department of Primary Industries

DQO: Data Quality Objectives

Element: Element Environment Pty Limited

EP&A Act: Environmental Planning & Assessment Act 1979

EPL: Environmental Protection Licence

ESA: combined Phase 1 and Phase 2 Environmental Site Assessment

GAA: Gordon Atkinson Associates

GSSE: GSS Environmental

IEC: International Environmental Consultants

JHA: Job Hazard Assessment

LOR: Limit of Reporting

MBAS: Methylene Blue Activated Substances (surfactants)

MHREP: Mining Rehabilitation and Environmental Management Plan

MOP: Mine Operations Plan

NATA: National Accredited Testing Association

NE: New Environment

NEPM (2013): National Environmental Protection (Assessment of Contamination) Measure 1999, amended in 2013

NSW I&I: former NSW Department of Industry and Investment

PAH: Polycyclic aromatic hydrocarbons

PID: Photo Ionisation Detector

PRP: Pollution Reduction Programme

QA/QC: Quality Assurance / Quality Control

RCA: RCA Australia

REF: Review of Environmental Factor

RGS: RGS Environmental

RPD: Relative Percent Difference

SAQP: Sampling Analysis and Quality Plan

SEARs: Secretary’s Environmental Assessment Requirements

SSD: State Significant Development

SVOC: Semi Volatile Organic Compounds

TPH: Total Petoleum Hydrocarbons

UFP: Unexpected Finds Protocol

UPSS: Underground Petroleum Storage Systems

UST: Underground Storage Tank

VOC: Volatile Organic Compounds

WHS: Work Health and Safety

Executive Summary

This combined Phase 1 and Phase 2 Environmental Site Assessment (ESA) was requested by Element Environment Pty Limited (Element), on behalf of Boral Cement Limited (Boral) and was completed in support of a State Significant Development (SSD) application. The Department of Planning & Environment (DP&E) Secretary's Environmental Assessment Requirements (SEARs) relating to potential contamination issues have also been considered. A Summary of Responses to SEARs is presented in the following Section of this report.

The area that is the subject of this ESA ("the Project site" or "the mine") is defined as the area within which mining and associated activities will continue to take place over the following 30 years including the establishment of a water supply dam as shown on Figures 1A, 1B, 2A and 2B in **Appendix A**. The Project site comprises approximately 846.4 hectares and is legally described as Lot 1 DP1124189, Part Lot 2 DP1124189, Part Lot 12 DP881240, Part Lot 23 DP867667, Part Lot 3 DP203290, Part Lot 6 DP203290, Part Lot 282 DP750029, Part Lot 22 DP867667, Part Lot 1 DP261615, Lot 1 DP860561, Lot 2 DP860561, Lot 1 DP106569, Lot 2 DP527500, Lot 1 DP527500, Lot 2 DP106569, Part Lot 100 DP1064794, Part Lot 12 DP570616, Lot 16 DP111641, Lot 14 DP111641, Lot 15 DP111641, Lot 22 DP111641, Lot 6 DP111641, Part Lot 111 DP830458, Part Lot 114 DP830458, Lot 112 DP830458, Lot 113 DP830458, Part Lot 2 DP1186554, Lot 1 DP617992, Lot 9 DP111645, Lot 1 DP132244, Lot 32 DP132244, Lot 3 DP106569, Lot 3 DP527501, Lot 4 DP106569, Part Lot 21 DP657523, Lot 3 DP617992, Lot 114 DP750029, Lot 82 DP750029, Lot 132 DP750029, Part Lot 7300 DP1149129, Part Lot 165 DP750029, Lot 193 DP750029, Lot115 DP750029, Lot 131 DP750029, Lot 154 DP750029, Part Lot 186 DP750029, Lot 179 DP750029, Lot 156 DP750029, Lot 197 DP750029, Lot 83 DP750029, Lot 155 DP750029, Lot 87 DP750029, Lot 1701 DP610507, Lot 1702 DP610507, Lot 98 DP750029, Part Lot 187 DP750029, Lot 191 DP750029, Part Lot 7302 DP1149129, Part Lot 7301 DP1149129 and Part Lot 7303 DP1149129.

The objective of the ESA was to identify the potential for contamination associated with past and present land use and to provide recommendations for any further intrusive investigation, management and / or remediation to protect human health and the environment that may be required to facilitate the proposed continuation of mining on the Project site.

The scope of works included a site walkover and desk based review of all available and relevant historical reports to identify areas of potential environmental concern (AECs). To assess with greater certainty whether the AECs identified posed a risk to human health or the environment, a targeted intrusive investigation was conducted which comprised the drilling of 10 boreholes and collection of an additional 9 surface or shallow soil samples in the following key areas: AEC5: Petrol UST, AEC13 Workshop/Interceptor; AEC14: Wash down Bays/Waste Oil Tank; AEC15: Oil AGST near Kiln and AEC16 Asbestos cement debris in former Marulan South Township. Representative soil samples (including quality control) were submitted for analysis at NATA accredited laboratories. The site visit and fieldworks were conducted in September 2014 and January 2015 respectively. In addition, available surface and groundwater results collected across the site were assessed from a contamination perspective.

The findings of the works completed are presented in this report which has been prepared in accordance with the NSW OEH (2011) Guidelines for Consultants Reporting on Contaminated Sites.

The site has been associated with mining and limestone manufacture since 1869. Boral has been operating the mine since 1987 under NSW Environmental Protection Licence No. 944, which requires environmental monitoring (including dust, air and groundwater) at stated frequency and locations across the mine.

The water bodies at the closest point to the Project site boundary are Barbers Creek (adjacent east) and Bungonia Creek (adjacent south) which flow into the Shoalhaven River (1250m south east). Two abstraction bores, namely WP16 (or EPL944 Licenced Discharge Point 13 / DPI Water Registered Bore GW110267) and WP17 (or DPI Registered Bore GW110268), surface water abstractions from Barbers Creek and seven groundwater monitoring bores are registered with NSW DPI Water. It is noted that although the surface water licence was renewed, this allocation cannot be extracted as Boral does not have any existing agreement in place with the current landowner to physically access the water since the pump was dismantled approximately 3 years ago. Groundwater within these monitoring wells was encountered at between 9.4 and 104m below ground level (bgl).

The ground conditions encountered in the boreholes drilled as part of the ESA intrusive investigations comprised asphalt or concrete surfacing: 0.05-0.3m; gravel sub base fill material: 0.3 – 0.5m; fill or reworked mine overburden materials: 0.5-4.0m; and sandstone in BH1 and BH2 only: 3.5-4.5m+. No groundwater was encountered during the drilling works. However, seepage was noted from gravel sub base beneath the concrete in BH1 and BH2.

Contaminants of concern assessed included heavy metals, hydrocarbons (including TPH, BTEX, PAH, phenols, SVOC, VOC and surfactants as MBAS) and asbestos.

The testing results fall below the adopted site criteria with the following exceptions:

- Hydrocarbons at 0.5-0.9m in BH8 (located east of the westernmost former oil AGST near the Kiln) exceeded the NEPM (2013) Management Limits (shown on attached Figure 5.1);
- Isolated asbestos cement fragments were identified at the surface (ASB01 and ASB05) and in shallow soil (ASB05) in building footprints associated with former Marulan South township which exceed the NEPM (2013) requirement for no visible asbestos at the surface or in the upper 10cm of soil (see Figure 5.3); and
- The kerb of the westernmost bowling green was confirmed as containing asbestos and was sampled where it was damaged (ASB09).

Based on the findings of the ESA, no gross contamination was identified in the targeted areas that would hinder the proposed continuation of mining on the Project site. However, it is recommended that the following be completed to address isolated contamination identified:

- AEC16, as shown on Figure 5.3 should be inspected by a qualified occupational hygienist for any asbestos containing materials (ACM) at the surface. If any ACM is identified this should be removed, appropriately disposed and a clearance certificate issued;
- Where an absence of grass or vegetation is apparent within AEC16, a layer of 10cm of a clean suitable material should be placed and vegetation encouraged to grow;
- A note to be added to the current site asbestos register. The exact wording should be recommended by the occupational hygienist following completion of the inspection;
- The damaged kerb of the bowling green should be repaired (e.g. using epoxy resin) and the entire kerb painted to prevent further deterioration of the asbestos containing structure. A label should be affixed and a note added to the site asbestos register. A hand propelled mower should be used around the edges of the bowling green to prevent further damage to the kerb;
- Although no contamination was noted in the boreholes drilled adjacent to the petrol UST (AEC5), it must be recognised that this represents a potential ongoing risk of pollution to soil and groundwater. If the UST is removed in the future it should be remediated and validated in accordance with the UPSS Regulations (2014) and environmental best practice at that time;
- Connection of the pumping line from the proposed Marulan Creek Dam into the existing Tallong Water Pipeline may cause ACM to be exposed depending on where that connection is made and must be conducted by an appropriately qualified and experienced person to mitigate potential risk to human health and the environment (AEC12);
- All potential contaminants (e.g. hydrocarbons and ACM) are removed from equipment as part of the decommissioning of machinery and spare parts prior to being placed in the Old Machinery / Scrap Yard (AEC17). Where this is not practical, appropriate containment, signage and management should be implemented. Recovered hydrocarbons and ACM must be handled, stored, transported and disposed of appropriately; and
- Given the extensive history of the mine, the presence of isolated areas of contamination should not be discounted. Although these are unlikely to pose a significant risk to human health or the environment, it is recommended that an Unexpected Finds Protocol (UFP) is prepared that provides guidance in the event that future below ground excavations identify contaminated materials (e.g. asbestos, staining, odours). The UFP would outline procedures for handling, assessing and managing any contamination that may be identified as part of future mine expansion activities.

Although the site inspection and fieldwork was originally conducted in September 2014 and January 2015, Zoic considers this information to be reliable for the purposes of this ESA for the following reasons:

- The observations made during the site visit were used to determine whether additional investigation was required.

- On 9 June 2018, Boral advised Zoic that no significant changes have occurred to the site layout or operations since the site inspection and fieldwork conducted in 2014/2015 and no pollution incidents have occurred.
- The 2015/2016 and 2016/2017 Annual Environmental Management Reports provided to NSW EPA stated:
    - No construction activities have occurred on site;
    - Workshop spills are collected via a drainage network / grease trap and emptied by licensed contractor
    - Other site wastes are collected / stored and regularly emptied by a licensed contractor
    - Hazardous materials are inspected by an external service provider (Noel Arnold and Associates). The latest inspection was in July 2017. All hazardous material depots are compliant with the relevant regulations and standards;
    - No contaminated land related non-compliances with EPL 944 (Marulan South Limestone Mine and Lime Plant) were reported within the monitoring periods;
    - Groundwater monitoring, in addition to inventory records would detect leakage from bulk fuel storage areas;
    - The potential for hydrocarbon contamination resulting from leakages and spills continues to be minimised by the implementation of documented hydrocarbon spill procedures and the use of biological oil spill kits located across site operational areas. These spill kits are maintained and serviced by approved contractor services and checked by Boral.
- An UFP has been recommended to manage the potential for discovery of contamination during the implementation of future mine expansion plans.

Summary of Responses to SEARs

The following table outlines the locations in the report where responses are required with respect to potential contamination issues to address the SEARs:

Stakeholders	Contamination Consideration	Location in Report
Water NSW	The location, management and storage of existing hazardous materials.	Section 3.2
NSW Department of Primary Industries (DPI) – Comment by Agriculture NSW	Pollution impacts to surface water which may potentially affect the Turkey Farms approximately 850m to the west and north west of the Mine.	Sections 6, 9 and 10
	Groundwater contamination which may potentially affect the Turkey Farms approximately 850m to the south west and north west of the Mine.	Sections 6, 9 and 10
NSW Office of Water	Assessment of impacts on surface and groundwater sources.	Sections 9 and 10
NSW Office of Environment and Heritage	Nature and degree of impact for both surface and groundwater	Sections 9 and 10
	Acid sulphate soils	Section 4
NSW EPA	Site History	Section 3
	Environmental Setting	Section 4
	Existing Waste and Chemicals Handling	Section 3.2
	Contaminants of potential concern	Section 6
	Potential for soil contamination	Section 6
	Potential for water contamination	Section 6
	Describe existing soil conditions and contamination	Sections 4, 5, 9 and 10
	Describe existing surface and groundwater quality	Section 4, 5, 9 and 10
	Identify impacts associated with acid sulfate soils or potential acid sulfate soils.	Section 4
	Existing environmental licences	Section 3.2

Stakeholders	Contamination Consideration	Location in Report
NSW EPA (continued)	GENERAL Outline cleaner production actions, including: f) Soil contamination treatment and prevention systems	Not applicable as treatment of soil contamination is not required. Prevention of localised soil contamination from identified AEC is managed by existing environmental management procedures for the operation of the mine.
	GENERAL Outline construction works including: a) Actions to address any existing soil contamination	Sections 10 and 11
	WASTE AND CHEMICALS d) Identification of the history of spoil material and whether there is any likelihood of contaminated material, and if so, measures for the management of any contaminated material	Section 3.2, 10 and 11
	GENERAL Provide an overview of the affected environment to place the proposal in its local and regional environmental context including: b) Topography c) Surrounding land uses e) Soil types	Section 3.2
	SOIL CONTAMINATION Provide details of site history – if earthworks are proposed, this needs to be considered with regard to possible soil contamination, for example, if the site was previously a landfill site.	Sections 3 and 6
	GENERAL • Provide an overview of the methodology used to identify and prioritise issues • Provide a summary of the outcomes of the process • Describe baseline conditions • Assess impacts (include reference to other relevant studies) • Describe management and mitigation measures	The entire ESA

Stakeholders	Contamination Consideration	Location in Report
NSW EPA (continued)	SOIL CONTAMINATION • Identify any likely impacts resulting from the construction or operation of the proposal, including the likelihood of: a) Disturbing any existing contaminated soil; b) Contamination of soil by operation of the activity; c) Disturbing acid sulfate or potential acid sulfate soils.	Sections 4 and 6
	• Reference should be made to relevant guidelines e.g. Contaminated Sites - Guidelines for Consultants Reporting on Contaminated Sites (OEH, 2011); Contaminated Sites - Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report (EPA, 2003).	Section 1
	• Describe and assess the effectiveness or adequacy of any soil management and mitigation measures during construction and operation of the proposal including: a) Proposals for site remediation - see Managing Land Contamination, Planning Guidelines SEPP 55 - Remediation of Land (Department of Urban Affairs and Planning and Environment Protection Authority, 1998); and	Sections 10 and 11
	• Proposals for the management of these soils - see Assessing and Managing Acid Sulfate Soils, Environment Protection Authority, 1995 (note that this is the only methodology accepted by the EPA).	Not applicable

Table of Contents

1. Introduction

1.1. Background

This combined Phase 1 and Phase 2 Environmental Site Assessment (ESA) has been prepared for Element Environment Pty Limited (Element) on behalf of Boral Cement Limited (Boral).

The Marulan South Limestone Mine ("the mine") is located at the end of Marulan South Road, Marulan South, NSW approximately 10 kilometres south east of the township of Marulan in the NSW Southern Tablelands. The mine operates using open cut techniques and extracts up to 3.38 million tonnes of limestone per year for the production of limestone based products for the cement, steel, agricultural and construction markets.

The area that is the subject of this ESA ("the Project site" or "the mine") is defined as the area within which mining and associated activities will continue to take place over the following 30 years including the establishment of a water supply dam and associated Overburden Emplacement Areas shown on Figures 1A, 1B, 2A and 2B in **Appendix A**. The Project site comprises approximately 846.4 hectares and is legally described as Lot 1 DP1124189, Part Lot 2 DP1124189, Part Lot 12 DP881240, Part Lot 23 DP867667, Part Lot 3 DP203290, Part Lot 6 DP203290, Part Lot 282 DP750029, Part Lot 22 DP867667, Part Lot 1 DP261615, Lot 1 DP860561, Lot 2 DP860561, Lot 1 DP106569, Lot 2 DP527500, Lot 1 DP527500, Lot 2 DP106569, Part Lot 100 DP1064794, Part Lot 12 DP570616, Lot 16 DP111641, Lot 14 DP111641, Lot 15 DP111641, Lot 22 DP111641, Lot 6 DP111641, Part Lot 111 DP830458, Part Lot 114 DP830458, Lot 112 DP830458, Lot 113 DP830458, Part Lot 2 DP1186554, Lot 1 DP617992, Lot 9 DP111645, Lot 1 DP132244, Lot 32 DP132244, Lot 3 DP106569, Lot 3 DP527501, Lot 4 DP106569, Part Lot 21 DP657523, Lot 3 DP617992, Lot 114 DP750029, Lot 82 DP750029, Lot 132 DP750029, Part Lot 7300 DP1149129, Part Lot 165 DP750029, Lot 193 DP750029, Lot115 DP750029, Lot 131 DP750029, Lot 154 DP750029, Part Lot 186 DP750029, Lot 179 DP750029, Lot 156 DP750029, Lot 197 DP750029, Lot 83 DP750029, Lot 155 DP750029, Lot 87 DP750029, Lot 1701 DP610507, Lot 1702 DP610507, Lot 98 DP750029, Part Lot 187 DP750029, Lot 191 DP750029, Part Lot 7302 DP1149129, Part Lot 7301 DP1149129 and Part Lot 7303 DP1149129.

The mine has operated since 1869 and is a strategically important asset for Boral, as it supplies the main ingredient for the manufacture of cement at Berrima and Maldon Cement Works. 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 (CML) 16, Environment Protection Licence 944, 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 (MOP), a development consent under the EP&A Act will need to be in place.

Achieving approval to continue operations at the mine is critical to the business not only for Marulan South but also at its downstream sites and clients. Boral is seeking approval for continued mining at the site through an application for a state significant development (SSD) based on a 30 year mine plan with associated development of an overburden emplacement area and mine water supply dam.

Zoic conducted the site inspection and fieldwork in September 2014 and January 2015 respectively. This report was originally drafted in 2015 and completed in 2016. However, as Boral decided to revise the previous mine plan due to new geological information from the most recent drilling campaign, the Disturbance Footprint of the proposed 30 year mine plan changed. The revised Disturbance Footprint was established by Boral in January 2018 and the Zoic ESA has since been updated to include this change. No additional site works needed to be completed by Zoic.

1.2. Objective and Scope of Work

This ESA was completed in support of the SSD application to assess the environmental condition of the site.

The objective of the ESA was to identify the potential for contamination associated with past and present land use and provide recommendations for any further intrusive investigation, management and / or remediation that may be required to facilitate the continued operations of the mine, to ensure the protection of human health and the environment, both on and off the Project site.

The ESA scope of work included:

- A site walkover and desk based review of all available and relevant historical reports to identify areas of potential environmental concern (AECs);
- Preparation of a Sampling, Analysis and Quality Plan (SAQP) for the investigative works;
- Preparation of a Job Hazard Assessment (JHA) to manage the proposed works in accordance with Work Health & Safety (WHS) Regulations 2011;
- Clearing proposed borehole locations for buried utilities;
- Borehole drilling (BH1 to BH10 inclusive) and soil sampling including:
  - 10 boreholes using a rotary percussive drill rig on 14 and 15 January 2015, advanced through fill and overburden material and 0.5m into natural soil or between 2 to 4.5m depth whichever was the shallower.
  - 9 shallow soil samples (0-0.1m depth) collected using hand tools / mechanical excavator on 15 January 2015 to facilitate analysis for asbestos in areas of former buildings.
  - Sampling screening with a photo ionisation detector (PID) to determine the presence of volatile hydrocarbons and to aid sample scheduling.
  - Submission of 24 selected soil samples (includes 2 duplicate and 2 triplicate samples) for laboratory analysis at NATA accredited laboratories.
  - Collection of 4 fragments of suspected asbestos containing material (ACM) and submission for confirmatory analysis at a NATA accredited laboratory.

- Monthly surface and groundwater monitoring (“Ongoing Sampling”) is conducted by International Environmental Consultants (IEC) on behalf of Boral and the results with respect to potential impacts of contamination are evaluated and discussed in this report.
- Groundwater sampling for the purposes of supporting this ESA (“ESA Sampling”) was also conducted by Australasian Groundwater and Environmental Consultants (AGEC) and the results with respect to potential impacts of contamination are evaluated and discussed in this report; and
- Preparation of a combined Phase 1 and Phase 2 ESA report in accordance with the NSW OEH (2011) Guidelines for Consultants Reporting on Contaminated Sites and with due consideration to other guidelines made and approved by NSW EPA including SEPP55 (1998) Remediation of Land and NSW EPA (2015) Duty to Report Contamination under Section 60 of the CLM Act (1997).

2. Site Identification and Description

This section provides detail on the Project site and its land use. It describes the surrounding land uses and summarises any potential sensitive receptors.

2.1. Site Identification

The Project site location is shown in Figure 1A and 1B, **Appendix A**. The site identification and land use details include:

Table 2.1: Site Identification

Title	Details
Street Address:	Lot 4, Hume Street, Marulan South, NSW 2579
Property Description:	Lot 1 DP1124189, Part Lot 2 DP1124189, Part Lot 12 DP881240, Part Lot 23 DP867667, Part Lot 3 DP203290, Part Lot 6 DP203290, Part Lot 282 DP750029, Part Lot 22 DP867667, Part Lot 1 DP261615, Lot 1 DP860561, Lot 2 DP860561, Lot 1 DP106569, Lot 2 DP527500, Lot 1 DP527500, Lot 2 DP106569, Part Lot 100 DP1064794, Part Lot 12 DP570616, Lot 16 DP111641, Lot 14 DP111641, Lot 15 DP111641, Lot 22 DP111641, Lot 6 DP111641, Part Lot 111 DP830458, Part Lot 114 DP830458, Lot 112 DP830458, Lot 113 DP830458, Part Lot 2 DP1186554, Lot 1 DP617992, Lot 9 DP111645, Lot 1 DP132244, Lot 32 DP132244, Lot 3 DP106569, Lot 3 DP527501, Lot 4 DP106569, Part Lot 21 DP657523, Lot 3 DP617992, Lot 114 DP750029, Lot 82 DP750029, Lot 132 DP750029, Part Lot 7300 DP1149129, Part Lot 165 DP750029, Lot 193 DP750029, Lot115 DP750029, Lot 131 DP750029, Lot 154 DP750029, Part Lot 186 DP750029, Lot 179 DP750029, Lot 156 DP750029, Lot 197 DP750029, Lot 83 DP750029, Lot 155 DP750029, Lot 87 DP750029, Lot 1701 DP610507, Lot 1702 DP610507, Lot 98 DP750029, Part Lot 187 DP750029, Lot 191 DP750029, Part Lot 7302 DP1149129, Part Lot 7301 DP1149129 and Part Lot 7303 DP1149129.
Current Site Ownership:	Boral Cement Limited, Boral Resources (NSW) Pty Ltd, Boral Limited, Crown Land, Freehold
Property Size:	The Project site comprises approximately 846.4 hectares. The proposed disturbance footprint associated with the 30 year mine plan is 256.5 hectares. The total mine disturbance footprint (pre-SSD disturbance and 30 year SSD disturbance footprint) is 598 hectares.
Local Government Area:	Goulburn Mulwaree Council
Current Use:	High grade limestone mine consisting of an open pit divided into North and South sections and associated overburden emplacement areas, processing areas, rail loading facility, administration and laboratory facilities.
Proposed Use:	Ongoing limestone mine and water supply dam
Subdivision:	It is understood that the properties through which the Marulan South Road realignment takes place will be the subject of a straight land swap with Council.

Title	Details
Zoning – Existing:	RU1 Primary Production and E3 Environmental Management (Goulburn Mulwaree LEP 2009)

2.2. Surrounding Land Use

The mine is located at the end of Marulan South Road, Marulan South, approximately 10 kilometres south east of the township of Marulan in the NSW Southern Tablelands. Immediately adjoining land uses are described as follows:

Table 2.2: Site Surrounds

Direction	Details
North:	Peppertree Quarry
East:	Morton National Park, Barbers Creek Gorge and Shoalhaven River and Gorge
South:	Bungonia National Park and State Conservation Area and Bungonia Gorge
West:	Agricultural lime facility, fireworks storage facility, two poultry farms and rural residential properties

3. Previous Environmental Investigations

3.1. Introduction

On 30 March 2011, the former NSW Department of Industry and Investment (NSW I&I) approved the MOP for 2009 to 2015 which was accompanied by a Review of Environmental Factors (REF) and a Broad Brush Qualitative Risk Assessment for Consolidated Mining Lease No. 16 (CML 16). The approval was subject to various conditions including the provision of additional information for the management of the ‘waste lime dump’ and the removal of the ‘Tallong Water Supply Pipeline’.

Comments received from NSW I&I required that a Phase 1 Contaminated Land Assessment (Phase 1) must be conducted before any contaminated material is inadvertently excavated and disbursed to other areas.

A Phase 1 was conducted by RCA Australia Pty Limited (RCA (Approved 2011)) and was targeted to five separate lots within the site. The assessment identified historical and current potentially contaminating activities requiring further assessment. In undertaking the Phase 1, RCA undertook a review of previous reports prepared for the site that had relevance to contaminated land.

The following sections provide a summary of the salient points from RCA’s document review in the context of this ESA. In addition, Zoic has included a review of additional information prepared post 2011 and subsequently provided by Boral as part of this ESA. .

3.1.1. EPA NSW (May 1995) Mining Rehabilitation and Environmental Management Plan (MREMP)

RCA (2011) stated that a letter report was provided to the Mine Manager (Alan Johnston) at the time regarding non-compliance with environmental objectives and the need for notices as part of a Pollution Reduction Programme (PRP).

Key aspects of the report regarding contaminated land that warranted immediate attention were:

- PRP 2 - ongoing acceptance of waste from the Marulan South Township to the refuse tip on the eastern face of Mount Fuji[1] was to be considered and discussed with EPA and Goulburn Mulwaree Council. Works needed to make emplacement comply with goals and objectives of draft guidelines;
- The actions from Boral were that the disposal to the landfill was ceased and the facility capped in 1996. The EPA was notified of rehabilitation plans for the ongoing operations as part of the MOP to 2015;
- PRP 3 - Turbid groundwater was noted in a previous inspection to be discharging from Main Gully to Bungonia Creek. As a result, turbidity monitoring was to continue;
- Turbidity monitoring has continued and a GSS Environmental report on Surface Water Assessment was completed in 2009;
- No comments were made on the fuel storage or machinery/scrap areas of the site; and
- RCA noted that the NSW I&I had requested more information to be provided on fuel facilities in correspondence dated 17 March 2010.

---

[1] Historical waste lime from the kilns (and other discards) was placed on a large stockpile on the western flank of the North Pit and was subsequently referred to as ‘Mount Fuji’. The volume of waste lime was estimated to be 1M tonnes by Gordon Atkinson & Associates (GAA).

3.1.2. Dames and Moore (November 1995) Solid Waste Landfill Conceptual Closure Plan

RCA (2011) summarised the report as follows:

- The site had been used for a period of 20 years (ca. 1975 to 1995) for domestic waste disposal [Zoic understands that this refers to the landfill on the eastern face of Mount Fuji]. The landfill had a depth of 5 to 10m over an area of 2500m², with a resultant volume range from 12,500 to 25,000m³. The landfill was covered with local soil as a general fill (300mm) which overlies a clay cover (300mm). RCA noted that from inspection of old topographic surveys that the refuse tip was located in a previous gully. The area is underlain by Silurian shale and groundwater is thought to be 30m below the base of the landfill. RCA noted that the landfill was at an elevation of approximately 590m, and groundwater was likely to be at 290 to 300m elevation from the Aquaterra groundwater report. The landfill had a base assumed to be in the shale;
- No borehole or test pit records were available to indicate pre-construction, prior to capping and closure conditions and/or groundwater/leachate characterisation; and
- RCA presumed that the main objective of the closure was to stop infiltration for future leachate production. Retardation and degradation of any previous leachate was considered to have occurred in shaley materials beneath the landfill. No evidence of methane gas at the surface (vegetation dieback etc.) was noted by RCA.

3.1.3. Dames and Moore (April 1997) Completion Report for Solid Waste Landfill

RCA (2011) summarised the report as follows:

- In 1996 works commenced and were completed in December 1996. Dames and Moore undertook an inspection and were satisfied with the landfill being completed on the basis of inspecting after regrading and soils placed over a clay cap;
- Management principles were required to ensure the landfill continued to function and these were to maintain surface drains, maintain clay cap thickness and notify Dames and Moore (now URS) of any environmental or health and safety incidents associated with the landfill. RCA was not aware whether Boral informed URS when landfill materials were encountered by BMD during the northern pit western batters overburden removal contract in 2008; and
- Boral indicated that there has been no work in the landfill area that would have changed the placed materials or drains. However, Boral informed RCA that BMD construction did encounter 5 to 10 truckloads of refuse when undertaking the overburden cut of shale and the refuse materials were taken to the Western Overburden Emplacement and incorporated with other materials in the overburden mass.

3.1.4. Crossend Safety and Risk Management Services (October 2003) Chemicals Management Audit Report

RCA (2011) summarised the report as follows:

- One of the high priority recommendations was to clean up the oil storage area below the retaining wall adjacent to the kiln pre-heater (significant evidence of leaks and spills and no bunding);
- Some of the medium priority recommendations were to repair the pump for the diesel tank and have containment for the lubricating oil drums; and
- Some of the areas where risk controls were absent or less than adequate were the ageing unleaded petrol tank and unleaded petrol dispenser in poor condition (no bund).

3.1.5. New Environment (January 2004) Pre-Demolition Asbestos Survey Report (Calcimatic Kiln No.1)

RCA (2011) summarised the report as follows:

- The document was compiled at the request of Blue Circle Southern Cement (BCSC) (now Boral), prior to the demolition of the No.1 Calcimatic kiln facility;
- The document was thorough in identifying the areas that may contain asbestos and clear in outlining the limitations for the survey, for example, hidden or inaccessible locations;
- The document clearly outlined the details of the areas that were inspected, if asbestos was not detected (e.g. no asbestos was detected in the rotating section of the kiln) and if samples were taken and subsequent analysis showed that asbestos was detected (e.g. circular seals in the air heat exchanger);
- The extent of asbestos in the hearth section was not known at the time of compiling the document;
- The New Environment (NE) "Recommendations" stated that "This document should be held as an Asbestos Register of the site and updated whenever there is a change in the situation". RCA understands the meaning of this comment to be that the NE document may be considered as an Asbestos Register if Boral holds the document and continues to update it as changes occur within the site (as registers can become outdated);
- The NE document mentions valuable points about the management of asbestos, including the removal of asbestos prior to refurbishment or demolition. The NE document mentions that "Asbestos air monitoring, ..., is mandatory during the removal of friable asbestos and recommended during the removal of bonded asbestos";
- RCA noted that they had not sighted results of any asbestos monitoring, a report for any asbestos monitoring or any asbestos clearance reports;
- The NE document mentions that "if asbestos is to remain, a management plan, including occupational health and safety measures, is to be put in place". The NE document also mentions valuable points about the management of asbestos including site restrictions and occupational health and safety measures. RCA took these comments into account for the proposed asbestos management plan; and
- In addition to the NE document for the No.1 Calcimatic kiln facility, there is evidence that asbestos samples were taken from certain areas of the facility in 2005 and analysed. In summary, most of the asbestos results showed that asbestos was not detected. One sample result showed that asbestos was detected (Chrysotile). Further, at the time of compiling this report there was no evidence that an assessment report of these findings was provided to Boral. RCA recommended that:
  - An assessment report is compiled for Boral and the key findings are included in the asbestos management plan that Boral adopts for the site; and
  - Any findings are included in the site asbestos register (if not already included for the No.1 Calcimatic kiln facility).

3.1.6. New Environment (July 2005) Asbestos Survey Report

RCA (2011) summarised the report as follows:

- Although the document was entitled “Asbestos Survey Report”, the document may be considered as an Asbestos Register if Boral holds the document and continues to update it as changes occur within the site (as registers can become outdated (Section 5, page 21 and Section 5 of Appendix II);
- The document was thorough in identifying the areas that may contain asbestos and was clear in outlining the limitations for the survey, for example, hidden or inaccessible locations such as wall cavities. The document provided further detail for the areas of the inspection, for example, the Laboratory, Work Shed and Coal Ball Mill;
- The document clearly outlined the asbestos samples that were taken including location and the results of the sample analysis for asbestos. For example, the Brown Floor Tiles within the maintenance workshop were found by NE to contain asbestos. In addition, the asbestos type was outlined where a sample was analysed, and for the example described here, the asbestos type was shown as Chrysotile;
- The document recommended that some other areas of the site be assessed for the presence of asbestos, particularly if excavation activities are to take place. Reference was made to subsurface fill material near the Community Hall, Bowling Club Greens and grounds may contain asbestos [Zoic notes that the 2005 report refers to “The AC debris present on ground surfaces near the community hall, bowling club and grounds formerly occupied by cottages indicates the possibility of fill containing AC debris.”];
- The NE document mentioned valuable points about the management of asbestos including site restrictions and occupational health and safety measures. RCA took these comments into account for the proposed Asbestos Management Plan, including the comments regarding other asbestos materials identified within the plant, for example, friable asbestos (sprayed insulation or pipe lagging) that were identified by NE, as these should be managed by Boral;
- The report recommended that a work plan be prepared for asbestos works/removal; and
- There was no mention of asbestos associated with the Tallong water pipeline therefore RCA assumed that this was outside the scope of NE’s work.

3.1.7. GSS Environmental (February 2008) Broad Brush Risk Assessment Relating to Environmental Aspects

RCA (2011) summarised the report as follows:

- Risk register Ref OC-096-098 Bulk Fuel Storage. This shows a raw risk of HIGH with existing controls and a MEDIUM risk with proposed controls. A 140,000L diesel and 10,000L petrol above ground storage tanks were planned to be decommissioned in 2008 and be upgraded in 2009 with an above ground storage tank for 95,000L of diesel. The facility will be located where any leakage cannot get into the floor of the mine. The HIGH risk to the fuel storage due to the possibility of a leak through the floor of the tank is noted. No revised risk ranking was given but with proposed control/actions RCA expects the risk will be reduced to LOW. RCA has not been informed of any leaks from the previous facilities to ground and/or groundwater (RCA notes that a 12,000L underground petrol storage tank is included in the May 2009 Dangerous Goods Register, and this is not noted in the Broad Brush Risk Register);

- Risk register Ref OC-115. This shows that with existing controls there is a raw HIGH risk associated with the lime plant waste emplacement. However, the current control is end tipping of materials into a confined area in the Western Overburden Emplacement. Future control to reduce to a MEDIUM risk, is to develop the same area with disposal cells and a study to evaluate if the materials can be used elsewhere (off site) in various commercial applications to reduce the volume disposed. (RCA has been informed that trials are currently in progress to recycle kiln dust into lime product, reclaim quicklime spillage through flash calcination and use hydrated lime sludge in hydrated lime manufacturing);
- RCA considers that this possible re-use principle should also be applied to any similar historically placed quicklime materials in Mount Fuji which contains approximately 1 Million tonnes (as estimated by GAA) of predominantly lime plant waste (Quicklime); and
- Risk registers Ref OC133 Old Landfill. This shows a HIGH raw risk with existing controls, and with proposed action a HIGH RISK related to an old landfill that occurs on the site, and the fact that the location is not fully known. The existing control is to move and fully encapsulate the waste to the Western Overburden Emplacement. The future control is to prepare an environmental monitoring plan and/or procedure so that the problem is not just transferred to another location at the site. With the proposed control/actions RCA expects the risk will be reduced to MEDIUM, as shown by GSSE, and NO residual risk after a management plan or procedure is completed.

Zoic notes that the aim of the document was to provide the basis for identifying all environmental aspects and issues requiring consideration as part the ongoing operation of the mine. The following potential sources of contamination were identified in the document:

- Workshop (oil spills, transfer of diesel and lubes around site in truck);
- Site Waste Management (oily rags, scrap steel, empty 205L oil drums, redundant chemicals, oil filters, engine coolant, batteries);
- Bulk Fuel Storage (140KL diesel tank, 10KL petrol tank, spillage during refill and discharge, on site transport);
- Vehicle Washdown Bays (oil / water separator, surface run off);
- Mine Processing Plant (spills and leaks from gearboxes etc); and
- Lime Kiln and Hydrate Plant (spills and leaks from gearboxes etc).

3.1.8. Aquaterra (2009) Groundwater Report

RCA (2011) summarised the report as follows:

- Groundwater is considered to occur in the limestone aquifer at possibly 290m (950 feet) or less. Groundwater is extracted for use in industrial purposes (dusts suppression) from two bores (WP16/WP17 noted as north and south pit bores) located in the northern section of the North Pit, and are valid to 2014;
- Two bores located in the western area of the Western Overburden Emplacement are decommissioned. RCA understands from GAA that the bores may be recommissioned in the near future and licensed for rehabilitation purposes;
- Sediment control measures below the new Eastern and Western Overburden Emplacement works dams will enable the current reliance for processing water (which is currently obtained from the Tallong Dam via pipeline and on site groundwater extraction boreholes) to be reduced and the use from the works dams increased;
- Aquaterra comment that potential water quality impacts to groundwater are considered to be from oils/grease and total suspended solids (TSS) impacts;

- RCA noted that in relation to the old landfill there are no records of the landfill depth and base (and it is unlikely due to its age) that this landfill was lined, however it is understood that shale is at the base. There is however, no mention of any leachate impact from the refuse landfill site located on the eastern flank of Mount Fuji to the underlying limestone;
- RCA noted that groundwater monitoring (as opposed to surface water monitoring) has occurred from the north pit bore on a monthly interval where oil, grease, and TSS have been monitored;
- Diversion of surface water from the mine area to the North and South pits will require monitoring of oil and grease and rapid action (spill kits) to be taken to prevent any further contamination of groundwater from surface water; and
- Groundwater is considered to occur in the Limestone Aquifer, at possibly 290m below datum (950 feet or less), with the base of the North and South pits being planned during the current MOP period to be at 530m and 340m below datum respectively.

3.1.9. GSSE (2009) Surface Water Report

RCA (2011) summarised the report as follows:

- Surface water management and monitoring is undertaken at the Western Overburden Emplacement, Main Gully and Middle Gully where the current waste lime is disposed. A 4ML sediment control dam is proposed for the Western Overburden Emplacement;
- The risk of oil and grease laden surface waters discharging off site via drainage lines will be reduced by having diversion of waters into the North Pit, as detailed in the MOP; and
- Also in the Western Overburden Emplacement, a new pre-treatment sediment dam will receive “dirty water” from any refuse tip relocated materials as well as from waste lime placement areas.

3.1.10. Blue Circle Southern Cement (May 2009) WorkCover Notification of Dangerous Goods on Premises Form

RCA (2011) summarised the report as follows:

- The form was submitted by Robert Patterson of BCSC on 5 May 2009; and
- In terms of potential hydrocarbon pollution sources the form lists that the site has the following bulk fuel storage: one underground maximum 12,000L petrol tank and one above ground maximum 93,000L diesel tank.

3.1.11. GSSE (November 2009) Review of Environmental Factors

RCA (2011) summarised the report as follows:

- The site activities are considered to not impact on the groundwater flow regime and the potential impacts to groundwater are considered likely to be related to pollution from on-site activities such as oil, grease and total suspended solids (Aquaterra 2009). While the underlying limestone is an aquifer (with karstic properties) there is no public drinking water or agricultural abstraction downstream from the site;
- Mitigation measures consist of ongoing monitoring in accordance with EPL No. 944 to assess any groundwater pollution. Should any contamination be recorded then rapid action (spill kits and off site disposal) will be undertaken by Boral to ensure that contamination does not reach groundwater;
- Surface water management review was undertaken by GSSE for the eastern, western and single pit emplacement areas, the gully and the single pit void. The review appears to have not included leachate impact from the refuse tip materials at the eastern flank of Mount Fuji (or at an area of possible relocation in the Western Overburden Emplacement), on surface water or groundwater;

- From a small data set, and from locations as a result of a variation to EPL 944 dated February 2009, no hydrocarbon contamination from mining equipment and associated activities has been found either at the pit or at the downstream Main Gully sample point locations. In addition, sampling from water storage areas indicated no oils or grease were detected. Further data assessment will be required as part of the ongoing monitoring at this site;
- RCA considered that specific mitigation measures for monitoring of the groundwater impact of leachate from old tip refuse materials, and at least one hydrocarbon monitoring borehole at the old UST area and at the drum tank disposal area are necessary to confirm baseline perched water quality (or lack of groundwater) had not been impacted and there is an ongoing low risk of impact;
- Soils and land capability have been assessed over three separate soil surveys and by GSSE during 2005 and 2006. For rehabilitation purposes any contaminated soils will be removed to an appropriate approved off site landfill facility or treated and disposed on site following agreement with OEH. The location of this facility is likely to be within the main Western Overburden Emplacement, however RCA was not clear where this area would be located and whether OEH would approve this;
- The mining activities were not expected to pose a significant risk of harm significant enough to warrant regulation in terms of contaminated land regulation; and
- However, RCA recommended legal opinion should be obtained. It was stated by Boral that they were aware of previous land use activities (including a previous refuse landfill location) also hydrocarbon storage and an area of old plant/equipment that may have potential to cause or contribute to contamination (RCA noted that the RCA Phase 1 Contaminated Land Assessment was a commitment from Boral to further identify contaminated land issues and prepare management plans to address issues).

3.1.12. Boral Cement Limited (November 2009) MOP

RCA (2011) summarised the report as follows:

- The MOP covered the period from January 2009 to June 2015;
- Within the MOP hazardous substances section, hydrocarbons were reported in one petrol, one oil, and four distillate facilities (above ground storage facilities). These, in RCA's opinion, could have the potential to contaminate from overfill and fuel spillages. Hazardous and dangerous goods were inspected yearly to check for any problems and the need for upgrades;
- Above ground tanks were decommissioned during 2008 and replaced in 2009 by a 95,000 litre above ground bunded storage tank. RCA was not aware of a validation report undertaken to confirm residual contamination following tank removal;
- Waste management indicated that recovered grease and oil materials from an oil/grease separator were stored on site and removed by a recycling contractor and that grease drums and oil filters were stored until collection by a waste recycling contractor. Details of how and where grease, oil filters, and drums are stored was not provided; and
- The site used ground/surface waters for mine dust suppression.

3.1.13. Boral Cement Limited (2009) MOP Review of Environmental Factors (REF) Environmental Risk Register

RCA (2011) summarised the report as follows:

- Hydraulic Hose Oil Spill – remove equipment to controlled area as soon as possible managed by employee awareness, pre-start checks, environment awareness training, spill kits, incident reporting, trained service men, purpose built truck;

- Spillage from smaller related hydrocarbon storage - managed by secondary containment bunds, employee awareness, pre-start checks, environment awareness training, spill kits, incident reporting;
- Waste Management – managed by waste bins where required, collected by waste contractors, training for employees, environment awareness training, spill kits; and
- Transfer of Hydrocarbons from Service Truck – managed by employee awareness, pre-start checks, environment awareness training, spill kits, incident reporting, trained service men, purpose built truck.

3.1.14. Boral Cement Limited (June 2011) MOP Amendment 1A Waste Lime Management

RCA (2011) summarised the report as follows:

- The MOP covers the period from January 2009 to June 2015;
- Waste lime management at the site was discussed in relation to the existing historical placement at Mount Fuji, and the current waste lime disposal area adjacent to the Western Overburden Emplacement;
- Waste lime management proposals were discussed for the current disposal area. Details of a containment bund currently being constructed, ongoing placement of materials in the containment area and final capping and completion details were provided;
- Details of a waste lime reduction programme were provided; and
- Details of specific safe work operating procedures (SWOP) for the Waste Lime Emplacement Area were provided.

3.1.15. RCA (October 2011) Phase 1 Contaminated Land Report

Zoic understands that the purpose of the report was to satisfy the requirements of NSW I & I resulting from their review of the initial MOP and supporting REF (November 2009) and further develop an understanding of the potential contamination present within and associated with the site, and the likely impacts of those contaminants.

In particular, RCA (2011) was requested to assess the likelihood of contaminated materials associated with a refuse tip as part of “Mount Fuji” and the history of the site and asbestos associated with the Tallong water supply pipeline that runs through Boral Resources (NSW) Pty Ltd land.

RCA (2011) recommended the following actions:

Refuse Tip (Mount Fuji eastern flank)

In order to determine the nature and condition of materials to be removed once encroachment into Mount Fuji occurred, RCA considered further limited shallow boreholes or excavator test pit investigations are undertaken to confirm no contamination, and to assist in developing an environmental/site management plan.

In addition, due to the previous slope failure in some of the material in 2008, the need to gather geotechnical information on the properties of materials was suggested so further slope stability assessment could be undertaken for any future additional overburden removal.

Oil Drum Disposal Area

Since there was no validation report for the drum area, further shallow test pit investigations (assume a minimum of four backhoe test pits) was prudent to confirm no residual contamination, or to assist in developing environmental management plans which should include bunding.

Bulk Fuel Storage Area (AGSTs and UST)

Since there was no validation report for the above ground storage tank (AGST) area following decommissioning, further test pit investigations (assume a minimum of four backhoe test pits) would be prudent to confirm no residual contamination or to assist in developing environmental management plans.

In accordance with the UPSS Regulations groundwater monitoring boreholes are necessary before June 2011 and three installations are the typical requirement. Alternatively, the storage could be transferred to an AGST facility and the underground storage tank (UST) decommissioned.

Scrap/Mine Machinery Storage Area

Further test pit investigations (assume four test pits) would be prudent at the above areas to confirm no residual contamination associated with fuel loss from redundant plant or machinery.

Waste Lime Disposal Area

Additional test pits were required in order to provide information for scheme design of containment cell embankments to ensure that such features had adequate foundations and slope stability was not an issue. Further, TIRIS expressed concerns with waste lime management following the review of the MOP Amendment 1A Waste Lime Management, commenting as follows:

“more information is required on the ongoing management of the waste lime to ensure no long term impacts such as leachate production and impacts to soils that will be detrimental to the environment and rehabilitation”.

In order to address the above concerns RCA proposed installing groundwater wells to assist in the assessment of leachate production from the ‘target’ waste lime area, and the impact of any leachates on the environment (refer to RCA’s proposal, reference no. 7584-103 dated September 2011).

Tallong water supply pipeline (AC clad) removal/disposal

RCA recommended that Boral should treat the entire water pipeline as containing asbestos products. This included the section of pipeline required for removal as part of the “Peppertree Quarry” development (pipe length approximately 1.5 km). An estimate was obtained in May 2010 for the removal of the 1.5km of pipeline for the Peppertree quarry development amounting to approximately $124,000.

The above works should be included in the site wide asbestos management plan. An example of the plan framework was attached as Appendix C, for the consideration of Boral.

Asbestos associated with the No.1 Calcimatic kiln facility

RCA recommended that for this facility and the previous sampling and analysis carried out in 2005 – (a) an assessment report is compiled for Boral, and the key findings are included in the asbestos management plan that Boral adopts for the site; and (b) any findings are included in the site asbestos register (if not already included for the No.1 Calcimatic kiln facility).

3.1.16. GAA on behalf of Boral (Various: 2006 to 2013 inclusive) AEMR

Information relating to contaminated land was extracted by Zoic from available historical AEMR reports and can be summarised as follows:

- 2006-2007: The site contained an old rubbish dump on the western side of the North Pit. The site had been sealed to prevent leachate and surveyed to facilitate control when the site is disturbed as part of the future mining of the North Pit;
- 2006-2007: The former site of the Calcimatic Kiln that was subject to removal of asbestos prior to demolition was subjected to additional sampling and subsequently cleared of potential asbestos contamination during 2005;

- 2007-2009: No changes in the status of contaminated land during the reporting period. The site contained an old rubbish dump on the western side of the North Pit. The site had been sealed to prevent leachate and surveyed to facilitate control when the site is disturbed as part of the future mining of the North Pit. The Broad Brush Risk Assessment of February 2008 identified old landfills containing “unknown materials” as potentially high environmental risk. Specialist advice was to be sought and management plans prepared to assist with the reclamation of these areas in association with overburden removal and mining;
- 2009-2012: These AEMRs reported on: Hydrocarbon and chemical management and the handling of hydrocarbon contaminated materials; Review and update of the site Asbestos Register contained in the “Asbestos Survey Report” Report No. 6011/02/ASR, dated 13 July 2005; and
- Identification and assessment of other potential land contamination issues including those likely to be associated with the Tallong AC water pipeline, the “Mt Fuji” waste lime dump and former site refuse dumps.

Zoic notes that these reports were prepared to fulfill the AEMR requirements for the relevant annual reporting periods of Consolidated Mining Lease (CML) No. 16 – Condition 2 for the Marulan South Limestone Mine.

3.1.17. RPS (July 2013) Surface and Groundwater Data Review

RPS stated that the report had the following aims and objectives:

- To determine the adequacy of existing site monitoring data;
- To identify any gaps in the current monitoring network at the mine;
- To identify additional surface and groundwater monitoring data which is likely to be required; and
- To recommend a field programme which will adequately inform the following:
    - Formation of a robust conceptual groundwater model (CGM) to be used to inform all stakeholders of the current groundwater regime underlying the site;
    - Construction of the numerical groundwater impact model required for project approval from the regulators; and
    - Inform submissions relating to the recent Aquifer Interference Policy and associated licensing requirements.

RPS made the following conclusions:

- Groundwater quality monitoring has been ongoing since October 2008 at the mine. Monitoring comprised quarterly chemistry samples from the site production bore and intermittent samples from the south Quarry Pit Floor and the “Blow Hole” discharge point;
- A number of data gaps in the hydrogeological information in reference to a DA approval currently existed. The majority of these data gaps may be addressed by a hydrogeological investigation programme involving the installation of paired piezometers and subsequent permeability testing and routine monitoring where groundwater ingresses have been encountered;
- Quarterly sampling of the existing site production bore remains in place. Analysis comprising the existing full suite of parameters was recommended;
- A field investigation programme comprising the installation of 6 paired piezometers across the site should be implemented;
- An additional single piezometer should be installed in the south pit in the vicinity of the sump;

- Flow monitoring using a manual Vale Port flow meter should take place at upstream and downstream locations on the Bungonia and Barbers Creeks. Monitoring should also comprise water quality samples;
- The locations of the paired piezometer locations, along with the surface water monitoring points on the Bungonia and Barbers Creeks could be scoped out during a site meeting. Ground truthing of the monitoring locations would be important as the accessibility of the monitoring point would be the key driver in selecting the location;
- Monthly chemistry and flow monitoring at the main gully sampling point should take place. This would replace the current practice of monitoring only after significant rainfall events. Parameters in the analysis suite should comprise those included in the site production bore analysis suite;
- When the field investigation is complete, a forward plan for sampling any water ingress will be made. The parameters which should be sampled for and the recommended sampling frequency will be made in the field completion report;
- An automatic water level logger should be installed into the site production bore and set to record at daily intervals. A flow meter should also be installed at this point to record daily water take from the aquifer;
- Automatic water level loggers should also be installed in 3 paired piezometers (6 loggers in total) and set to record water level at daily intervals;
- The existing groundwater monitoring data should be compiled into one single database so that data manipulation and analysis can easily be undertaken;
- Regulatory liaison is recommended as soon as possible, and throughout the project so that all parties understand the programme and the level of investigation and assessment required; and
- A site meeting should be arranged to discuss the outcomes of this report and how the outcomes will be implemented.

3.1.18. RPS (August 2014) Hydrogeological Investigation

RPS stated that the groundwater investigation was designed to:

- Confirm the depth of the unconfined groundwater table and the potentiometic head of the deeper confined aquifers;
- Refine the delineation of the geological formations in the vicinity of the Mine and their effect on the hydrogeological regime;
- Provide for a robust and defendable conceptualisation of the hydrogeological processes; and
- Enable the collection of a baseline hydrogeological dataset to understand the seasonal fluctuations and stresses on the groundwater resource.

Eight standpipe piezometers were installed to enhance the resolution of groundwater monitoring at the Mine. Depths of drilling ranged between 40 and 205m bgl. The resulting groundwater network will allow for the collection of baseline groundwater monitoring data to refine and increase the understanding of the groundwater resource in the local and regional area.

Wells were installed in limestone, weathered granite and fractured granite with response zones between 36.5 and 60m and 72 and 127.5m for shallow and deep wells respectively.

Hydraulic testing was conducted on the piezometers to determine indicative values of aquifer hydraulic conductivity with results confirming previous work completed at the mine and refining the site conceptualisation.

A general direction of groundwater flow is indicated from the northwest towards the mine area. Water levels within the limestone are substantially lower than the surrounding lithologies suggesting elevated permeability with the limestone acting as a drain, with groundwater potentially discharging to the south towards Bungonia Creek.

The difference in groundwater elevations between the two pits is inferred to be controlled by the cross-cutting dyke that separates the two pits, and restricts groundwater flow. The hydraulic gradient within the limestone appears to the south, consistent with the strike of the unit. The reduced groundwater elevations below south pit are also indicative of a groundwater discharge/outflow to the south of the south pit.

RPS made the following recommendations:

- Monthly measurements of groundwater level and field water quality parameters (pH, EC and temperature);
- Monthly downloading of the automated logger network. This should include the collation, validation and barometric conversion of all data;
- Biannual groundwater sampling for laboratory chemical analysis (including pH, EC, TDS, alkalinity, sulfate, chloride, major cations, dissolved metals, fluoride and ionic balance). Zoic notes that this was only used to determine the chemical composition of the groundwater and not potential impacts from AEC (e.g. hydrocarbons);
- Monitoring bores should be purged in accordance with the groundwater sampling guidelines (EPA 2000) prior to sampling for field water quality parameters and comprehensive chemical analysis. To achieve this across the monitoring network low-flow sampling is recommended; and
- Six monthly review of monitoring data to ensure there are no gaps in the collected dataset.

3.1.19. GAA on behalf of Boral (19 December 2014) AEMR

Information relating to contaminated land was extracted by Zoic from the AEMR (2013/2014) report and can be summarised as follows:

- No non-compliances with EPL 944 (Marulan South Limestone Mine and Lime Plant) were reported within the monitoring period;
- No environmental complaints were received in the 2013/2014 monitoring period;
- Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor;
- The workshop channels all runoff through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor;
- Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor;
- A Notice of Variation to the site EPL (EPA dated 7 August 2014) advised that concentration limits for solid particles and other emissions from the kiln and hydrator have been updated to Group 5 emission standards; and
- Shale overburden mixed with waste lime has continued to be successfully removed from the former “Mt Fuji” waste lime dump. During this process the former site refuse dump located above the western batters of the North Pit has been identified. Refuse has been monitored by placing in holding stockpiles to permit visual checking of any potentially hazardous materials observed during excavation. A small quantity of asbestos material was discovered during the latter months of this AEMR (2013/2014) period and isolated prior to removal from site in accordance with site asbestos management protocols.

3.1.20. RGS Environmental (23 March 2015) Geochemical Assessment of Overburden Rock Materials from the Marulan Limestone Mine

Information relating to contaminated land was extracted by Zoic from the RGS report and can be summarised as follows:

- RGS collected 25 representative samples of overburden material from the mine pit and subjected these to a series of geochemical tests to determine the potential of the material to generate acidity, salts and soluble metals / metalloids;
- Testing was conducted in accordance with technical guidelines for geochemical assessment of mine waste in Australia (DITR 2007 and AMIRA 2002) and worldwide (INAP 2009);
- All samples were tested for pH, electrical conductivity, total sulphur and acid neutralising capacity to determined net acid producing potential (NAPP). One sample was tested for chromium reducible sulphur;
- Twelve of the original samples were used to generate six composite samples of similar lithology and were tested for total cations, total metals and metalloids and major cations and anions;
- The overburden rock material sample results can be summarised as follows:
    - Slightly alkaline with a median pH of 8.5.
    - Typically low EC with a median of 144ms/cm (samples of weathered dyke and shale has EC>1000mg/cm but make up a relatively small component of overburden rock mass).
    - Total sulphur content typical of background concentrations (<0.1%). A sample from the mafic dyke contained 0.14% sulphur which is present as sulphide sulphur.
    - Very low maximum potential acidity (MPA, median value 0.15kg H_2SO_4/t).
    - Acid neutralising potential of more than an order of magnitude greater than MPA (median value 3.9kg H_2SO_4/t).
    - NAPP has a median value of -3.7kg H_2SO_4/t and the waste rock has a negligible risk of generating any significant acidity and / or neutral acid mine drainage.
    - Metal and metalloid concentrations fall below NEPM (2013) HIL C criteria and are suitable for landscaping purposes post closure.
    - Metal and metalloid concentrations are generally not enriched above average crustal abundance values. The exception being calcium in limestone and arsenic, cobalt and manganese in the relatively small amount of contact between the limestone and shales.
    - “worst case” leachate from waste rock indicated slightly alkaline pH; low salinity and dissolved solids (except shale / mudstone); low cations and anions (except shale / mudstone); metals and metalloids less than LOR (minor exceptions aluminium and chromium); and, are unlikely to impact upon the quality of the surface and groundwater resources at the site.

- RGS recommended that any shale / mudstone materials are preferentially placed in the core of the overburden emplacements away from final rehabilitated surfaces. In addition, surface and seepage water from overburden emplacements should be monitored quarterly for pH, EC, TSS, metals / metalloids and major ions.

3.1.21. GAA on behalf of Boral (30 October 2015) AEMR

Information relating to contaminated land was extracted by Zoic from the AEMR (2014/2015) report and can be summarised as follows:

- No contaminated land related non-compliances with EPL 944 (Marulan South Limestone Mine and Lime Plant) were reported within the monitoring period;

- No environmental complaints were received in the AEMR (2014/2015) monitoring period;
- Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor;
- The workshop channels all runoff through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor;
- Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor;
- A Notice of Variation to the site EPL (EPA dated 7 August 2014) advised that concentration limits for solid particles and other emissions from the kiln and hydrator have been updated to Group 5 emission standards; and
- Shale overburden mixed with waste lime has continued to be successfully removed from the former “Mt Fuji” waste lime dump now substantially completed. During this process the former site refuse dump located above the western batters of the North Pit has been identified. Refuse has been monitored by placing in holding stockpiles to permit visual checking of any potentially hazardous materials observed during excavation. A small quantity of asbestos material was discovered during the latter months of the AEMR (2013/2014) period and isolated prior to removal from site in accordance with site asbestos management protocols on 9 July 2015.

3.1.22. Boral (2015-2016) AEMR

Information relating to contaminated land was extracted by Zoic from the AEMR (2015/2016) report and can be summarised as follows:

- As per legislative requirements a review of contaminated land at the Marulan South site and potential risks was undertaken in 2015 as a part of the “duty to report”. No issues or significant land contamination were identified;
- One environmental enquiry was noted in the AEMR (2015/2016) monitoring period. Discolouration of water in Bungonia Creek, which was the subject of the enquiry, was attributed as natural discharge from above the cave systems rather than the site itself;
- Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor;
- The workshop channels all runoff through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor; and
- Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor.

3.1.23. Boral (2016/2017) AMER

Information relating to contaminated land was extracted by Zoic from the AEMR (2016/2017) report and can be summarised as follows:

- On 2 March 2016 the 2009/2016 MOP/REF was extended until 31 March 2018;
- No construction activities have been undertaken;
- Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor;
- The workshop channels all runoff through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor;
- Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor;

- Hazardous materials are inspected by an external service provider (Noel Arnold and Associates). The latest inspection was in July 2017. All hazardous material depots are compliant with the relevant regulations and standards;
- No contaminated land related non-compliances with EPL 944 (Marulan South Limestone Mine and Lime Plant) were reported within the monitoring period;
- Groundwater monitoring, in addition to inventory records would detect significant leakage from bulk fuel storage areas; and
- The potential for hydrocarbon contamination resulting from leakages and spills continues to be minimised by the implementation of documented hydrocarbon spill procedures and the use of biological oil spill kits located across site operational areas. These spill kits are maintained and serviced by approved contractor services and checked by Boral.

3.1.24. Boral (1 April 2018-26 February 2023) Mine Operation Plan (MOP)

Information relating to contaminated land was extracted by Zoic from the MOP, which will be implemented shortly, and can be summarised as follows:

- Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor;
- The workshop channels all runoff through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor. Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor; Once these have been disposed of, certificates of disposal at appropriate facilities are are provided;
- The potential sources of pollution from the mine to groundwater are oil & grease and total suspended solids (TSS). These COPC will be monitored within 6 wells installed during the 2014/2015 AEMR and one additional well installed during the 2016/2017 AEMR period;
- Water monitoring and reporting requirements in accordance with EPL 944 include the North pit bore. Boral maintains an ongoing monitoring point being the automatic water sampler located in the lower section of Main Gully, this water monitoring point is triggered automatically when the water in the area rises during a rain event;
- Dangerous goods depots include 1 x Petrol, 2 x LPG, 1 x oils, 1 x compressed gas and 1 x distillate are utilised at the mine in accordance with new licencing for Acknowledgement of Notification of Dangerous Goods on Premises - Licence Number 35/008099.
- Hazardous and Dangerous material facilities are inspected at least annually by an externally accredited inspector to check for any problems or upgrades required under the regulations;
- As required, all enclosures to fuel facilities are bunded to meet AS 1940 Storage and Handling of Flammable and Combustible Liquids, 2017;
- A Phase 1 Contaminated Land Assessment was undertaken during 2010 to update and further identify potential land contamination issues on site. The results from this assessment, and the recommendations within, will be used by Boral to appropriately manage any potentially contaminated lands to be impacted upon during the MOP period; and
- Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution (including sedimentation) or soil contamination or erosion, unless otherwise authorised by a relevant approval, and in accordance with an accepted Mining Operations Plan.

Correspondence from NSW Planning & Environment Resources & Geoscience dated 1 March 2018 (Ref OUT18/2241) provided Notice of Approval of Mining Operations Plan – 2018-2023 Marulan South Limestone Mine.

3.1.25. Marulan SSD 2018 Assessment Reports

Niche Biodiversity Assessment, EMM Heritage (Aboriginal and Historic) Assessments and the LAMAC Soils, Land and Rehabilitation Assessment were conducted as part of the SSD submission for the Project site. These studies involved walkover inspections of large parts of the mine site and therefore had the opportunity to identify areas of potential contamination.

Furthermore, LAMAC Soils, Land and Rehabilitation Assessment included test pitting of all undisturbed soils to establish agricultural potential and EMM conducted substantial test excavations as part of the Aboriginal heritage assessment.

Zoic understands that no additional indicators of potential contamination were identified during the walkover inspections or test pitting works conducted as part of these studies.

3.2. Site History and Surrounds

The site history is summarised in this section. This information has been sourced from the reports listed in Section 3.1 above together with other references as stated.

Table 3.1: Summary of Site History

Item	Details
Summary of Past Land Use:	- Pre 1953: numerous different mining leases - 1953-1974: Northern Pit operated by Southern Portland Cement Limited (SPC) which was owned by Australian Iron & Steel (BHP) - 1953-1960: Southern Pit owned by Metropolitan Portland Cement - 1960-1974: Southern Pit owned by Australian Portland Cement Manufacturers of Australia (APCM(A)) which was formed by the Blue Circle (UK) company following the purchase of Commonwealth Portland Cement, Standard Portland Cement and Metropolitan Portland Cement - 1974-1987: North and South Pits owned by BCSC - 1987 – present: Boral
Summary of Planning Certificates:	RCA (2011) obtained Section 149 (2) and (5) Planning Certificates from Goulburn Mulwaree Council to provide information related to contaminated land as prescribed by Section 59 (2) of the Contaminated Land Management Act 1997 (CLM Act 1997), which includes whether the site is: - Deemed as being significantly contaminated land as defined by CLM Act 1997 - Subject to a management order as defined by CLM Act 1997 - Subject to an approved voluntary management plan as defined by CLM Act 1997 - Subject to an ongoing maintenance order as defined by CLM Act 1997 - Subject of a site audit as defined by CLM Act 1997 Zoic notes that RCA (2011) only obtained Planning Certificates for Lots 82, 114 and 132 in DP750029 and Lot 4 in DP106569. Zoic considers that these lots relate to those parts of the mine with the highest levels of disturbance and consequently the highest potential for containing contaminated materials or contaminating activities. A review of the available Planning Certificates confirmed that Lots 82, 114 and 132 in DP750029 and Lot 4 in DP106569 are not affected by matters relating to CLM Act 1997 as outlined above.

Item	Details
	Given the above and extensive history of the site as a mine, obtaining copies of the Section 149 certificates for the remainder of the Project site is considered unnecessary to advise of potential contamination issues.
NSW EPA Records	AEMR (2016/2017) stated that Boral is the licensee of EPL 944 for the “Marulan South Limestone Mine and Lime Plant” for between 100,000 and 250,000 tpa of lime production and between 2 and 5 million tpa of minerals obtained by mining. The latest Annual Return for the period 28 January 2016 to 27 January 2017 was submitted 22 August 2017. No non-compliances with licence conditions were recorded and no pollution complaints were received during the EPA reporting period. NSW EPA has issued a Radiation Licence (5061123) which licences sale or possession of radioactive substances or items containing radioactive substances valid until 21 August 2018. This licence is related to a low level radioactive source which is used in fixed radiation gauges to facilitate operation of the Belt Analyser on Conveyor 2. NSW EPA electronic registers were accessed by Zoic on 10 October 2014 and the following was determined: List of NSW Contaminated Sites Notified to EPA - Section 60 Notices for Contaminated Sites: The BP Service Station on the north and south bound carriageways of the Hume Highway were listed for Marulan. These sites are located over 4kms from the mine site and are unlikely to pose a potential risk CLM Record of Notices There were no CLM Notices for sites in the Goulburn Mulwaree Council area for Marulan. The closest site to the mine related to a former Gas Works and Mobil Service Station in Goulburn, which are too far away to pose a potential risk POEO Public Register - In the suburb of Marulan there are records of 2 POEO current licences for quarries including Holcim and Gunlake - In the suburb of Marulan South, there is record of 1 POEO current licence for the mine site (EPL 944)
WorkCover Dangerous Goods Licenses:	A summary of WorkCover Licences was provided by Boral in AEMR (2016/2017) as follows: - A former ammonium nitrate depot was removed in February 2016; - 11-100005-004 Licence for Orica to import explosives (Cert No. 000004-000018012) valid until 15 June 2021 - XMNF100033 Licence to manufacture explosives issued valid until 29 October 2020 - 35/008099 Dangerous Goods stored in 6 depots covering petrol, diesel, flammable liquid, compressed gas, explosives and ammonium nitrate acknowledged by WorkCover in January 2015

Item	Details
	AEMR (2016/2017) stated that Hazardous and Dangerous material facilities continue to be inspected at least annually by an externally accredited inspector to check for any problems or upgrades required under the WHS Regulation 2017. As required, all enclosures to fuel facilities are bunded to meet AS 1940 Storage and Handling of Flammable and Combustible Liquids, 2004.
Summary of Aerial Photographs (on site):	- No historical aerial photographs were available prior to 1972 but a Summary of Past Land Uses is provided above, which predate 1972 - A selection of historical aerial photographs between 1972 and 2018 are presented in **Appendix A** - Between 1972 and 1984 the general configuration of the mine (Processing in North, the North Pit and South Pit) had been established and by 1984 the extreme southern section of the Western Overburden Emplacement had been developed - By 2011 the mine pits were significantly deeper and the Western Overburden Emplacement had been extended northwards - With the exception of the North and South Pits becoming deeper with excavation benches visible and the Western Overburden Emplacement extending slightly further northwards and growing in height, little significant other change was noted between 2011 and 2014 - No significant change was noted on the 2017 and 2018 aerial photographs other than the “centre ridge” that separated the North and South pits has been mined out. Noting limitations of the resolution on some images, review of available historical aerial maps did not identify any additional areas of potentially contaminating activities that were not already identified in the historical documents discussed in Section 3.1 above.
Summary of Aerial Photographs (off site):	- No historical aerial photographs covering the surrounding area were available prior to 1972 - Between 1972 and 2018 the surrounding land use has comprised primarily rural residential or bushland as well as a couple of poultry farms, an agricultural lime fertilizer manufacturer and fireworks distributor - The major recent change in neighbouring landuse has been the establishment of the Peppertree Quarry which commenced operations in early 2014, immediately north of the mine site Noting limitations of the resolution on some images, review of available historical aerial maps did not identify any potentially contaminating activities on land immediately adjacent to the Project site.
Inventory of Chemicals and Wastes and their Location:	Chemical Inventory - Crossend Safety & Risk Management Services P/L (2003) prepared a list of chemicals for the mine. A copy of the list, showing location and quantity, is presented in **Appendix B** In summary, the groups of chemicals that may give rise to site contamination include: ○ Metals ○ Acids and alkali ○ Hydrocarbons (fuel and oils) ○ Herbicides and pesticides ○ Cleaning products and surfactants

Item	Details
	○ Waste oil (polycyclic aromatic hydrocarbons) - RCA (2011) stated that the area that contained historic AGSTs, the current AGST (diesel) and the tank disposal area were not inspected due to operational access difficulties. The location of these areas was not provided by RCA (2011). <u>Historical Waste Disposal</u> - Historical waste lime from the kilns (and other discards) was placed on a large stockpile which was referred to as Mount Fuji. A small domestic landfill site was reportedly present on the eastern flank of Mount Fuji. RCA (2011) made the following observations: ○ The materials were placed in a large hill which lies to the west of the north pit and occurs as a lobe of waste lime with steep slopes to all sides, particularly in the north. There were tension cracks apparent at the plateau of the hill with air space and vegetation growth along the lines ○ Material volume was estimated by GAA to be approximately 1 Million tonnes ○ The eastern flank of Mount Fuji had a small domestic waste tip constructed, which has been capped since 2005. The materials remaining were not determined and future overburden removal will destabilise this area and result in slope failure of tip materials ○ Parts of the central and lower eastern flank were affected by tension cracks that extended from a lower large slope failure in overburden materials ○ Tipping is understood to have ceased about 20 years ago. - A small waste disposal area (possibly an infilled gully), historically occupied by old workings and a kiln, was understood to be present to the west of the southern pit. RCA (2011) stated that they were unable to inspect the area due to access difficulties. - An old machinery / scrap yard was present to the north of the North Pit. RCA (2011) noted that various broken, redundant machinery from the mine were present in this area and there was the possibility of small fuel leakages from some items. <u>Current Waste Disposal</u> - The current Waste Lime Emplacement Area has operated since November 2009 and is located adjacent to the Western Overburden Emplacement. It was understood that this would be upgraded to use cell containment areas in 2010. RCA (2011) made the following observations: ○ Quicklime was end tipped from dumpers and pushed into a low lying area by front end loader/bulldozer ○ The materials were a mixture of fine loose powder and loose sandy silty white materials, were caustic with a pH of 13 and highly corrosive and had caused die back of trees and vegetation in the area ○ There was evidence of flow of materials towards the south of the area due to liquefying after heavy rainfall. There was potential for ongoing tipping in the area to result in a flow of slurry like materials towards, and over, a lip of material in the south of the site

Item	Details
	o The materials were very unstable to track or walk over, and form a crust after tipping ▶ AEMR (2016/2017) provided the following information with respect to waste: o Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor o The workshop channels all runoff through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor o Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor ▶ AEMR (2014/2015) stated that shale overburden mixed with waste lime has continued to be successfully removed from the former “Mt Fuji” waste lime dump and is now substantially completed. During this process the former site refuse dump located above the western batters of the North Pit has been identified. Refuse has been monitored by placing in holding stockpiles to permit visual checking of any potentially hazardous materials observed during excavation. A small quantity of asbestos material was discovered during the latter months of the AEMR (2013/2014) period and isolated prior to removal from site in accordance with site asbestos management protocols on 9 July 2015.
Description of Manufacturing / Industrial Processes and Location:	Processing / bulk handling of mined materials takes place in the northern part of the mine in the Limestone Primary Processing and Lime Production Plant areas and includes the following: ▶ Crushing ▶ Reclaiming ▶ Screening ▶ Lime Burning ▶ Coal Firing ▶ Hydrating ▶ Bulk Loading ▶ Rail Loading Zoic notes that the above processing / bulk handling is associated with naturally occurring mined materials and are not considered to generate potentially contaminating products. The exception is point sources of hydrocarbons / oils associated with maintenance of the machines and conveyor belt systems. This has been considered further in Section 3.3 below as AEC 7, 8 and 9.
Product Spill and Loss History:	RCA (2011) reported that: ▶ Previously four AGST (3no. totalling 140KL diesel and 1no. totalling 10KL of petrol) were removed from the base of the North Pit but that no validation report was prepared ▶ No records of product spills and / or loss history prior to the decommissioning of AGSTs were provided.

Item	Details
	AEMR (2013/2014) stated that: - A major improvement in the on-site storage and containment of hydrocarbons occurred in late 2008 with the relocation and upgrade of “in-pit” fuel storage facilities from the north western corner of the North Pit to a site within the mine stockpile / rehandle area. - This licenced depot comprising a 95,000 litre (also referred to as 93KL), self bunded diesel tank, two of the former diesel tanks now used to store oily residue/rainwater runoff collections, improved fuel and oil dispensing systems, concrete aprons and drains, environmental collection pits and appropriate safety structures continues to be utilised. - AEMR (2013/2014) stated that monitoring requiring drilling within the area immediately surrounding the UST was to be undertaken in accordance with the 2008 NSW DECCW UPSS Regulations. AEMR (2016/2017) stated that the future of the (1 x Petrol) depot and an existing 12,000 litre UST located at the Store had been subject to further risk assessment in accordance with AEMR (2013/2014) recommendations. - Improvements in regard hydrocarbon management were previously reported in the AMER (2011/2012) and included commencement of works to upgrade the lubrication system and layout within the workshop service bays. These works completed as scheduled during November 2012, improved the “cleanliness” of the oil lubrication and storage system, reduced oil contamination and spillage and therefore improved housekeeping within the workshop environment. - The potential for hydrocarbon contamination resulting from leakages and spills continues to be minimised by the implementation of documented hydrocarbon spill procedures and the use of biological oil spill kits located across site operational areas. These spill kits are maintained and serviced by approved contractors. - Review of procedures, equipment and training for hydrocarbon management and spill response is an ongoing commitment.
Discharges to Land, Air & Water:	Refer to permits, licenses and approvals below.
Complaint History:	AEMR (2016/2017) stated that no complaints were received in the current reporting period. AEMR (2012/2013) described complaints from neighbours regarding dust.
Sewer & Service Plans:	AEMR (2016/2017) states the following regarding sewerage waste management: - No changes to sewerage waste management have occurred during the reporting period. - The Marulan South Limestone Mine continues to operate five sewerage treatment facilities: o 1 x Main envirocycle unit that receives effluent from main offices, laboratory, bathrooms, store and conference room. o 2 x Lime plant envirocycle units servicing the kiln control room, hydration, dispatch and workshop areas. o 2 x Septic tanks. One located at the “machine shop”/primary crusher the other adjacent to the “Fettlers’ shed”. - A third septic system services the former “Club” facility, north of the main office and located “off-lease”.

Item	Details
	- To ensure no overflow occurs from the "machine shop"/primary crusher septic tank, this unit continues to be inspected and pumped out weekly by an accredited waste disposal contractor. The "Fettler's shed" and "Club" units are adequately serviced by adsorption trenches. Service Plans for other utilities are available on site and were consulted during intrusive investigation works.
Permits, Licenses and Approvals:	The EPL 944 authorises and regulates Cement or Lime Works and Mining for Minerals and requires monthly dust monitoring (nearest residence and store paddock hill), annual air emissions monitoring (Kiln Stack and Lime Hydration Plant Stack) and groundwater monitoring (North Pit Bore) for oil and grease and TSS on a quarterly basis.
Additional Information:	When RCA (2011) interviewed several management staff at the mine, they provided the following with respect to contamination: - 5-10 truckloads of refuse were reported as part of the overburden cut in the western side of the north pit (not all of which was domestic waste). It is understood that the materials were dumped in the Western Overburden Emplacement - Soils impacted by minor oil spillages were excavated and placed in the area of the new waste lime emplacement facility. RCA (2011) confirmed that some dark materials were observed but no hydrocarbon sheen was present - Waste oil drums were stored around the Water Tanks. The drums were collected for recycling on a monthly basis. RCA (2011) did not inspect this area due to time constraints - Refuse materials were reportedly dumped in the gully since the 1930s. Zoic understands that this gully was located to the west of the North Pit. The area was originally set up for waste lime, was then used for spills and then for refuse from the township. The rubbish tip was present in 1979 and appeared as a large "hole" in the gully west/east trend. Tipping ceased between 1990 and approximately 1995

3.3. Summary of Key Findings from Historical Information

Areas of potential environmental concern (AEC) identified from review of historical information can be summarised as follows:

1. Refuse tip on eastern flank of “Mount Fuji” (Mixed Waste)
2. Waste oil drum disposal area (Hydrocarbons)
3. Former bulk fuel storage area in North Pit (3 x UST Diesel: 140,000L and 1 x AGST Petrol: 10,000L)
4. Bulk fuel storage area (95,000L AGST – Diesel)
5. Bulk fuel storage area (12,000 UST – Petrol)
6. Former old workings / kiln then infilled gully south west of South Pit (Mixed Waste – RCA (2011))
7. Processing Plant (Oil Leaks)
8. Lime Kiln (Oil Leaks)
9. Hydrate Plant (Oil Leaks)
10. Western Overburden Emplacement Area (oil stained soils noted by RCA (2011))
11. Undisturbed Areas (Potential for contamination within currently undisturbed terrain within proposed disturbance footprint shown on Figure 2A in Appendix A (e.g. overburden placement areas, haul roads, mine pit expansion)
12. Proposed Marulan Creek Dam (Potential for contamination beneath proposed dam wall, inundation area and Tallong Water Pipeline)
13. Workshop / Interceptor (Hydrocarbons)
14. Wash down bays / waste oil tanks (Hydrocarbons and surfactants)
15. Oil storage below retaining wall near Kiln Pre-heater (Significant leaks - Crossend 2003)
16. Surface asbestos debris near community hall, bowling greens and cottages (New Environment 2005)
17. Old Machinery / Scrap Yard (Oil / Fuel Leaks)
18. Former explosives storage shed that was historically used for the temporary storage of a low level radioactive source. The only radioactive source present on site is within the fixed radiation gauge on Conveyor 2.

3.4. Integrity Assessment

All sources of information referenced above were in general agreement. This degree of consistency suggests that the historical assessment described above has an appropriate level of accuracy necessary to achieve the objectives of this ESA report.

4. Geology, Hydrogeology and Hydrology

The geology, hydrogeology and hydrology is summarised in this section. This information has been sourced from reports discussed in Section 3.1 together with other references as stated.

Table 4: Summary of Regional Geology, Hydrogeology and Hydrology

Title	Details
Geology and Soil Map Conditions:	The Wollongong 1:250000 Geological Series Sheet SI 56-9 Second Edition 1966 indicates the following: - A north north east to south south west trending fault is present in the western part of the site - The geology to the west of the fault is Silurian slate, phyllite, sandstone and limestone with Devonian granite, granodiorite, diorite and porphyry beyond - The geology to the east of the fault is Ordovician slate, quartz and phyllite - The Geology to the north of the fault is Devonian granite, granodiorite, diorite and porphyry A detailed description of the geology beneath the Project site is presented in Geo Res (2018) Marulan South Limestone Mine Geological Report for DRE's input to SEARs. This document indicates north north west to south south east trending geology. The following geological sequence from the Tallong Beds (oldest) through the Bungonia Limestone Group to the Tangarang Volcanics (youngest) is roughly conformable and was presumably rotated (to lie dipping steeply to the west with a N/S strike): - Glenrock Granodiorite: (now 1 of 12 plutons of the Arthurslie Suite (Da)) - Tangarang Volcanics: (now Tangarang Formation (Dkt) of the Bindook Group (Dk)) - Bungonia Limestone Group: (now "Bungonia Group" (Sb)) - Tallong Beds: (now "Abercrombie Formation (Oaa) of the Adaminaby Group" (Oa))
Acid Sulfate Soils:	Given the inland location and height of the site, it is considered unlikely that acid sulfate soils are present.
Location of Fill Materials:	Fill materials were identified during drilling around the processing and workshop areas of the northern part of the site (presumably used to create a level development platform) and around the former South Marulan Township where demolition has occurred. A substantial volume of waste lime is present on the western edge of the northern pit (i.e. former Mount Fuji). This waste was generated through operation of the site lime plant during the 70's – 90's. Waste lime from this location is now being placed in the Western Overburden Emplacement as this area is being stripped for future mining.
Summary of Registered Bores:	Refer to Water Abstraction details below.

Title	Details
Depth to Groundwater:	RPS (2014) stated that: - Eight standpipe piezometers were installed across the mine to enhance the resolution of groundwater monitoring. Depths of drilling ranged between 40 and 205m bgl. - Wells were installed in limestone, weathered granite and fractured granite with response zones between 36.5 and 60m and 72 and 127.5m for shallow and deep wells respectively. - Groundwater was encountered at between 19.4 and 102m below ground level. AGEC (2018) Marulan Groundwater Technical Study (G1714) stated that: - The land elevation at the project site ranges from 630m AHD in the west and 130m AHD at the confluence of Barbers Creek and Bungonia Creek in the east. - During high rainfall events the maximum groundwater level was at 430.75m AHD or approximately 9.4m below the pit floor.
Direction and Rate of Groundwater Flow:	RPS (August 2014) stated that the general direction of groundwater flow is indicated from the northwest towards the Mine area. Water levels within the limestone are substantially lower than the surrounding lithologies suggesting elevated permeability with the limestone acting as a drain, with groundwater potentially discharging to the south towards Bungonia Creek. The difference in groundwater elevations between the two pits is inferred to be controlled by the cross-cutting dyke that separates the two pits, and restricts groundwater flow. The hydraulic gradient within the limestone appears to the south, consistent with the strike of the unit. The reduced groundwater elevations below south pit are also indicative of a groundwater discharge/outflow to the south of the south pit. Hydraulic conductivity within the granite ranged from 0.01 to 3.2m/day depending on the state of weathering. Hydraulic tests within the limestone were deemed to be unreliable. Flow through limestone is generally via fractures rather than porosity of the stratum and can therefore be highly variable.
Water Abstraction:	NSW DPI Water has issued the following water licences for the mine site: - Bore monitoring licence (10BL605442-455 and 10BL605449-450)) was obtained to facilitate installation and monitoring of 6 groundwater bores on 10 October 2013 in perpetuity; - Bore monitoring licence (10BL605796) was obtained to facilitate installation and monitoring of a 7th groundwater bore on 26 August 2016 in perpetuity; - Bores WP16 and WP17 (10WA116142 and WAL24697) extraction of 12ML per annum for industrial purposes. DPI Water lists tenure type as continuing valid until 10 August 2024; - Barbers Creek (10WA102352, WAL25352, WAL25207) extraction of 76ML from Tallong Weir for mining and 1ML for domestic purposes. DPI Water lists tenure type as continuing valid until 30 June 2024;

Title	Details
	- Barbers Creek (10WA102377, WAL25373) extraction of 10ML for mining purposes. DPI Water lists tenure type as continuing valid until 25 April 2026. In correspondence dated 26 March 2018, Boral has advise that the 10ML cannot be used as the abstraction point does not lie on their land and no access agreement is in place from the current land owner; and - Groundwater (ROI17-1-061) 838ML allocation granted 27 September 2017.
Nearest Water Body:	The main perennial water bodies at the closest point to the site boundary are Barbers Creek (adjacent east) and Bungonia Creek (adjacent south) which flow into the Shoalhaven River (1250m south east).
Direction of Surface Run Off:	Where not captured by site infrastructure, surface water run off from the northern parts of the site generally drains eastwards into the North Pit. Surface water run off from the southern parts of the site generally drain south eastwards into the South Pit with some runoff bypassing the South Pit and draining via Main Gully into Bungonia Creek.

5. Site Condition and Surrounding Environment

5.1. Site Inspection

On 30 September 2014, Rebeka Hall (Zoic), Graeme Malpass (Zoic), Grant Thomson (Boral Environment Officer) and Les Longhurst (Boral Mine Manager) conducted an inspection and walkover of accessible areas of the site. The site layout and photographs taken are presented on Marulan Works Visitor Access Guide in **Appendix B** and included in **Appendix D** respectively.

Key findings from the site inspection have been included in the following sections. No visual or olfactory evidence of significant contamination was identified during the site visit. Particular attention was paid to AECs identified in Section 3.3. The observations made during the site visit were used to determine whether additional investigation was required. This is discussed further in Section 6.

5.2. Site Condition

The information on site condition required by NSW OEH (2011) is summarised in the following table.

Table 5.2: Current Site Condition

Item	Details
Topography and Drainage:	The land to the north and west of the site is characterised by relatively level land comprising the Peppertree Quarry site and predominantly rural properties respectively. Whereas the land to the east and south comprises steep valleys to Barbers and Bungonia Creeks respectively. The topography of the site has been significantly altered by mining and is dominated by the North and South Pits. In a north to southerly direction the land falls from approximately 615m AHD to 515m AHD in the North Pit and 415m AHD in the South Pit before rising and falling into Bungonia Creek (approximately 270m AHD). In a west to easterly direction the land falls from approximately 630m AHD to 515m AHD in the North Pit before rising and falling into Barbers Creek (approximately 200m AHD). Where not captured by site infrastructure, surface water run off from the northern parts of the site generally drains eastwards into the North Pit. Surface water run off from the southern parts of the site generally drain south eastwards into the South Pit with some runoff bypassing the South Pit and draining via Main Gully into Bungonia Creek.
Boundary Condition:	Due to the size of the site, the boundary condition could not be observed in its entirety. Where site boundaries were noted they were delineated with post and wire fencing along the access roads or steep slopes into the creek valleys to the east and south.
Visible Signs of Contamination:	No visible signs of contamination were noted. The only exception being localised surface staining on the concrete slab of the workshop and adjacent to the diesel AGST bowser.
Vegetation:	Vegetation appeared to be in a generally healthy condition with no die back or adverse contamination impacts noted.

Item	Details
Presence of Drums, Wastes and Fill Materials:	Oils, lubricants, coolants and degreasers for mining plant and equipment are mainly stored in drums or bulk containers in the workshop. Drainage in the workshop and surrounds is linked to the waste oil interceptor (details in **Appendix B**). Fill materials were identified during drilling around the processing and workshop areas of the northern part of the site (presumably used to create a level development platform) and around the former South Marulan Township where demolition has occurred. A substantial volume of waste lime is present on the western edge of the northern pit (i.e. former Mount Fuji). This waste was generated through operation of the site lime plant during the 70's – 90's. Waste lime from this location is now being placed in the Western Overburden Emplacement as this area is being stripped for future mining. Wastes are collected on a regular basis by licensed contractors. Waste oil is collected from AGST every 3 months or as required. Oil filters are recycled.
Odours:	No chemical / nuisance odours were noted during the site inspection.
Condition of Buildings & Roads:	The buildings were considered to be in good condition. The condition of roads and hardstanding was difficult to determine in certain areas due to the presence of sand and dust, but generally appeared in good condition where visibility was good.
Quality of Surface Water:	Advisian (2018) Surface Water Assessment stated that *"The difference between the observed upstream and downstream water quality for Barbers Creek and Bungonia Creek is not significant, indicating that under existing operational practices, South Marulan Limestone Mine has no effect on surface water quality.* *The Marulan Creek water quality data indicates that water quality improves as it moves down stream. Also the water quality for both Marulan Creek and Tangarang Creek indicate that this water is diluted in Barbers Creek, as demonstrated by the comparably better water quality of Barbers Creek."*
Flood Potential:	Section 149 (2) and (5) obtained by RCA (2011) for Lots 82, 114 and 132 in DP750029 and Lot 4 in DP106569 stated that these areas of the site were not subject to flood development controls. As outlined previously, the mine site is located in an elevated position on a plateau, high above the larger drainage systems of the Barbers and Bungonia Creeks and the Shoalhaven River. Only minor ephemeral drainage systems traverse the mine site. The mine site is therefore located in an area of low flood potential. The proposed water supply dam is to be located within Marulan Creek, which although a slightly larger creek system than those traversing the mine site, flows are generally low and flooding is localised within the banks or immediate vicinity of the creek.

Item	Details
Relevant Local Sensitive Receptors:	The UPSS Regulation - Sensitive Zones Map for Goulburn Mulwaree Council (12 January 2010) indicates that Marulan South lies adjacent to a Sensitive Zone (to the east and south), which requires consideration when assessing potential impacts to groundwater from USTs. The closest sensitive sites are the Bungonia National Park and Morton National Park to the south and east which are used for recreation. The closest sensitive features to the south and east are Bungonia and Barbers Creeks that both drain into the Shoalhaven River. 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). 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. The locations of these are shown on Figure 1B.

6. Conceptual Site Model

Based on a review of data detailed in Sections 3 and 5 above, the following table presents the potential AEC and associated contaminants of potential concern (COPC). Their locations are shown on Figure 4 in **Appendix A** and representative photographs are presented in **Appendix D**.

Table 6.1: Potential Sources of Contamination

AEC No.	AEC	COPC	Review of AEC (based on walkover and discussion with Boral)	Intrusive Investigation Required?
1	Refuse tip on eastern flank of "Mount Fuji" (Mixed Waste)	M8, TPH, asbestos, SVOC, VOC	Boral advised that the tip had been excavated in its entirety and disposed off-site to appropriately licensed facilities. Details of appropriate asbestos removal, handling and disposal including an asbestos clearance certificate, monitoring report and relevant licensing provided by Boral are presented in **Appendix B**. Zoic inspected the area of the former tip during the site visit and noted that it had been removed (refer to Photo 1 in **Appendix D**) Although Dames and Moore (1997) stated that 5 to 10 truckloads of refuse were encountered by a contractor when undertaking a cut of overburden in proximity to the landfill, it is considered that this will have been disseminated within the larger inert mass of the Western Overburden Emplacement Area and is considered unlikely to pose a significant risk to human health or the environment	No
2	Waste oil drum disposal area	M8, TPH, BTEX, PAH	Boral advised that the waste oil drum store had been upgraded to a roofed store built on stilts with associated bunding (refer to Photo 2 in **Appendix D).** Zoic observed the waste oil drum store to confirm no visual evidence of contamination.	No
3	Former bulk fuel storage area in North Pit (3 x AGST Diesel: 140,000L and 1 x AGST Petrol: 10,000L)	M8, TPH, BTEX, PAH	Boral advised that the AGSTs were removed from the pit and the area had since been excavated to remove limestone (refer to Photo 3 in **Appendix D**).	No

AEC No.	AEC	COPC	Review of AEC (based on walkover and discussion with Boral)	Intrusive Investigation Required?
			A combination of historic aerial photograph review and site inspection confirmed that no AGSTs exist in the Former bulk fuel storage area in North Pit.	
4	Bulk fuel storage area (95,000L AGST – Diesel)	M8, TPH, BTEX, PAH	Boral advised that no knowledge of spillage had occurred. Zoic noted that the AGST is double skinned, present on concrete with drainage to a waste oil interceptor (refer to Photo 4 in **Appendix D**).	No
5	Bulk fuel storage area (12,000 UST – Petrol)	M8, TPH, BTEX, PAH	An aged bowser is present and is occasionally used for petrol powered equipment which could pose a potential risk should leaks or spills occur (refer to Photo 5 in **Appendix D**). No records of filling or use available. Bowser display no longer working.	Yes
6	Old workings / kiln / infilled gully to the south west of South Pit	Asbestos	Area comprised a collapsed kiln constructed from brick and metal. A second kiln feature was also noted with some heavily rusted drums and scrap metal. No visual evidence of filling or contamination (i.e. staining, ACM fragments) was noted (refer to Photo 6 in **Appendix D**).	No
7	Processing Plant (Oil Leaks)	TPH, PAH	Oil is only used locally for lubrication and no evidence of significant spillage was noted during the site inspection or fieldwork (refer to Photo 7 in **Appendix D**).	No
8	Lime Kiln (Oil Leaks)	TPH, PAH	Oil is only used locally for lubrication and no evidence of significant spillage was noted during the site inspection or fieldwork (refer to Photo 8 in **Appendix D**).	No
9	Hydrate Plant (Oil Leaks)	TPH, PAH	Oil is only used locally for lubrication and no evidence of significant spillage was noted during the site inspection or fieldwork (refer to Photo 9 in **Appendix D**).	No
10	Western Overburden Emplacement area (including oil stained soils noted by RCA (2011))	TPH, PAH	No visual evidence of contamination (e.g. staining) was noted during the site walkover. Boral representatives were unable to recall the presence of oil stained soils at this locality. (refer to Photo 10 in **Appendix D**).	No

AEC No.	AEC	COPC	Review of AEC (based on walkover and discussion with Boral)	Intrusive Investigation Required?
			The Waste Lime Emplacement Area is located within the Western Overburden Emplacement Area. The Waste Lime Emplacement Area is not considered to represent an AEC as it was designed and constructed in consultation with the Department of Resources and is operated in accordance with environmental controls which form part of the approved MOP.	
11	Undisturbed Areas (Potential for contamination within currently undisturbed terrain within proposed Disturbance Footprint shown on Figure 2A in Appendix A (e.g. overburden placement areas, haul roads, mine pit expansion)	NA	Areas of previously undeveloped land, that are proposed to be disturbed by the Project have been thoroughly surveyed by a combination of specialists and site personnel during the various technical investigations undertaken as part of the SSD assessment process including Aboriginal and historic heritage, biodiversity and soils. Based on specialist surveys, a walkover of particular parts of the Project site by Zoic, site personnel knowledge and review of available historical information it was concluded that these parts of the Project site are considered unlikely to have been impacted by contaminants (refer to Photo 11 in **Appendix D**).	No
12	Proposed Marulan Creek Dam (Potential for contamination beneath proposed dam wall, inundation area and along the Tallong Water Pipeline)	NA	The proposed Marulan Creek Dam site comprises previously undeveloped land along Marulan Creek with historical disturbances including the construction of Boral's private railway line in 1928, the Tallong Water Pipeline and minor unsealed access tracks (refer to Photo 12 in **Appendix D**). Based on substantial site survey by the Project's specialist team (as outlined above) and review of available historical information, this part of the Project site is considered unlikely to have been impacted by contaminants. Based on discussions with Boral, the private railway line is not considered to represent an AEC in its own right for the following reasons: - The rail corridor is controlled by Boral	No

AEC No.	AEC	COPC	Review of AEC (based on walkover and discussion with Boral)	Intrusive Investigation Required?
			- Boral is not aware of any significant spillages (or derailment resulting in such) - Operations are strictly managed from an environmental and a safety perspective in accordance with a Rail Infrastructure Manual - Works within the rail corridor require task specific risk assessment to manage WHS and environmental risks - An Emergency Management Plan exists and would include prevention of pollution in the unlikely event of a derailment. Boral advised that the majority of the Tallong Water Pipeline is below ground, with the exception of the crossing of Marulan Creek, downstream of the proposed Marulan Creek Dam Wall. Although the section of the pipeline in the vicinity of the Marulan Creek Dam does contain asbestos, it will not be disturbed by the Project. One exception may be during the connection of the pumping line from the proposed Marulan Creek Dam into the existing Tallong Water Pipeline when ACM may be exposed.	
13	Workshop / oil interceptor	M8, TPH, PAH, SVOC, VOC	Operational – potential for soil contamination from spills or leakage noting that drainage goes via the waste oil interceptor (refer to Photo 13 in **Appendix D**).	Yes
14	Wash down bays / waste oil tanks	M8, TPH, PAH, BTEX, surfactants	Operational – potential for soil contamination from run off or leakage noting that partial drainage goes via the waste oil interceptor (refer to Photo 14 in **Appendix D**).	Yes
15	Oil storage below retaining wall near Kiln Pre-heater (significant leaks noted by Crossend (2003))	TPH, PAH	No visual evidence of contamination but the vicinity of disused, empty AGSTs needs to be investigated (refer to Photo 15 in **Appendix D**).	Yes
16	Surface asbestos debris near community hall, bowling greens and cottages (noted by New Environment (2005))	Asbestos	Potential for surface asbestos due to historical demolition of former Marulan South Township. Sampling to be targeted to surface identification of ACM fragment or to provide general coverage within footprints of former structures (refer to Photo 16 in **Appendix D**).	Yes

AEC No.	AEC	COPC	Review of AEC (based on walkover and discussion with Boral)	Intrusive Investigation Required?
			Note: The Project does not propose any development/disturbance within the area of the former Marulan South Township. Risk of exposure to ACM in this area is very low and would be limited to maintenance activities e.g. mowing.	
17	Old Machinery / Scrap Yard	M8, TPH, BTEX, PAH	Area was well ordered with good housekeeping and no visual evidence of potential contamination (refer to Photo 17 in **Appendix D**).	No
18	Explosive Store	Radiation	Comprises an isolated secure brick built explosive store which was also historically used to temporarily store low level radioactive equipment in accordance with an appropriate license. Store to be retained. The only low level radioactive source present on the Project site relates to fixed gauges associated with Conveyor 2. Refer to Photo 18 in **Appendix D**).	No

The potential sources of contamination listed above are predominantly located around the Processing Plant to the north or north-west of the North Pit.

The surfacing in these areas comprises hardstanding or compacted gravel which is likely to prevent direct contact with any potential contamination. The area of the former Marulan South Township is predominantly grassed with a few areas of bare soil.

The closest groundwater monitoring well to this area of the site is MW5 (refer to Figure 6 in Appendix A), which encountered standing water levels at 23m below ground level. The borehole log indicates clay soils over granite with the response zone being installed in the granite. Clay soil is likely to slow the downward migration of any contaminants that may be present.

Based on investigations by RPS (2014) and AGEC (2016), local groundwater was considered to preferentially drain into the limestone strata within the Mine and then migrate either southwards or eastwards into Bungonia and Barbers Creeks respectively. Any impacted groundwater from the AEC outlined above would be required to migrate approximately 2km before leaving the southern site boundary. In the event that groundwater migrates to the east, any impacted groundwater would be required to migrate approximately 1km before leaving the site boundaries.

Any impacted surface water not captured by the waste oil interceptor system would be directed to the North Pit and would then infiltrate to groundwater before migrating in the manner described above.

Based on the above, it is considered unlikely that sensitive environmental receptors (e.g. two Turkey Farms located approximately 850m hydraulically upgradient of the western boundary of the Mine) would be impacted by any contamination identified in the AEC discussed above.

Dependent on the location of any contamination, potential human receptors could include site visitors / site workers.

7. Sampling Analysis and Quality Plan

As outlined in Section 6 above, a number of AECs were identified that require further intrusive investigation to address the project objectives. The sampling, analysis and quality plan for these investigative works is outlined below.

7.1. Data Quality Objectives

The data quality objectives (DQO) process is a systematic planning tool based on the scientific method for establishing criteria for data quality and for developing data collection designs. The DQO defines the experimental process required to test a hypothesis.

The DQO process has been developed to ensure that efforts relating to data collection are cost effective, by eliminating unnecessary, duplicative or overly precise data whilst at the same time, ensuring the data collected is of sufficient quality and quantity to support defensible decision making.

It is recognised that the most efficient way to accomplish these goals is to establish criteria for defensible decision making before data collection begins and develop a data collection design based on these criteria. By using the DQO process to plan the investigation effort, the relevant parties can improve the effectiveness, efficiency and defensibility of a decision in a resource and cost effective manner.

7.2. Guidance Documents

DQO have been developed to detail the type of data that is needed to meet the overall objectives of this Project (refer to Section 1.2). The DQO have been developed in general accordance with procedures stated in the guidelines presented in Section 12 of this report.

7.3. Process for DQO Development

The DQO process consists of seven steps, which are designed to clarify the study objectives, define the appropriate type of data and specify tolerable levels of potential decision errors. The seven-step DQO process adopted for the works was as follows:

- Step 1 – Defining the Problem. The first step in the DQO process is to ‘define the problem’ that has initiated the investigation;
- Step 2 – Identify the Decision. The second step in the process is to define the decision statement that the study will attempt to resolve;
- Step 3 – Identify Inputs to the Decision. In this step, the different types of information needed to resolve the decision statement are identified;
- Step 4 – Define the Study Boundaries;
- Step 5 – Develop a Decision Rule;
- Step 6 – Specify Limits on Decision Errors; and
- Step 7 – Optimise the Design for obtaining the Data.

These Steps have been followed for the site, with results presented in **Appendix E**.

7.4. Sampling and Analysis Plan (Soil)

The rationale for the selection of the sampling and analysis plan is presented below:

7.4.1. Sampling Pattern

Figures 5.1 to 5.3 inclusive in **Appendix A** shows the investigation locations on a site plan.

Borehole locations were targeted to identified AEC based on the discussions presented in Section 6 of this report.

7.4.2. Sampling Density

The investigation was not conducted to comply with the minimum number of sampling locations outlined in NSW EPA (1995) but was targeted to the identified AEC to determine whether any contamination present would need to be addressed as part of the SSD Application.

7.4.3. Sampling Depths

Zoic obtained samples from the following depths, as appropriate, during the intrusive investigation works:

- Surface or shallow depth (generally 0 to 0.10m);
- Every subsequent 0.5m or change in strata;
- As a general rule, samples targeted depths where visible or olfactory evidence of contamination was observed; and
- Natural soil underlying fill materials, if encountered.

7.5. Sampling Methodology (Soil)

7.5.1. General

A description of the sampling methods adopted for the ESA is presented below. Ground conditions and sampling details are presented on the borehole logs in **Appendix F**. Copies of calibration certificates for the field instrument (PID) are presented in **Appendix G.** Sample Chain of Custody (CoC) forms are presented in **Appendix I**:

Intrusive Investigation and Soil Sampling:

- Ten boreholes (BH01 to 10 inclusive) were advanced using a rotary percussive drill rig on 14 and 15 January 2015, through fill and overburden material and 0.5m into natural soil or between 2 to 4.5m depth whichever was the shallower. Soil samples were collected from the drill cuttings;
- Nine shallow soil samples (0-0.1m depth) were collected using hand tools / mechanical excavator on 15 January 2015;
- Ground conditions were described and details of any discolouration, staining, odours or other indicators of contamination noted;
- Soil samples were taken using clean disposable nitrile gloves. When collecting samples, care was taken to ensure that they were representative of the soil encountered and not taken directly adjacent to the hand tool or excavator bucket so as to limit the potential for cross contamination;

- Soil samples were placed in new laboratory supplied sample containers; and
- Filled soil sample containers were checked to ensure that they were free of headspace and then placed in an iced Esky to cool samples to below ambient conditions.

Sample Handling:

- All sample containers were provided by the laboratory and were appropriate for the COPC. Sample containers were labelled with the sample number, project number and date obtained. This information was recorded on the COC form;
- Samples were transported directly to the primary laboratory ALS Environmental in Sydney within 24 hours of completing fieldworks to allow technical holding times for analysis to be achieved and minimise any interference with the samples. Interlab duplicate samples were forwarded by the primary laboratory to the secondary laboratory Envirolab Services in Sydney;
- COC forms and custody seals were kept in the Esky for delivery to the laboratory; and
- Sample receipts were checked against copies of the COC and filed.

7.5.2. Field Screening

The following outlines the procedure adopted for use of the PID in the field:

Preliminary

- Calibration of the PID instrument with isobutylene gas (100ppm). This was conducted by Airmet Scientific prior to the field work.

Screening

- Placement of a soil sample into a re-sealable plastic bag until half filled, then sealed;
- Measurement of background VOC concentrations in ambient air prior to each reading to account for sensor drift; and
- Using the point of the PID, punch a small hole in the bag. Place the tip of the PID in the bag and monitor the readout and note the maximum concentration during the recording period. The results are presented on the borehole logs in **Appendix F**.

Elevated PID readings, visual and olfactory indicators were used to aid in determining sampling depth and scheduling samples for chemical analysis.

7.5.3. Field QA/QC Sampling

The methodology for obtaining QA/QC samples was conducted as follows:

Duplicate Samples

In accordance with NEPM (2013) at least 1 in every 20 samples (5%) was submitted from a larger quantity of sample collected from the same sampling point, removed by a single action, where possible, and divided into two or three separate and unrelated sample containers for analysis at the same laboratory (intra-laboratory precision).

Triplicate Split Samples

In accordance with NEPM (2013) at least 1 in every 20 samples (5%) was submitted from a larger quantity of sample collected from the same sampling point, removed by a single action, where possible, and divided into two or three separate and unrelated sample containers for analysis at the check laboratory (inter-laboratory precision).

Trip Spikes

A single soil trip spike was prepared by ALS and accompanied the samples during fieldworks and transit.

Trip Blanks

A single soil trip blank was prepared by ALS and accompanied the sample during fieldworks and transit.

Rinsate Blanks

No rinsate blanks were obtained as strict operating procedures were followed to prevent cross-contamination, as detailed in section 7.5.1.

7.6. Sampling and Analysis Plan (Ground and Surface Water)

IEC undertakes regular surface water (quarterly) and groundwater (monthly) sampling from locations shown on Figure 6 in Appendix A on behalf of Boral. IEC obtain samples and send to the laboratory but have no involvement in analysing/assessing the data. Chemicals analytes typically included heavy metals and occasionally petroleum hydrocarbons (as oil and grease). For clarity, this surface water and groundwater data is referred to as *"Ongoing Sampling"* and is being collected to establish a baseline. This work has been conducted variously between October 2008 and present and the results to January 2018 are presented in Section 9.2 below.

Surface and groundwater sampling for the purposes of supporting this Phase 1 and Phase 2 ESA was also conducted by IEC and AGEC. For clarity, this surface and groundwater data is referred to as *"ESA Sampling"*. This work was conducted as a one off event in November 2014 (Surface Water) and February 2015 (Groundwater) and the results are presented in Sections 9.5 and 9.6 below.

Zoic has used all available surface and groundwater monitoring data (i.e. both Ongoing and ESA Sampling) to achieve the ESA objectives.

7.6.1. Sampling Pattern

Figure 6 in **Appendix A** shows the locations of surface and groundwater sampling locations.

Sampling locations were selected to identify AEC based on the discussions presented in Section 6 of this report or to provide general coverage.

7.6.2. Sampling Density

The locations (MW5 and North Pit Bore) of the samples taken for groundwater analysis by AGEC were selected on the basis that they were closest to the northern end of the pit (i.e. identified source areas) to provide a potential worst case scenario of groundwater quality.

The locations (Bungonia Creek Down, Barbers Creek Down and Main Gully Autosampler) of the samples taken for surface water analysis by IEC were selected on the basis that they were representative of water quality immediately downstream of any mine drainage outfalls into adjacent watercourses.

7.6.3. Well Construction

Groundwater sampling was conducted by AGEC from existing wells or abstraction bores.

RPS (August 2014) stated that the standpipe piezometers were installed in accordance with specifications outlined in the Minimum Construction Requirements for Water Bores in Australia (NUDLC 2012) and are considered appropriate for the purposes of this assessment.

7.6.4. Sample Handling

Laboratory analysis for surface and groundwater ESA Sampling included consideration of metals and hydrocarbons based on the nature of the AEC outlined in Section 6 above.

Based on discussions with IEC and AGEC, Zoic understands that the groundwater and surface water samples were collected in a consistent manner by suitably trained and experienced personnel directly from the selected location (surface water) or using a low flow submersible pump following removal of three well volumes (groundwater). Samples were placed in laboratory supplied containers and handled as per laboratory specifications (e.g. metals were field filtered). Samples were placed in ice filled Eskys / in the fridge overnight before transport to the NATA accredited laboratory. These approaches are considered to be reflective of current best practice sampling techniques.

8. Evaluation of QA/QC

The QA/QC results for soil duplicate (intra-laboratory) and triplicate (inter-laboratory) samples are summarised below the soil test results table in **Appendix C**. Discussion is provided in **Appendix H**.

Detailed QA/QC results are presented on the laboratory testing certificates presented in **Appendix I** and summarised in Table H1 in **Appendix H**.

Based on the information referenced above, it was concluded that the soil data is of an acceptable quality to achieve the objectives of this ESA, with the following comments:

- Relative Percent Differences (RPDs) calculated for inter-laboratory samples for lead and TPH F2 in filling materials are indicative of heterogeneous composition;
- A lab control sample result for hexachloropopylene in one sample was below the lower control limit which may indicate that the result was under reported. However, as the concentrations fall below the guidelines this is not considered to affect the quality of the results; and
- The Limit of Reporting (LOR) for MBAS was increased in two deeper samples which could indicate either potential high concentrations of MBAS or interference from unrelated organic or inorganic matter.

9. Results

9.1. Previous Sampling Results (Soil)

No historical soil test results relevant to the assessment of contamination have been provided to Zoic.

9.2. Ongoing Sampling Results (Ground and Surface Water)

The following table summarises the available ground and surface water results conducted by IEC, on behalf of Boral, on a ongoing basis or as part of the environment protection licence for the mine. The locations are shown on Figure 6 presented in **Appendix A**.

Table 9.2: Ground and Surface Water Results

Description	Data Status - Marulan	Testing Comment
Groundwater		
MW01	June 2014 – Dec 2016	Physico chemical and metals only
MW02	June 2014 – Jan 2018	Physico chemical and metals only
MW03S	June 2014 – Jan 2018	Physico chemical and metals only
MW03D	June 2014 – Jan 2018	Physico chemical and metals only
MW04S	June 2014 – Jan 2018	Physico chemical and metals only
MW04D	June 2014 – Jan 2018	Physico chemical and metals only
MW05	June 2014 –June 2017	Physico chemical and metals only
MW06	June 2014 –June 2017	Physico chemical and metals only
MW07	Apr 2017 – Jan 2018	Well was dry, no samples obtained
WP16* - North Pit	May 2008- Dec 2016	Physico chemical, metals, oil and grease and TPH (C6-C36)
Surface Water		
Marulan Creek Up	Nov 2014 – Oct 2017	Physico chemical and metals
Marulan Creek Down	Nov 2014 – Oct 2017	Physico chemical and metals
Barbers Creek Up	July 2014 – Jan 2018	Physico chemical and metals
Barbers Creek Down	July 2014 – Jan 2018	Physico chemical and metals
SR1 (Shoalhaven River)	July 2014 – Jan 2018	Physico chemical and metals
SR2 (Shoalhaven River)	July 2014 – Jan 2018	Physico chemical and metals
SR3 (Shoalhaven River)	July 2014 – Jan 2018	Physico chemical and metals
Bungonia Creek Up	July 2014 – Jan 2018	Physico chemical and metals
Bungonia Creek Down	July 2014 – Jan 2018	Physico chemical and metals
Main Gully Sample Point	March 2008- Dec 2015	Physico chemical, metals and oil and grease, TPH
Main Gully Auto Sampler	Feb 2008 – August 2015	Physico chemical, metals and oil and grease, TPH
South Pit (bottom)	Oct 2008- June 2012	Physico chemical, metals and oil and grease, TPH

*- it should be noted that the laboratory results incorrectly refer to VP16, rather than WP16. For consistency, this has been corrected within the report by Zoic to match the nomenclature of the bore licences.

With respect to available groundwater results, the following was noted:

- Aluminium (max 600µg/L), arsenic (max 149µg/L), chromium (max 450µg/L), copper (max 144µg/L), lead (max 46µg/L), nickel (max 47µg/L), selenium (max 100µg/L) and zinc (max 2450µg/L) were recorded on several occasions above the 55, 24, 1, 1.4, 3.4, 11, 5 and 8µg/L ANZECC (2000) Freshwater guidelines respectively;
- Oil and Grease recorded on 26 March 2015, 19 May 2015 and 21 July 2016 in WP16 - North Pit (6-9mg/L) was recorded above the 5mg/L limit of reporting but had returned to <5mg/L during the subsequent ten monitoring rounds. Given that the most recent readings taken over a 12 month period are below the detection limit, it is not considered as being indicative of significant environmental impacts;
- Monitoring wells MW3 and MW5 are upgradient (i.e. north and west of operational areas) whereas MW1, MW2, MW4 and MW6 are within or downgradient of the mine. When the maximum concentrations of metals recorded during the historical monitoring are compared, the concentrations in the up and downgradient parts of the mine are similar in magnitude.
- Bearing the above in mind and noting that aluminium, arsenic, chromium, copper, lead, nickel, selenium and zinc were occasionally elevated during the monitoring periods, the results are generally considered to be representative of typical background concentrations and not indicative of significant environmental impacts from site operations.

With respect to available surface water results, the following was noted:

- Aluminium (max 410µg/L), chromium (7.6µg/L) copper (max 14µg/L), selenium (max 10µg/L) and zinc (max 63µg/L) were recorded on several occasions above the 55, 1, 1.4, 5 and 8µg/L ANZECC (2000) Freshwater guidelines respectively. The results are considered to be representative of typical background concentrations and not indicative of significant environmental impacts. Furthermore, Advisian (2018) Water Quality Assessment concluded the following regarding surface water quality:Waste rock analysis identified aluminium and chromium at levels slightly above ANZECC (2000) criteria. Notwithstanding this result, data indicates that only aluminium was recorded above adopted criteria in the Shoalhaven River and Marulan Creek Upstream Samples. Given that aluminium concentrations are not elevated in Bungonia and Barbers Creeks, it is considered unlikely that the mine is causing these elevated results.
- The water quality is similar for both Barbers Creek and Bungonia Creek. Also, both creeks demonstrate a water quality decline similar to the Shoalhaven River when comparing upstream and downstream results. This indicates that water quality generally declines through this system possibly due to broader landuse and runoff quality issues (i.e. background conditions).
- The difference between the observed upstream and downstream water quality for Barbers Creek and Bungonia Creek is not significant, indicating that under existing operational practices, the mine has no effect on surface water quality.
- The Marulan Creek water quality data indicates that water quality improves as it moves down stream. Also the water quality for both Marulan Creek and Tangarang Creek indicate that this water is diluted in Barbers Creek, as demonstrated by the comparably better water quality of Barbers Creek.
- Where analysed, results for oil and grease fall below the detection limit of the test. The only exception being the Main Gully Autosampler where oil and grease was recorded at 6mg/L on one occasion in February 2010 above a detection limit of 2mg/L. Given that this was an isolated incident, it is not considered as being indicative of significant environmental impacts;

  - Copper concentrations recorded in the Main Gully Auto Sample show 20%ile, Median and 80%ile concentrations of 1.68, 1.9 and 2.1ug/L (compared to a guideline of 1.4mg/L). However, the absence of elevated statistical copper concentrations in any other surface water sampling point indicates these results are unlikely to be affecting surface water quality in receiving water downstream (e.g. Bungonia Creek or the Shoalhaven River); and
  - Where analysed, results for TPH fall below the detection limit of the test. The only exception being the Main Gully Autosampler in March 2012 ranged from 20-150μg/L C6-C9 and 100-500μg/L C10-C36. Although no Australian criteria are available for TPH, these concentrations are below the Dutch Intervention Value for Mineral Oil (600mg/L). Given the environmental setting of the site, location of AEC and distance to the closest surface water receptor, these concentrations are not considered to be indicative of significant environmental impacts.

9.3. Zoic Field Observations

The key observations made during the fieldworks conducted by Zoic can be summarised as follows:

- The weather conditions at the time of the fieldworks were fine with occasional showers;
- The ground conditions encountered at the site are presented on the borehole logs presented in **Appendix F**;
- The site was underlain by:
  - Asphalt or concrete surfacing: 0.05-0.3m
  - Gravel sub base fill material: 0.3 – 0.5m
  - Fill or mine overburden materials: 0.5-4.0m
  - Sandstone in BH1 and BH2 only: 3.5-4.5m+

- No groundwater was encountered during drilling works. However, seepage was noted from gravel subbase beneath the concrete in BH1 and BH2;
- No staining or sheens were observed but faint to strong hydrocarbon odours were noted in BH1, BH2, BH3, BH4, BH8 and BH9. Odour notes are shown on Borehole Logs in **Appendix F;**
- Notable PID results were recorded at BH2 (67.3ppm at 2.2-2.5m bgl), BH3 (5.6-14.2ppm at 0.5-2.0m bgl), BH7 (7.5-9.4ppm at 1.0-2.0m bgl) and BH8 (9.5-18ppm at 0.5-1.5m). Other PID results were below 3ppm. PID results are shown on the Borehole Logs in **Appendix F;** and
- No asbestos containing materials (ACM) were visually identified during borehole drilling.
- ACM was observed during shallow soil sampling as follows:

Table 9.3: Summary of ACM observations and results

Location	Field Description	Laboratory Description	Laboratory Result
ASB01	Dark brown sandy topsoil	Mid brown sandy soil with some grey rocks	Not detected
	Suspected ACM fragment on surface	Five pieces of bonded asbestos cement sheeting approx 55 x 30 x 4mm	Chrysotile, amosite and crocidolite detected
ASB02	Dark brown sandy topsoil	Not tested due to close proximity to ASB02 and ASB03	Not tested due to close proximity to ASB02 and ASB03

Location	Field Description	Laboratory Description	Laboratory Result
ASB03	Dark brown sandy clayey topsoil FILL	Mid brown sandy soil with some grey rocks plus some brick debris	Not detected
ASB04	Dark brown and grey silty sandy clayey topsoil	Grey sandy soil	Not detected
ASB05	Dark brown silty sandy clayey topsoil FILL Suspected ACM fragment on surface and in soil	Pale brown clay soil plus some cement sheeting and one small fragment of degraded and friable asbestos fibre board approx 6 x 5 x 3mm One piece of bonded asbestos cement sheeting approx 45 x 40 x 4mm	Chrysotile detected in soil and fragment
ASB06	Dark brown silty sandy topsoil	Not tested due to close proximity to ASB07	Not tested due to close proximity to ASB07
ASB07	Dark brown silty sandy topsoil FILL with limestone cobbles	Pale grey-brown sandy soil with some concrete debris and some vegetation	Not detected
ASB08	Light brown sand Suspected ACM fragment on surface	Pale brown sandy soil Three pieces of cement sheeting approx 50 x 40 x 4mm	Not detected Not detected
ASB09	Bowling Green kerb fragment	Two pieces of bonded asbestos cement sheeting approx 135 x 40 x 5mm	Chrysotile and Amosite detected in fragment

9.4. Zoic Soil Results

Laboratory results for soil samples are presented in **Appendix C** with comparison against the guidelines adopted for this assessment including:

- Ecological Investigation Levels (NEPM 2013 EILs) for a Commercial and Industrial Setting;
- Ecological Screening Levels for Hydrocarbons; for coarse soil in a Commercial and Industrial Setting (NEPM 2013 ESLs);
- Health Investigation Levels and Health Screening Levels for Generic Land Use Commercial and Industrial Soil D (NEPM 2013 HILs/HSLs), including asbestos HSLs; and
- Management Limits for Total Petroleum Hydrocarbons for Commercial and Industrial for coarse soil (NEPM 2013).

The sampling locations are presented on Figures 5.1 to 5.3 in **Appendix A**. Laboratory certificates are presented in **Appendix I**.

9.5. Groundwater Results (ESA Sampling)

As discussed in Section 7.6 above, AGEC conducted a single monitoring event (namely ESA Sampling) of selected representative groundwater wells for laboratory analysis of a comprehensive suite of analytes reflective of the contaminants identified in the AEC (i.e. metals and hydrocarbons).

The locations of the monitoring wells are presented on Figure 6 in **Appendix A**.

Laboratory results for groundwater samples collected by AGEC (as part of the ESA Sampling) are presented in **Appendix I** and can be summarised as follows:

Table 9.5: Summary of Groundwater Results

Constituents	ANZECC Fresh Criteria ug/L	MW1	MW2	MW5	WP16
		February 2015	February 2015	February 2015	February 2015
		Onsite Centre	Onsite S	Onsite NW	North Pit Bore
Aluminium	55	10	10	**180**	10
Arsenic	24	<1	<1	6	<1
Beryllium	60*	<1	<1	<1	<1
Barium	2000*	59	16	44	67
Cadmium	0.2	0.2	<0.1	<0.1	<0.2
Chromium	1	<1	<1	**3**	<1
Cobalt	1	<1	<1	<1	<1
Copper	1.4	**3**	<1	<1	**9**
Lead	3.4	<1	<1	<1	<1
Manganese	1900	37	25	<1	<1
Molybdenum	50*	2	<1	2	<1
Nickel	11	10	**15**	<1	<1
Selenium	5	<10	<10	<10	<10
Vanadium	100	<10	<10	<10	<10
Zinc	8	**18**	<5	**23**	**17**
Boron	370	50	<50	<50	<50
Mercury	0.06	<0.1	<0.1	<0.1	**0.5**
TPH: C_6-C_{10} (F1)	-	NT	NT	<20	<20
TPH: C_{10}-C_{16}(F2)	-	NT	NT	<100	<100
TPH C10-C40	600**	NT	NT	<100	<100
Benzene	950	NT	NT	<1	<1
Toluene	180	NT	NT	<2	<2
Ethylbenzene	80	NT	NT	<2	<2
Xylene	625	NT	NT	<2	<2
Phenols	320	NT	NT	5	<1
BaP	0.2	NT	NT	<0.5	<0.5
Napthalene	16	NT	NT	<1	<1
Anthracene	0.4	NT	NT	<1	<1
Phenanthrene	2	NT	NT	<1	<1
Fluoranthene	1.4	NT	NT	<1	<1

*** Australian Drinking Water Guideline (2011) used in lieu of ANZECC (2000)**

**** Dutch Intervention Value for mineral oil used for screening purposes only**

NT – Not tested. Hydrocarbons analysis was Targeted to MW5 and WP16 as these are located in closest proximity to the AEC.

Bold – Exceedance of Criteria

'-' Denotes no guideline available

9.6. Surface Water Results

As discussed in Section 7.6 above, IEC conducted a single monitoring event (namely ESA Sampling) of selected representative surface water sampling points for laboratory analysis of a comprehensive suite of analytes reflective of the contaminants identified in the AEC (i.e. metals and hydrocarbons).

The locations of the monitoring locations are presented on Figure 6 in **Appendix A**.

Laboratory results for surface water samples collected by IEC (as part of the ESA Sampling), are presented in **Appendix I** and can be summarised as follows:

Table 9.6: Summary of Surface Water Results

Constituents	ANZECC Fresh Criteria ug/L	Bungonia Creek Up	Barbers Creek Down	Main Gully Sample Point
		27.11.14	27.11.14	27.11.14
Aluminium	55	<10	<10	<10
Arsenic	24	<1	<1	<1
Beryllium	60*	<1	<1	<1
Barium	2000*	60	112	39
Cadmium	0.2	<0.1	<0.1	<0.1
Chromium	1	<1	<1	<1
Cobalt	1	<1	<1	<1
Copper	1.4	<1	<1	<1
Lead	3.4	<1	<1	<1
Manganese	1900	3	3	41
Molybdenum	50*	<1	<1	<1
Nickel	11	<1	<1	1
Selenium	5	<10	<10	<10
Vanadium	100	<10	<10	<10
Zinc	8	<5	<5	<5
Boron	370	<50	<50	<50
Mercury	0.06	<0.1	<0.1	<0.1
TPH: C_6-C_{10} (F1)	-	<20	<20	<20
TPH: C_{10}-C_{16}(F2)	-	<100	<100	<100
TPH C10-C36	600**	<50	<50	<50
Benzene	950	<1	<1	<1
Toluene	180	<2	<2	<2
Ethylbenzene	80	<2	<2	<2
Xylene	625	<2	<2	<2
Phenols	320	<1	<1	<1
BaP	0.2	<0.5	<0.5	<0.5
Napthalene	16	<1	<1	<1
Anthracene	0.4	<1	<1	<1
Phenanthrene	2	<1	<1	<1
Fluoranthene	1.4	<1	<1	<1

*** Australian Drinking Water Guideline (2011) used in lieu of ANZECC (2000)**
**** Dutch Intervention Value for mineral oil used for screening purposes only**
Bold – Exceedance of Criteria
‘-‘ Denotes no guideline available

10. Site Characterisation

10.1. Assessment of Soil Concentrations against Adopted Site Criteria

A comparison of soil analytical results exceeding adopted criteria (see **Appendix C)** is discussed below:

- TPH C10-C16 (1,170mg/kg) and TPH C16-C34 (8,500mg/kg) in BH8 at 0.5-0.9m are above the NEPM (2013) Commercial / Industrial Management Limits of 1,000 and 3,500mg/kg respectively. No odour was noted in the upper 0.5m of the borehole and the underlying sample in BH8 at 1.0-1.5m falls below the guideline (TPH of 150 and 1,070mg/kg respectively);
- As discussed in Section 9.2, asbestos cement fragments were identified at the surface in ASB01 and at the surface and within the upper 0.1m of soil in ASB05. Asbestos was also identified in the kerb of the westernmost bowling green, which was damaged at its north eastern corner by use of ramps to allow access for mowing equipment; and
- Although there is no soil guideline value for Anionic Surfactants as methylene blue active substances (MBAS), the detection limit (<1mg/kg) was raised in two of the four samples tested (<100 to <200mg/kg). The laboratory stated that this was as a result of matrix interference by inorganic or organic chemicals, which could include elevated concentrations of MBAS.

10.2. Assessment of Groundwater and Surface Water Concentrations against Adopted Site Criteria

The groundwater analytical results presented in Table 9.5 above, that were undertaken specifically for this ESA are similar to those recorded through ongoing groundwater monitoring and generally fall below the adopted criteria or limit of reporting, with the exception of aluminium, chromium, copper, nickel, zinc and mercury. As highlighted by RGS (Section 3 above) in the results of the geochemical testing they undertook of the overburden material on site (to determine the potential of the material to generate acidity, salts and soluble metals / metalloids), concentrations of aluminium and chromium are considered to be representative of the natural overburden rock. Concentrations of copper, nickel, zinc and mercury are typically less than an order of magnitude higher than the adopted criteria and are also considered to be representative of background conditions rather than indicators of potential contamination. Consequently, there is no requirement for management or remediation of groundwater to protect human health or the environment.

The surface water analytical results presented in Table 9.6 above that were undertaken specifically for this ESA are similar to those recorded through ongoing surface water monitoring and generally fall below the adopted criteria or limit of reporting. Consequently, there is no requirement for management or remediation of surface water to protect human health or the environment.

10.3. Assessment of Aesthetic Issues

Isolated fragments of asbestos cement were identified at the surface within former building footprints of the demolished Marulan South Township (AEC16) that lie within the Project site. Additionally, asbestos cement fragments were also identified within a soil sample taken at ASB05 from ground level to 0.1m bgl. Furthermore, asbestos cement was identified in the kerb of the westernmost bowling green. Management or remediation of these occurrences of ACM is recommended to minimise potential exposure risk to fragments of ACM.

NEPM (2013) states that in arriving at a balanced assessment (i.e. considering land use sensitivity), non hazardous (i.e. below site criteria) material and low odour residue that will decrease over time should not be a cause of concern or limit the use of a site in most circumstances. Although faint to strong hydrocarbon odours and corresponding PID results were recorded in some soil samples, they were generally present at depths of greater than 0.5m and analysis confirmed them to be chemically suitable for the ongoing commercial / industrial land use. In addition, hydrocarbon odours will decrease by naturally degrading. Consequently, no management or remediation is required for chemically related aesthetic issues in soils.

No odours, sheens or staining were observed in groundwater or surface water samples.

10.4. Assessment of Chemical Mixtures

When considering suitability for use of sites, the potential for exacerbation of potential risks to human health due to impacts associated with chemical mixtures, must be assessed.

The main contaminant of concern for ongoing use of the site is asbestos, consequently, as this is not a chemical contaminant the assessment of chemical mixtures is not required. The only chemical contaminant detected at the site is TPH, consequently, consideration of potential effects of chemical mixtures does not require further assessment.

10.5. Assessment of Potential Contaminant Migration and Exposure

Based on the soil data obtained as part of this ESA and the conceptual understanding of the site as discussed in Section 6 above, the following discussion is provided with regard to assessment of Potential Contaminant Migration and Exposure for the continued use of the mine:

- As outlined in Section 2.9 of Schedule B1 NEPM (2013), *"The management limits may have less relevance at operating industrial sites (including mine sites) which have no or limited sensitive receptors in the area of potential impact."*. As recommended in NEPM (2013), site specific consideration of contamination and potential exposure pathways in determining the appropriateness of the Management Limits are considered as follows:

  The concentrations of TPH recorded in BH8 at 0.5 to 0.9m depth are most likely the result of historical spillage from the adjacent redundant above ground oil storage tanks (AEC15). However, it is considered that the potential risk of human health exposure or migration of contamination is negligible for the following reasons:

    - The impact is considered to have been a surface spillage, which has now been covered by material that has raised this area;
    - Hydrocarbon concentrations fall below human health criteria;
    - Concentrations fall below CRC Care (2011) Technical Report 10 Direct Contact criteria and are unlikely to pose a risk to site personnel who may be exposed to soil material in the vicinity of BH8 through future excavation / construction works;
    - The absence of hydrocarbons in BH7 (Figure 5.1) indicates that impacts are not present on the northern side of the AGST, suggesting limited lateral migration of contamination has occurred;
    - Although the extent is not delineated, it would be expected that the highest concentration of any spillage would be immediately adjacent to its original source (noting that the AGST is no longer used and the absence of hydrocarbons in BH7, immediately north of the AGST);

  - The fact that the underlying sample at 1m was not impacted suggests limited downward migration of contamination has occurred; and
  - In the unlikely event that impact did reach groundwater (at least 20m depth) it would be required to migrate between 1 to 2km before reaching the nearest off site surface water receptor (Barbers or Bungonia Creeks).

- A potential human health exposure pathway exists for asbestos across the area of the former Marulan South Township (AEC 16) as follows:
  - Isolated asbestos cement fragments are present at the surface and within the upper 0.1m of soils which exceeds the NEPM (2013) guideline requirement of *"no visible asbestos for surface soil"*;
  - One of the fragments was described by the laboratory as being friable and degraded and thus has the potential to liberate asbestos fibres into the surrounding area;
  - Although the majority of this area is grassed or overgrown with vegetation, areas of bare ground are present; and
  - Mowing and landscaping activities have the potential to further damage or liberate asbestos fibres from the isolated asbestos cement fragments identified.

- A potential human health exposure pathway exists for asbestos present within the kerb of the westernmost bowling green (also within AEC16) to the north of the current administration building for the mine (ASB09) thus providing potential to liberate asbestos fibres into the surrounding area;
- Elevated limits of reporting for MBAS were identified in BH5 at 1-1.3m (<200mg/kg) and BH6 at 1.5-2m (<100mg/kg). However, it is considered that the potential risk of human health exposure or migration of contamination is negligible for the following reasons:
  - AEC14 was targeted to determine if contaminated run off from wash bays was occurring (i.e. a surface source);
  - Shallow samples from BH5 at 0-0.5 (<1mg/kg) and BH6 at 0-0.5m (<1mg/kg) reported MBAS concentrations below the detection limit of the test; and
  - Given a surface source, shallow impacts would be expected to be higher than those at greater depth, consequently, it is more probable that interference was caused by something other than contamination within the soil matrix.
- Based on the information available to date, it is considered there is no duty to report contamination to NSW EPA under the CLM Act 1997.

10.6. Requirement for Site Management / Remediation Strategy

Zoic considers that the following issues require management or remediation as part of continued site operations:

- Asbestos cement fragments on the surface and within the upper 0.1m of soil within the area of the former Marulan South Township (AEC16) that is located within the Project boundary;
- Asbestos within the kerb of the western most bowling green to the north of the current administration building for the mine (ASB09); and
- Although no impacted soils were encountered in the vicinity of the UST (AEC5), Zoic considers that it represents a potential ongoing risk of soil and groundwater contamination.

11. Conclusions and Recommendations

Based on the works described in this Phase 1 and Phase 2 ESA report, and subject to the Limitations presented in Section 13, Zoic provides the following conclusions and recommendations:

- The site has been associated with mining and limestone manufacture since 1875. Boral has been operating the mine from 1987 to present;
- The site operates under NSW EPL No. 944, which requires environmental monitoring (i.e. dust, air and groundwater) at an agreed number of locations;
- The water bodies at the closest point to the active parts of the mine are Barbers Creek (adjacent east) and Bungonia (adjacent south) which flow into the Shoalhaven River (1250m south east);
- Two abstraction bores, namely WP16 (or EPL944 Licenced Dishcarge Point 13 / DPI Water Registered Bore GW110267) and WP17 (or DPI Registered Bore GW110268), surface water abstractions from Barbers Creek and seven groundwater monitoring bores are registered with NSW DPI Water. It is noted that although the surface water licence was renewed, this allocation cannot be extracted as Boral does not have any existing agreement in place with the current landowner to physically access the water since the pump was dismantled approximately 3 years ago. Groundwater within these monitoring wells was encountered at between 9.4 and 104m below ground level (bgl).Based on a review of the site history, eighteen potential areas of environmental concern (AEC) were identified. These were inspected during a site walkover on 30 September 2015 and it was determined that the following five AECs required intrusive investigation:
    - AEC5: Petrol UST investigated with BH01 and BH02;
    - AEC13: Workshop / Interceptor investigated with BH03 to BH05 inclusive;
    - AEC14: Washdown Bays / Waste Oil Tank investigated with BH06;
    - AEC15: Disused Oil AGST near Kiln investigated with BH07 to BH10 inclusive; and
    - AEC16: ACM debris near community hall, bowling green and current / former cottages investigated with ASB01 to ASB09 inclusive.

- Contaminants of concern assessed included heavy metals, hydrocarbons (TPH, BTEX, PAH, phenols, SVOC, VOC and surfactants as MBAS) and asbestos;
- The ground conditions encountered in the boreholes comprised asphalt or concrete surfacing: 0.05-0.3m; gravel sub base fill material: 0.3 – 0.5m; fill or mine overburden materials: 0.5-4.0m; and sandstone in BH1 and BH2 only: 3.5-4.5m+;
- No groundwater was encountered during drilling works. However, seepage was noted from gravel sub base beneath the concrete in BH1 and BH2;
- No staining or sheens were observed but faint to strong hydrocarbon odours were noted in BH1, BH2, BH3, BH4, BH8 and BH9;
- Notable PID results were recorded at BH2 (67.3ppm at 2.2-2.5m bgl), BH3 (5.6-14.2ppm at 0.5-2.0m bgl), BH7 (7.5-9.4ppm at 1.0-2.0m bgl), BH8 (9.5-18ppm at 0.5-1.5m). Other PID results were below 3ppm;
- The testing results fall below the adopted site criteria with the following exceptions:
    - Hydrocarbon contamination at 0.5-0.9m in BH8 (located east of the westernmost former oil AGST near the Kiln - shown on attached Figure 5.1) exceeds the NEPM (2013) Management Limits;

  - Isolated asbestos cement (ACM) fragments were identified at the surface (ASB01 and ASB05) and in shallow soil (ASB05) which exceeds the NEPM (2013) requirement for no visible asbestos at the surface or in the upper 10cm of soil (see Figure 5.3); and
  - The kerb of the westernmost bowling green was confirmed as containing asbestos and was sampled where it was damaged in the north eastern corner (ASB09).

- As discussed in Section 10.5 above, the hydrocarbon impacted soil identified in BH8 is not considered to pose a risk to human health or the environment;
- The isolated asbestos cement fragments may pose a potential risk to human health as one of the fragments was described by the laboratory as being friable and badly degraded and mowing or landscaping activities may further degrade any ACM fragments and liberate fibres;
- The damaged area of the kerb may pose a potential risk to human health as fibres may be liberated; and
- Surface water and groundwater concentrations fall below the limit of reporting, the adopted guidelines or are considered to be representative of typical background concentrations influenced by natural local geochemical conditions.

Based on the findings of the ESA, it is recommended that the following be completed to address isolated contamination identified:

- The extent of AEC16 shown on Figure 5.3 should be inspected by a qualified occupational hygienist and any asbestos containing materials (ACM) identified at the surface are removed for disposal and a clearance certificate issued;
- Where an absence of grass or vegetation is apparent within AEC16, a layer of 10cm of clean suitable material should be placed and vegetation encouraged to grow;
- A note to be added to the site asbestos register. The exact wording should be recommended by the occupational hygienist following completion of the inspection;
- The damaged kerb of the bowling green should be repaired (e.g. using epoxy resin) and the entire kerb painted to prevent further deterioration of the asbestos containing structure. A label should be affixed and a note added to the site asbestos register. A hand propelled mower should be used around the edges of the bowling green to prevent further damage to the kerb; and
- Although no contamination was noted in the boreholes drilled adjacent to the petrol UST (AEC5), it must be recognised that this represents a potential ongoing risk of pollution to soil and groundwater. If the UST is removed in the future it should be remediated and validated in accordance with the UPSS Regulations (2014) and environmental best practice at that time.

The Mine is managed in accordance with the 2018/2023 MOP and supporting REF for CML No. 16 and ML1716 (approved on 1 March 2018 in correspondence from NSW Planning & Environment Resources & Geoscience (Ref: OUT18/2241) until 26 February 2023), together with the conditions of consents, leases and licences. In addition, environmental issues and opportunities continue to be managed in accordance with Site Environmental Management/Improvement Plans.

Components of Site Environmental Management/Improvement Plans include:

- The Boral Environmental Policy;
- Boral’s “LEAN” approach to operational excellence;
- Site Environmental Management Committee;
- Internal company monthly reporting of environmental protection actions/breaches;

- Environmental Awareness training; and
- Environmental Risk Assessments including:
  - the original "Broad Brush Environmental Risk Assessment" conducted in January 2008 that was updated for inclusion in the revised 2009/2015 MOP and supporting REF; and
  - The revised Environmental Risk Assessment contained in the 2018/2023 MOP.

Notwithstanding the above, it is also recommended that the following measures are implemented on site to prevent further contamination and/or address unexpected contamination identified:

- Connection of the pumping line from the proposed Marulan Creek Dam into the existing Tallong Water Pipeline may cause ACM to be exposed and must be conducted by an appropriately qualified and experienced person to mitigate potential risk to human health and the environment (AEC12);
- All potential contaminants (e.g. hydrocarbons and ACM) are removed from equipment as part of the decommissioning of machinery and spare parts prior to being placed in the Old Machinery / Scrap Yard (AEC17). Where this is not practical, appropriate containment, signage and management should be implemented. Recovered hydrocarbons and ACM must be handled, stored, transported and disposed of appropriately; Given the extensive history of the mine, the presence of isolated areas of contamination should not be discounted. Although these are unlikely to pose a significant risk to human health or the environment, it is recommended that an Unexpected Finds Protocol (UFP) is prepared that provides guidance in the event that future below ground excavations identify any potentially contaminated materials (e.g. asbestos, staining, odours).

Although the site inspection and fieldwork was originally conducted in September 2014 and January 2015, Zoic considers this information to be reliable for the purposes of this ESA for the following reasons:

- The observations made during the site visit were used to determine whether additional investigation was required.
- Boral has advised Zoic that no significant changes have occurred to the site layout or operations since the site inspection and fieldwork conducted in 2014/2015 and no pollution incidents have occurred.
- The 2015/2016 and 2016/2017 Annual Environmental Management Reports provided to NSW EPA stated:
  - No construction activities have occurred on site;
  - Workshop spills are collected via a drainage network / grease trap and emptied by licensed contractor
  - No construction activities have been conducted;
  - Other site wastes are collected / stored and regularly emptied by a licensed contractor
  - Hazardous materials are inspected by an external service provider (Noel Arnold and Associates). The latest inspection was in July 2017. All hazardous material depots are compliant with the relevant regulations and standards;
  - No contaminated land related non-compliances with EPL 944 (Marulan South Limestone Mine and Lime Plant) were reported within the monitoring periods;
  - Groundwater monitoring is ongoing, and in addition to inventory records would detect leakage from bulk fuel storage areas;

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

- An UFP has been recommended to manage the potential for discovery of contamination during the implementation of future mine expansion plans.

12. References

- NSW EPA (1995) Contaminated Sites: Sampling Design Guidelines. NSW EPA, Sydney;
- AS 4482 (1999) Guide to the sampling and investigation of potentially contaminated soil. Standards Australia, Sydney;
- WA DoH (2009) Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia. WA Department of Health, Perth;
- NSW OEH (2011) Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites. NSW OEH, Sydney;
- NEPM (2013) National Environment Protection (Assessment of Site Contamination) Measure, Schedule A and Schedules B(1)-B(9). National Environment Protection Council, Adelaide;
- NSW EPA (2015) Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997. NSW DECC, Sydney; and
- NSW EPA (2017) Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (3rd edition). NSW DEC, Sydney.

13. Limitations

This report has been prepared for use by the Client who commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the Client and other parties. The findings of this report are based on the scope of work outlined in Section 1. The report has been prepared specifically for the Client for the purposes of the commission, and use by any nominated third party in the agreement between Zoic and the Client. No warranties, express or implied, are offered to any third parties and no liability will be accepted for use or interpretation of this report by any third party (other than where specifically nominated in an agreement with the Client).

This report relates to only this Project and all results, conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose. This report should not be reproduced without prior approval by the Client, or amended in any way without prior approval by Zoic.

Subject to the scope of work, Zoic's assessment was limited strictly to identifying typical environmental conditions associated with the Project site and does not include evaluation of any other issues.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigation.

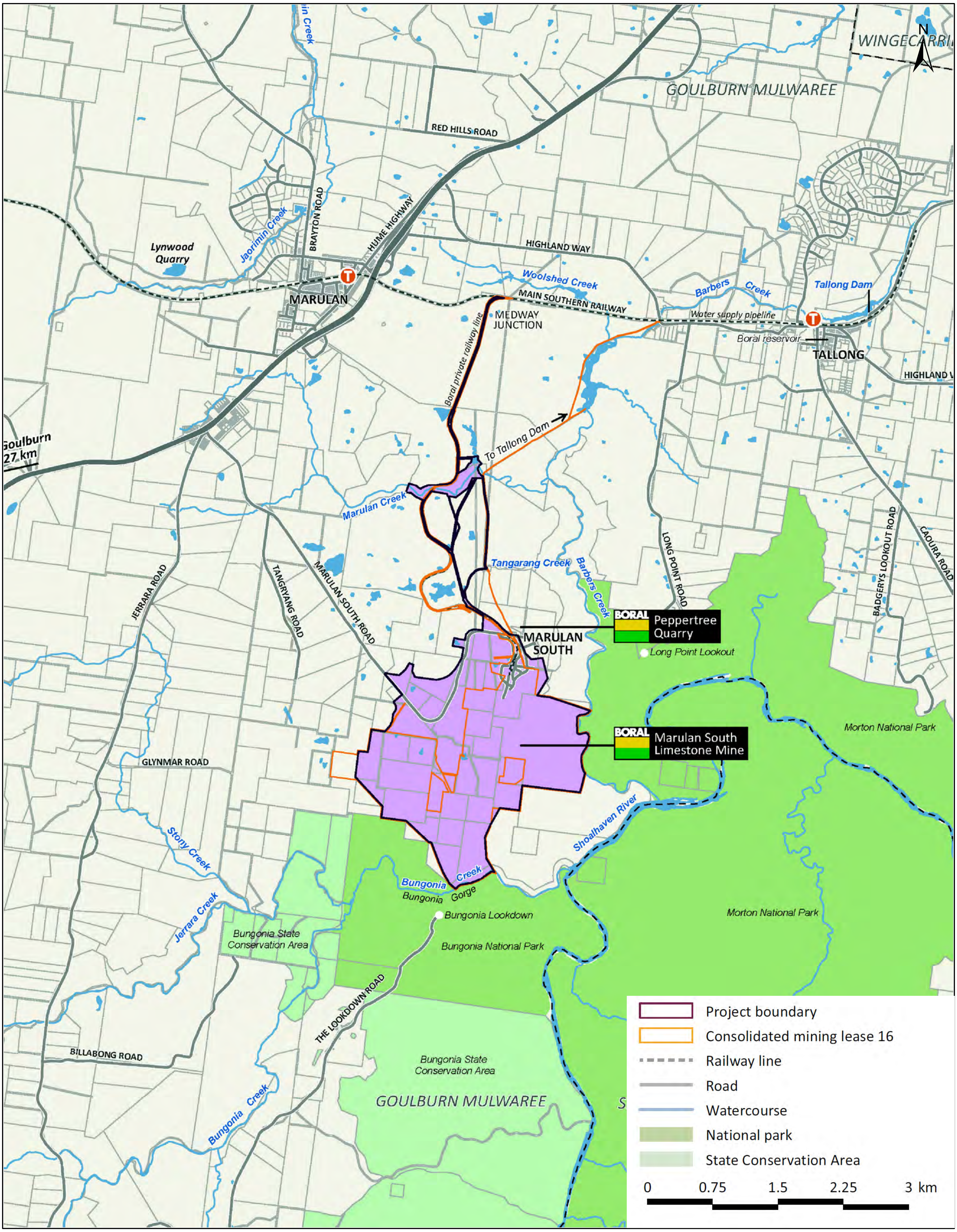
This report does not comment on any regulatory obligations based on the findings. This report relates only to the objectives stated and does not relate to any other work conducted for the Client.

The absence of any identified hazardous or toxic materials on the site should not be interpreted as a guarantee that such materials do not exist on the site.

All conclusions regarding the site are the professional opinions of the Zoic personnel involved with the Project, subject to the qualifications made above. While normal assessments of data reliability have been made, Zoic assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of Zoic, or developments resulting from situations outside the scope of this Project.

Zoic is not engaged in environmental assessment and reporting for the purpose of advertising sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes. The Client acknowledges that this report is for its exclusive use.

Appendix A – Figures



Source: PACT 2016

FIGURE 1A

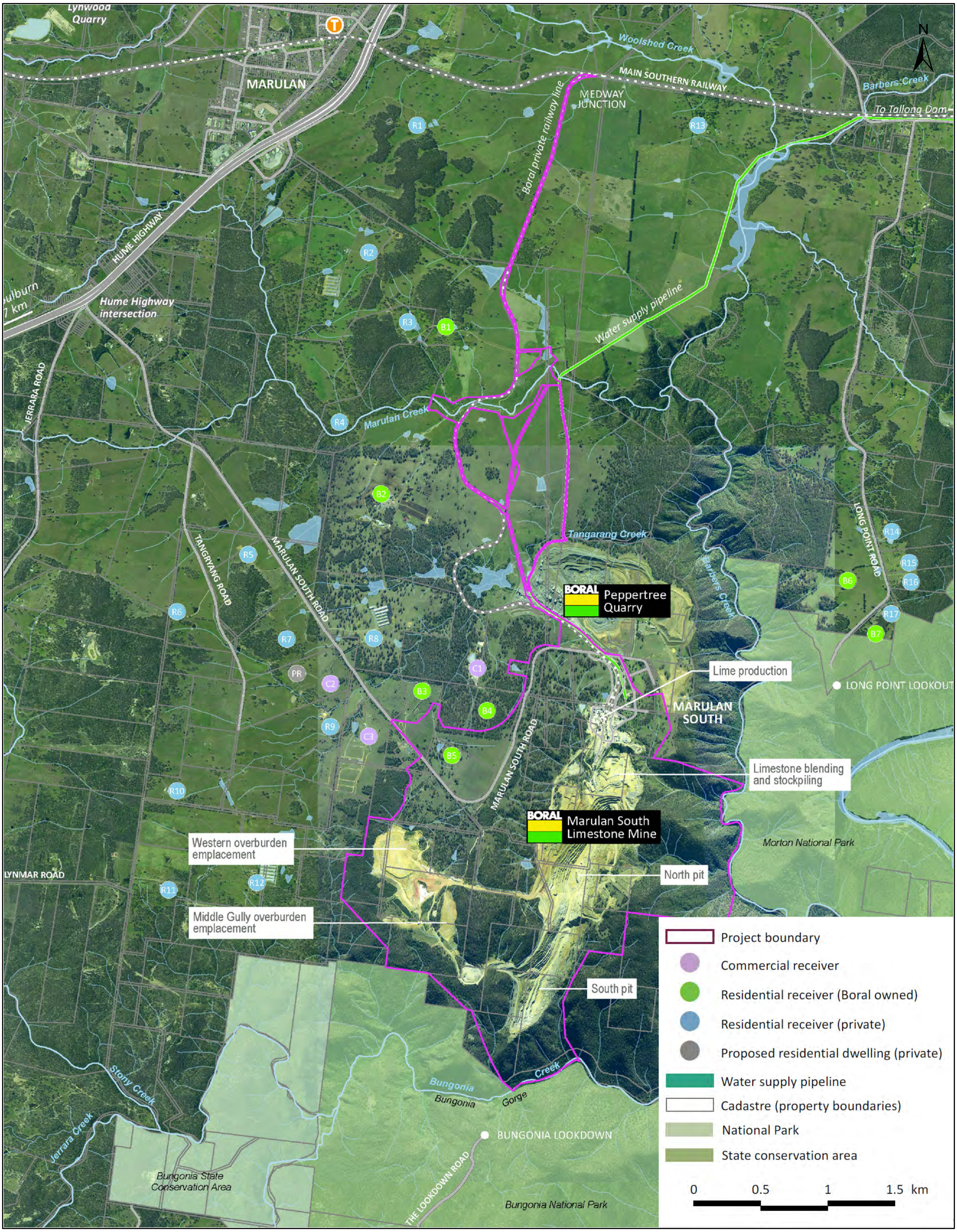
Site Location

Boral Cement Limited
26/06/2018
14071

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014. And Imagery from SixViewer (LPI NSW Government).



Source: PACT 2016

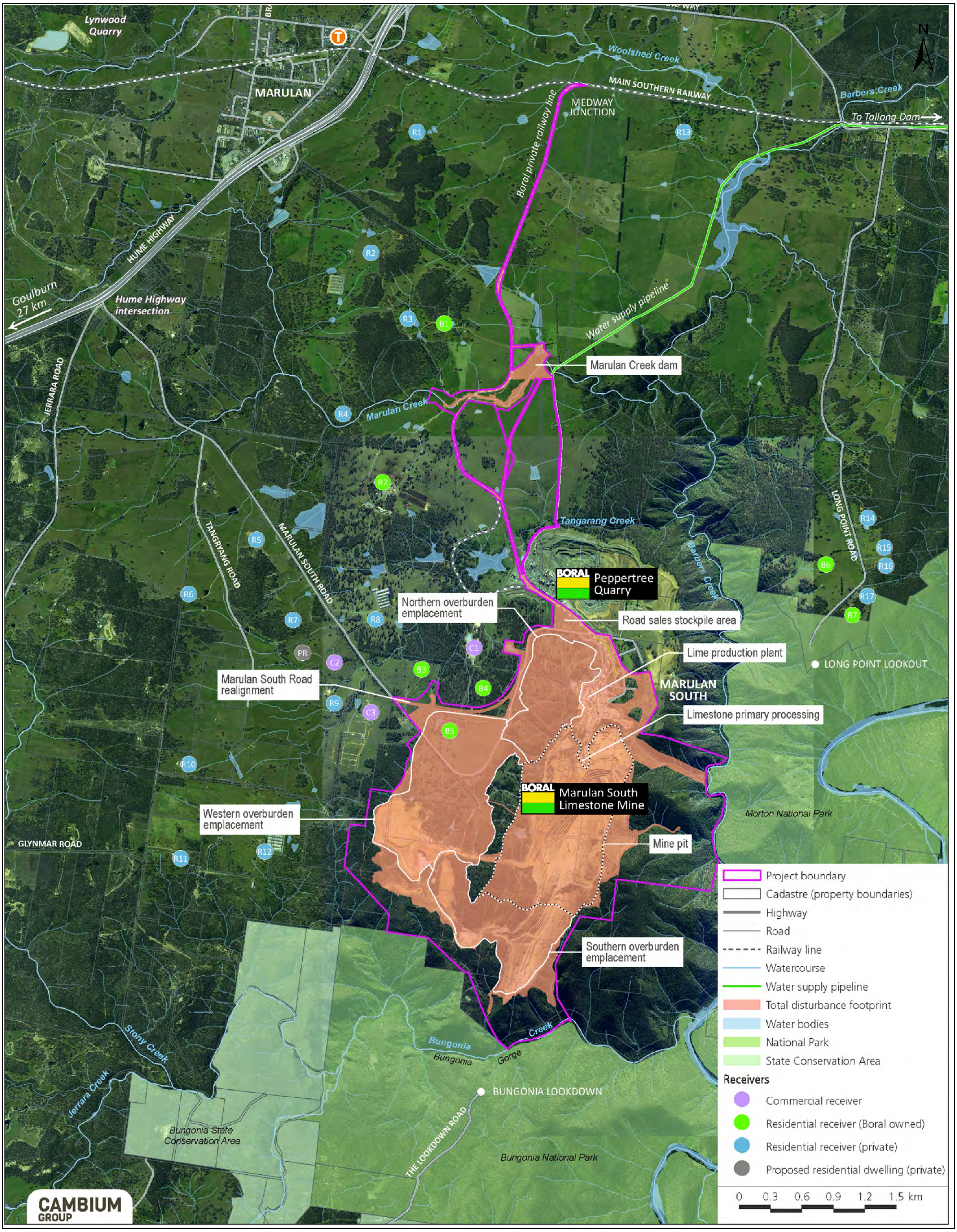
Boral Cement Limited
26/06/2018
14071

FIGURE 1B
Project Boundary

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014. And Imagery from SixViewer (LPI NSW Government).



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

FIGURE 2A

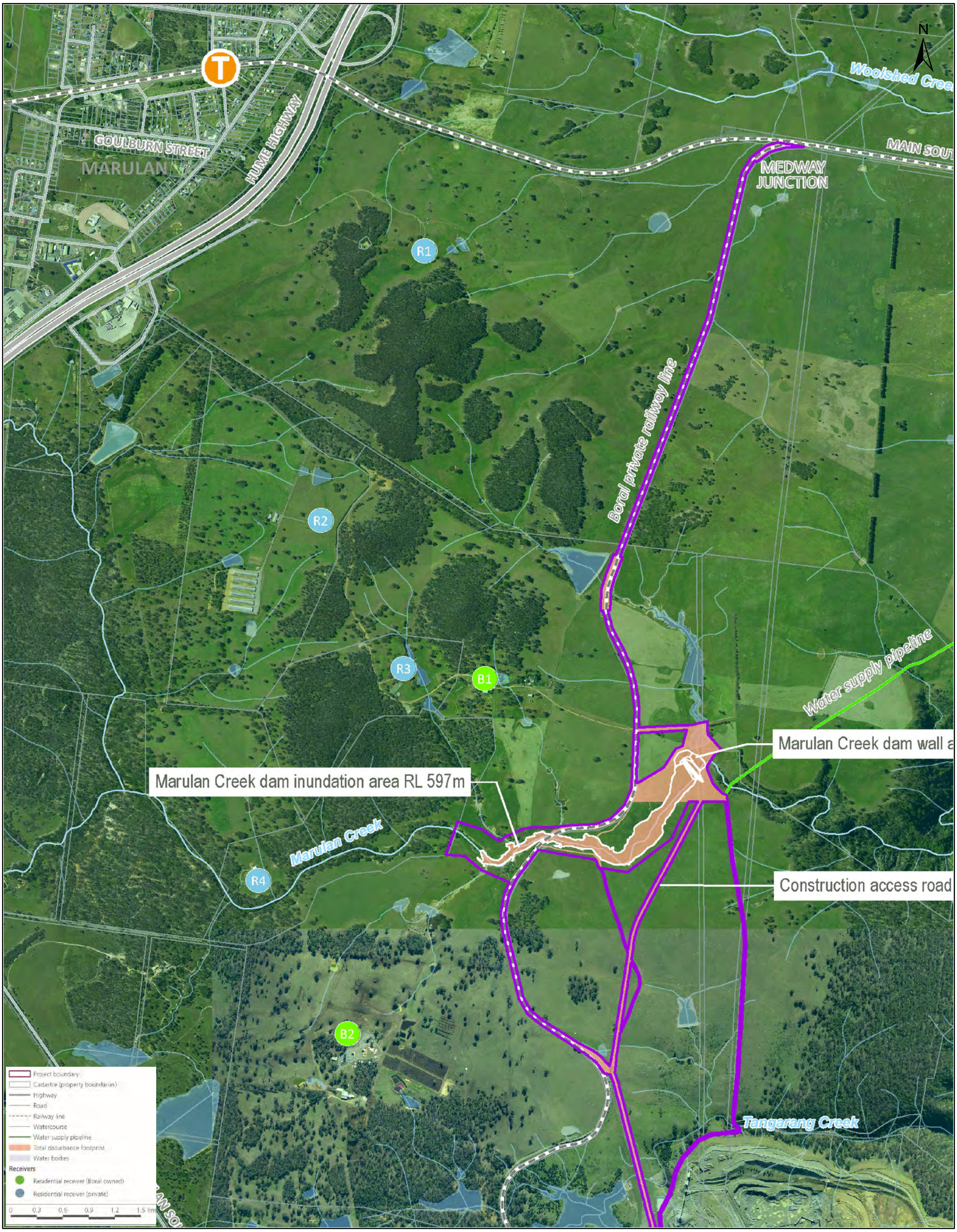
The Mine - Disturbance Footprint

Boral Cement Limited
26/06/2018
14071

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014. And Imagery from SixViewer (LPI NSW Government).



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

Boral Cement Limited
26/06/2018
14071

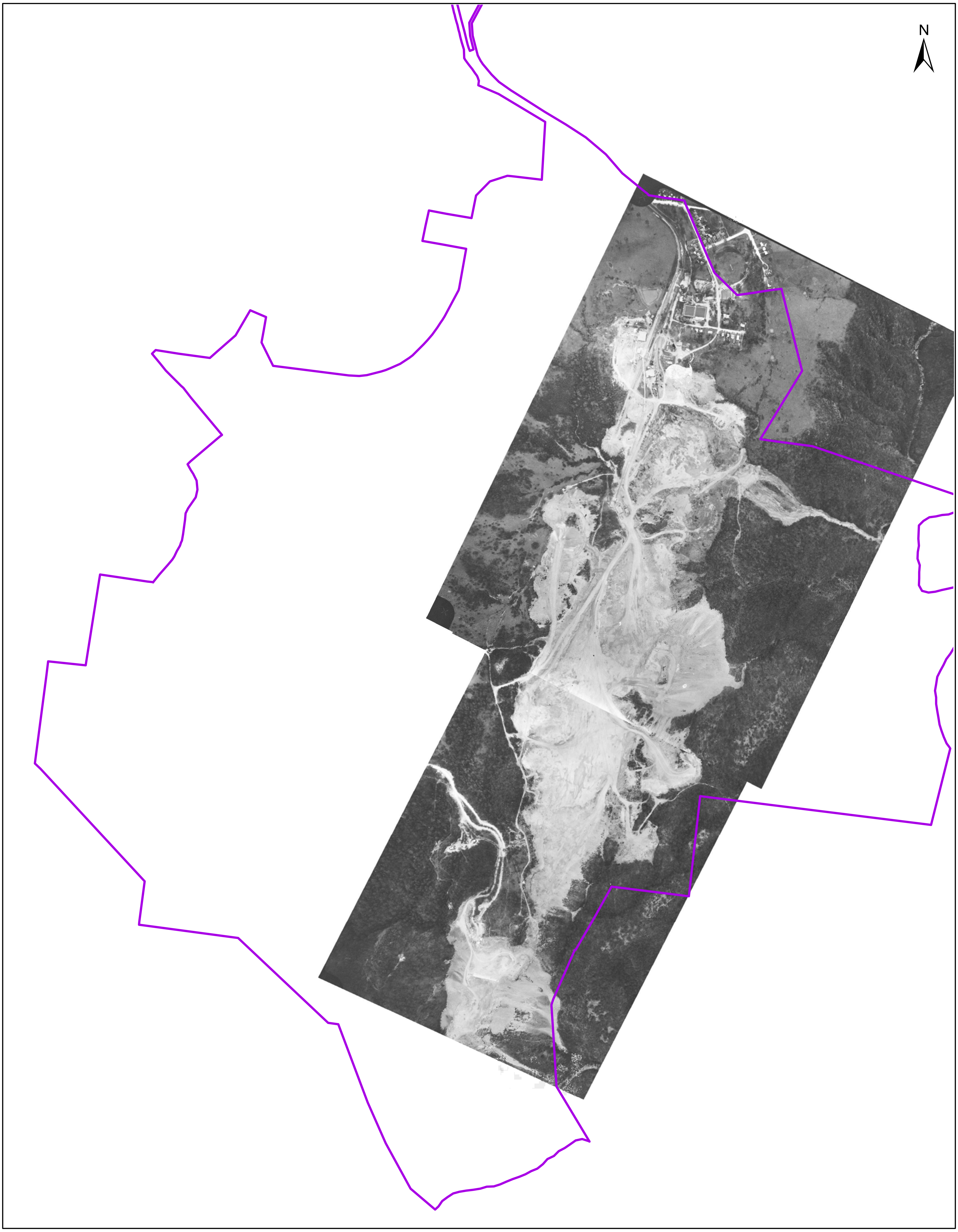
FIGURE 2B

Marulan Creek Dam - Disturbance Footprint

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014. And Imagery from SixViewer (LPI NSW Government).



LEGEND

▭ Project Boundary

FIGURE 3.1

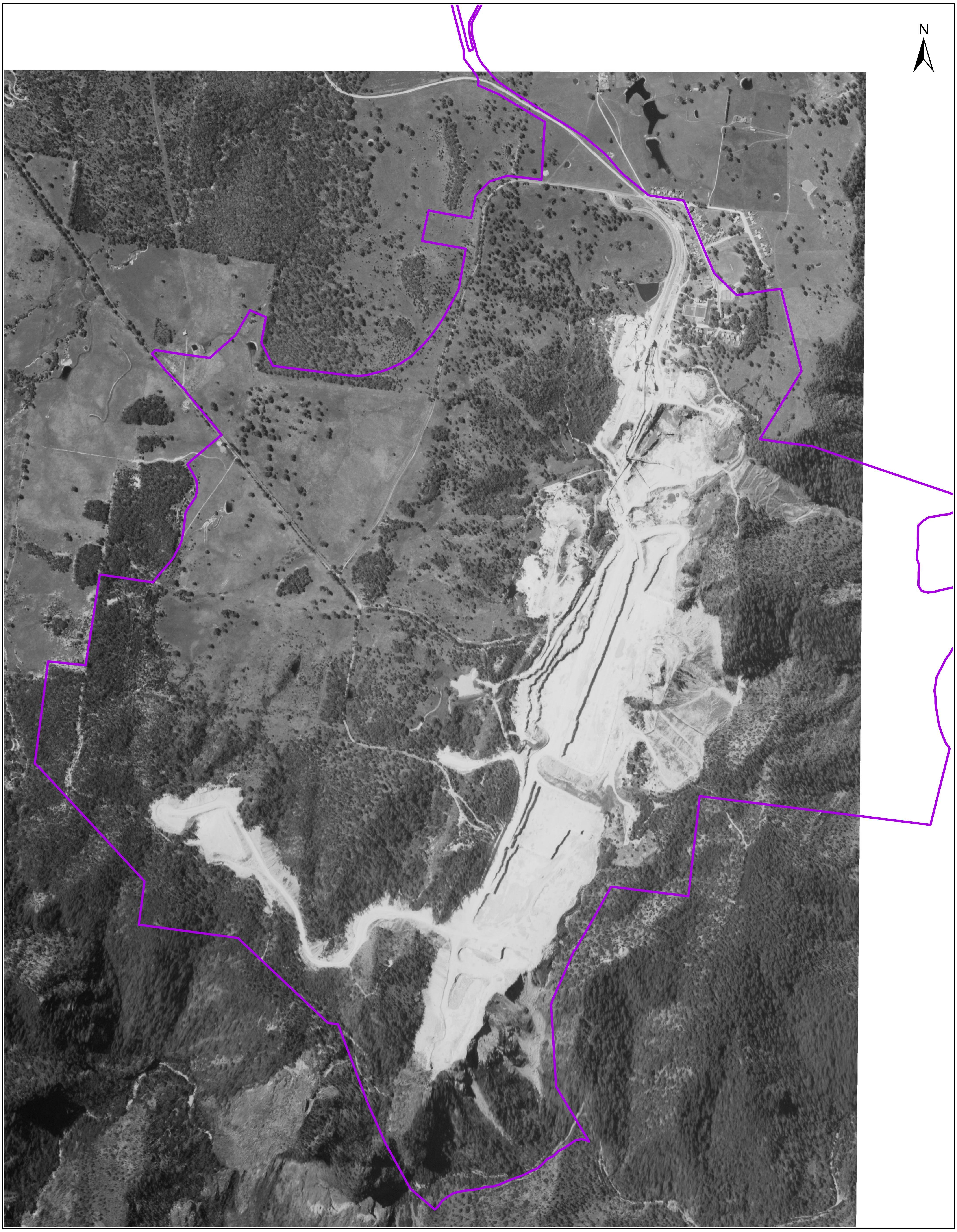
Historical Aerial Photograph 31-11-1972

Boral Cement Limited
26/06/2018
14071

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.



LEGEND

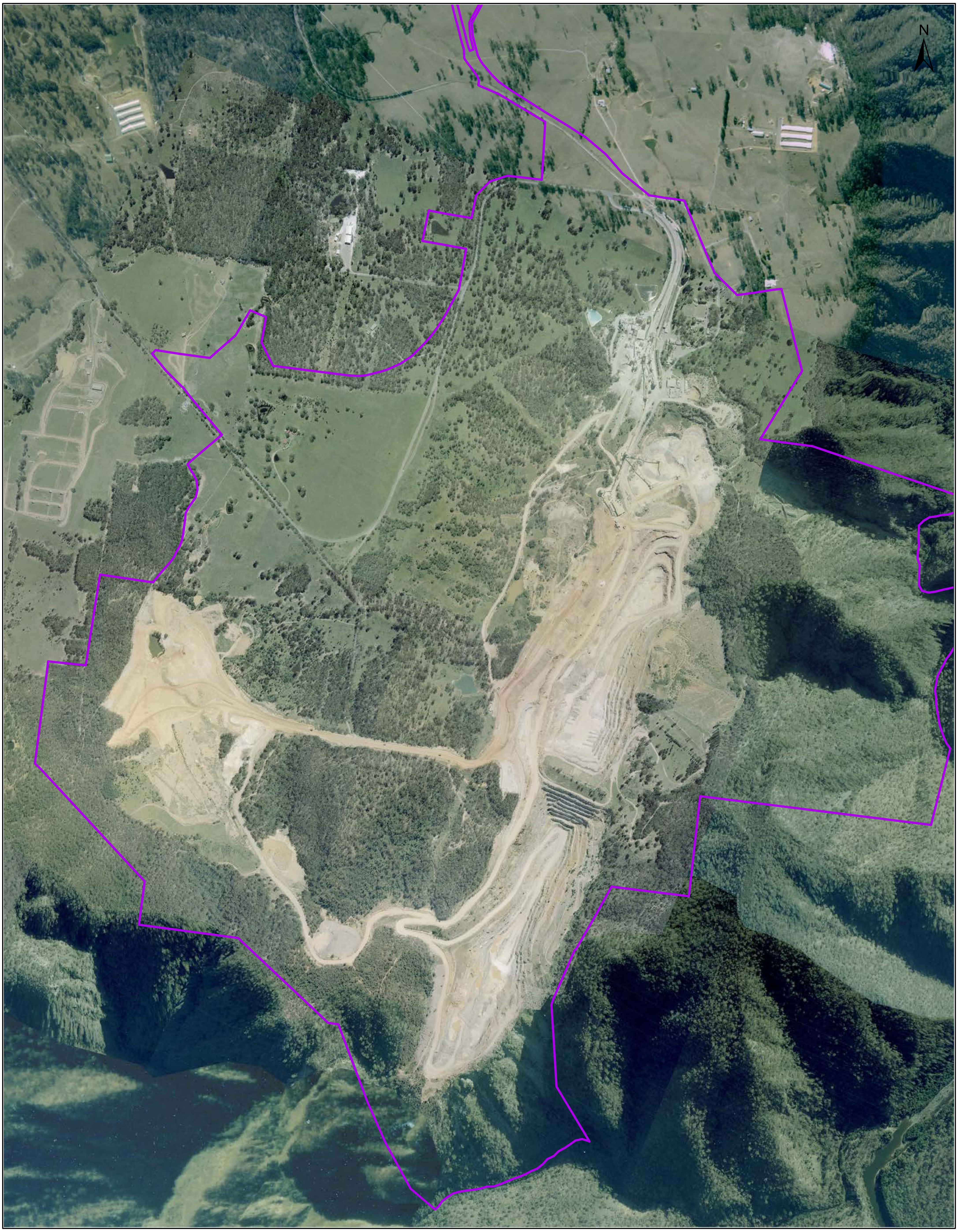
▭ Project Boundary

Boral Cement Limited
26/06/2018
14071

FIGURE 3.2

Historical Aerial Photograph 29-03-1984

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW



LEGEND

▭ Project Boundary

Boral Cement Limited
26/06/2018
14071

FIGURE 3.3

Historical Aerial Photograph 08-03-2001

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.

LEGEND

☐ Project Boundary

Boral Cement Limited
26/06/2018
14071

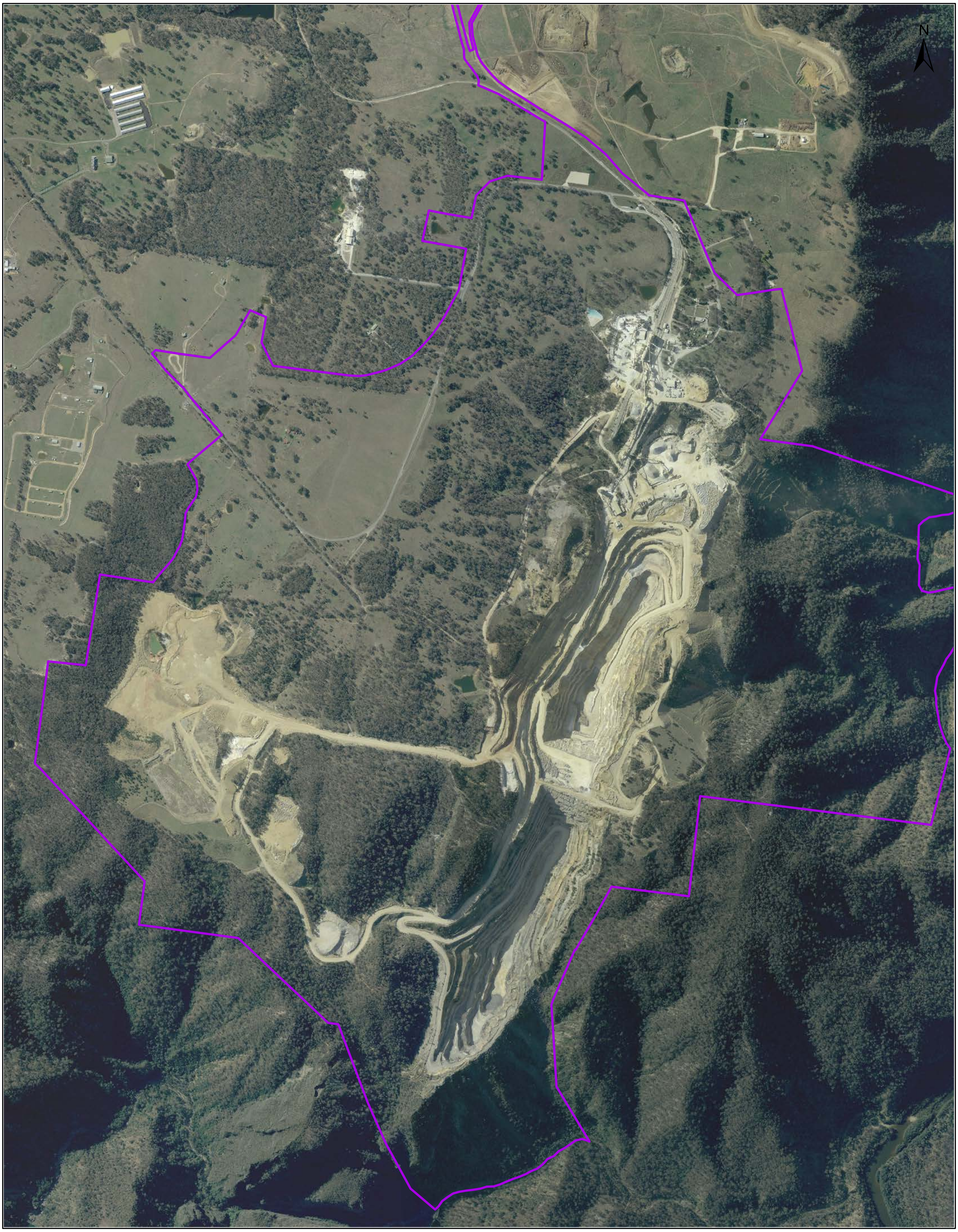
FIGURE 3.4

Historical Aerial Photograph Nov. 2009

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.



LEGEND

▭ Project Boundary

Boral Cement Limited

26/06/2018

14071

FIGURE 3.5

Historical Aerial Photograph Sept. 2011

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

LEGEND

▭ Project Boundary

Boral Cement Limited
26/06/2016
14071

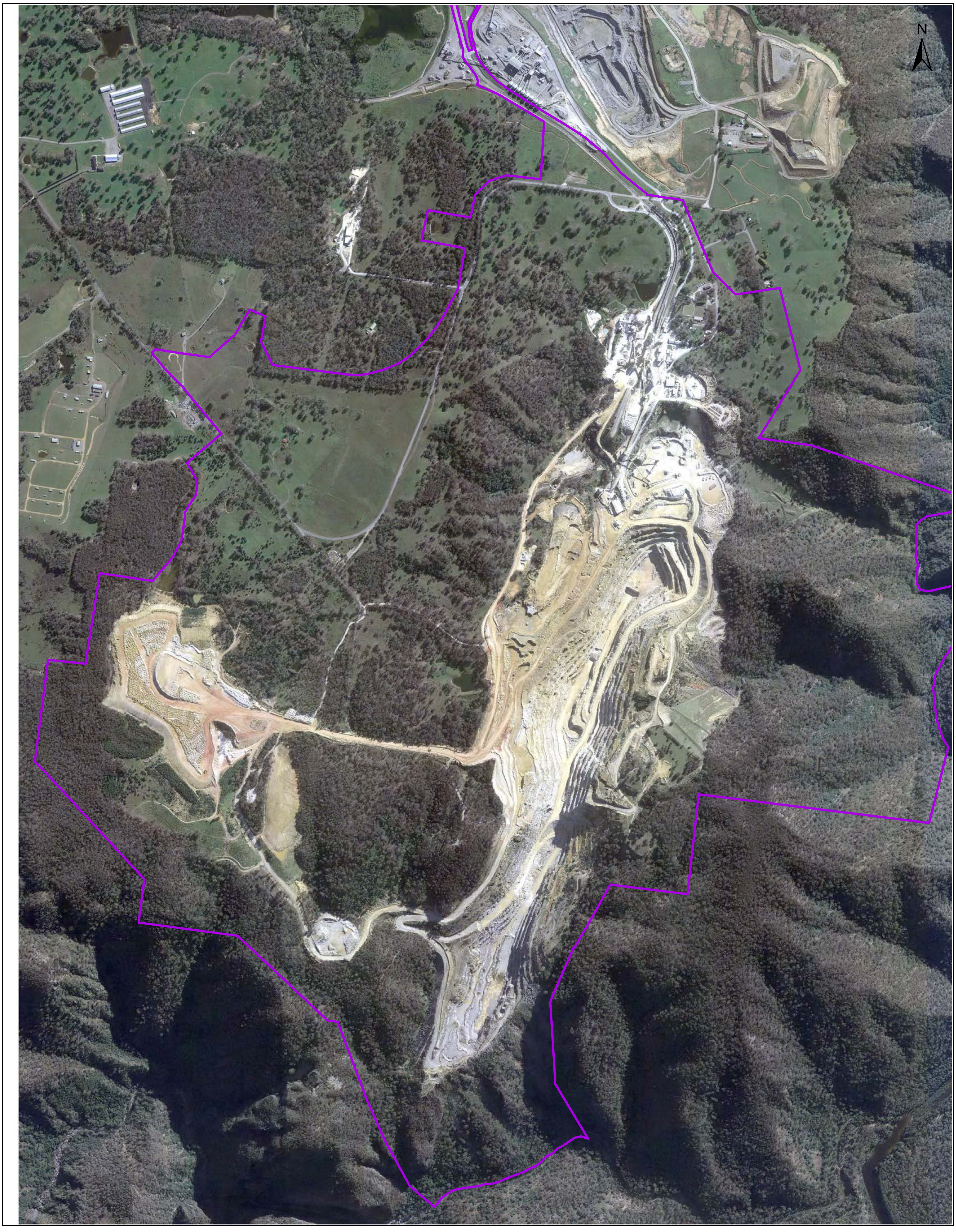
FIGURE 3.6

Historical Aerial Photograph May 2012

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.



LEGEND

▭ Project Boundary

FIGURE 3.7

Historical Aerial Photograph April 2017

Boral Cement Limited
26/06/2016
14071

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

LEGEND

▭ Project Boundary

Boral Cement Limited
26/06/2016
14071

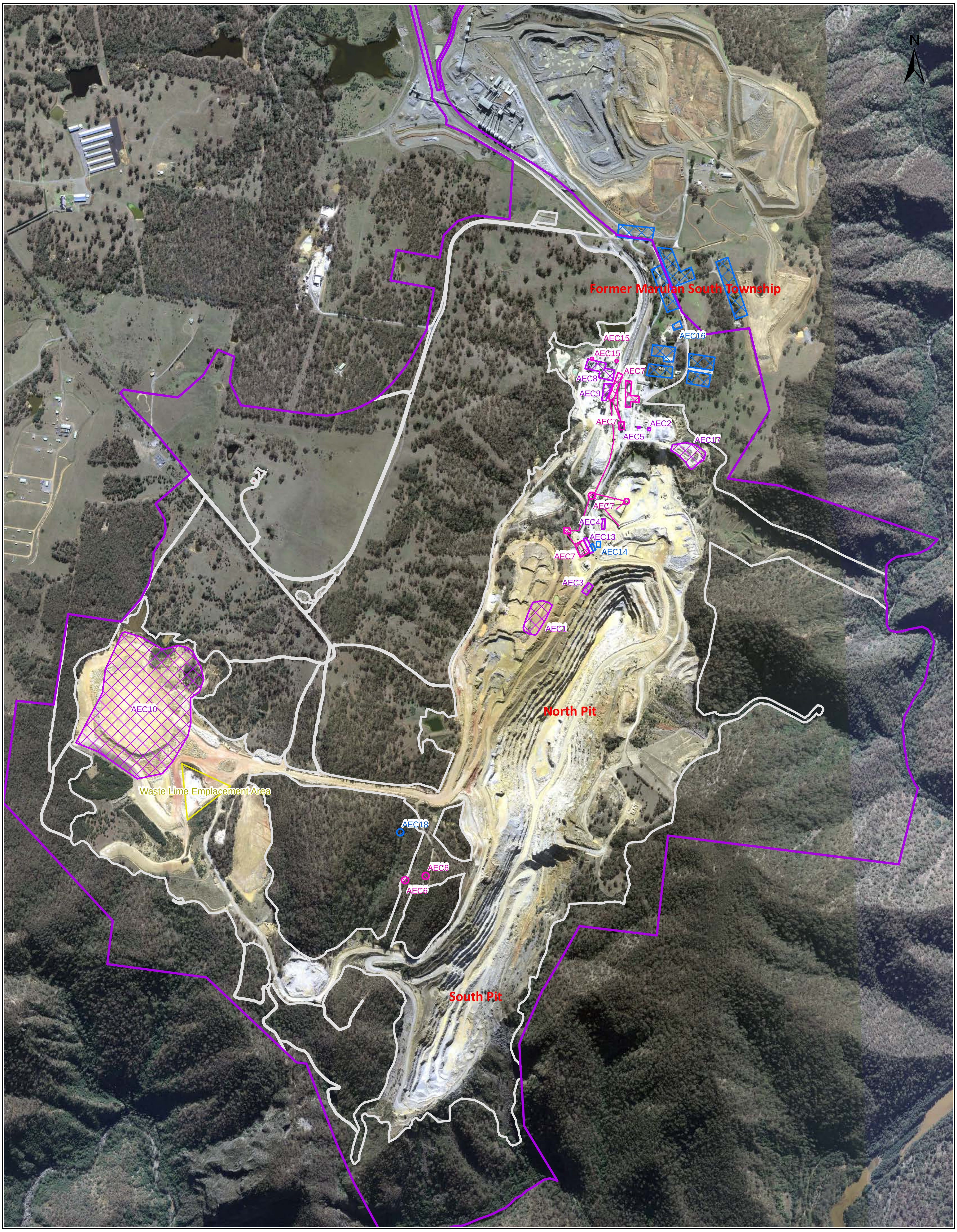
FIGURE 3.8

Historical Aerial Photograph April 2018

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.



LEGEND

▭ Project Boundary

▨ ▨ ▨ Areas of Environmental Concern

▭ Site Features

▭ Pre-SSD Disturbance Footprint

0 100 200 400 600 800 Meters

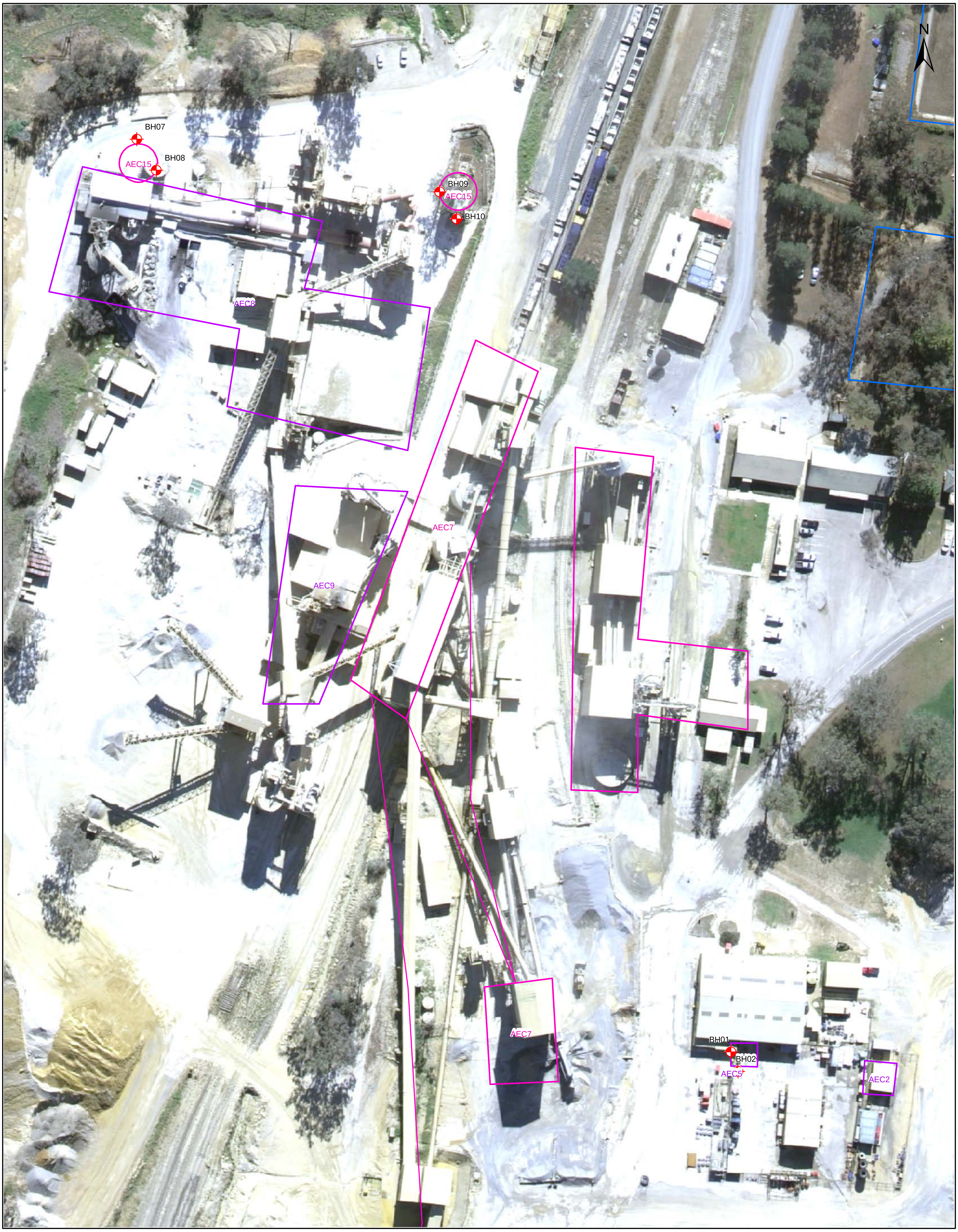
AECs not shown in Figure:
- AEC11. Currently undisturbed terrain within the proposed Disturbance Footprint of the Project Site as shown on Figure 2A
- AEC12. Currently undisturbed terrain within the proposed Disturbance Footprint of Marulan Creek Dam as shown on Figure 2B

Boral Cement Limited
26/06/2018
14071

FIGURE 4
Areas of Environmental Concern
Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014.



LEGEND

▭ Project Boundary

▨ ▨ ▨ Areas of Environmental Concern

⊕ Borehole Location

Boral Cement Limited
26/06/2018
14071

FIGURE 5.1

Sampling Locations

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014.

LEGEND

▭ Project Boundary

▨ ▨ ▨ Areas of Environmental Concern

⌖ Borehole Location

0 4.25 8.5 17 25.5 34 Meters

Boral Cement Limited
26/06/2018
14071

FIGURE 5.2
Sampling Locations

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014.

LEGEND

- ▭ Project Boundary
- ☒ ☒ ☒ Areas of Environmental Concern
- ⊕ Borehole Location
- ◐ Surface Sample Location

Boral Cement Limited
26/06/2018
14071

FIGURE 5.3
Sampling Locations

Marulan South Limestone Mine Continued Operations
Marulan South Road, Marulan NSW

ZOIC Environmental Pty Ltd - www.zoic.com.au

This product has been created to support the Marulan Limestone Mine SSD Approval and is not suitable for other purposes.
Background imagery source: Photomapping Services Pty Ltd project #5004, without warranty in relation to the data. Aerial photograph capture date: 1 May 2014.

Appendix B – Desk Study Information

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
3D Spray Enamel			2.1		250g (electrical workshop store)
3M EC-847					2 x 946mL (store)
3M Super 74 Foam Fast Adhesive					489g (builder's workshop)
3M Super 76 High Tack Adhesive					470g (builder's workshop)
732 Multi-Purpose Sealant					49 x 139mL (store)
732 Silastic	[				12 x 375mL (store)
A					
Acetic acid, glacial	[	Y	8, 3	II	2.5L (acid store)
Acetone	[	N	3	II	2.5L (wet lab), 2.5L (builder's workshop)
Acetylene	[	N	2.1		9 x G size (gas store), 1 x G size (fettlers' shed), 1 x G size (electrical workshop), 1 x G size (outside lime plant maintenance)
Adhesive					450g (painter's workshop)
Aerogard			2.1		150g (cleaner's room), 150g (electrical workshop store)
Alvania EP Grease 2	[				200kg (jaw crusher), 20kg (bottom store room machine shop), 6 x 20kg (oil store), 20kg (weighbridge)
Alvania RL 3 Grease					450g (electrical workshop), 2 x 450g (lime plant maintenance)
Ambi Pur					250mL (admin cleaner's room)
Ammonia solution (25%)	[	Y	8	III	2.5L (wet lab), 2.5L (lab store), 9 x 2.5L (acid store)
Ammonium chloride	[	Y			2 x 500g, 1kg (wet lab)

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
Ammonium nitrate (Nitropril)	[	N	5.1	III	48 tonne max (Nitropril store)
Ampol GT Multigrade					4L (bowling club shed)
Antidust A					2 x 200g (lab store)
Aquablock					4 x 25L (electrical workshop mezzanine)
Aqua Plus 999					25L (store), 25L (generator room)
Aquasol					1kg (gardener's shed)
Argoshield			2.2		1 x G size (gas store)
B					
B&N Window and ??? Cleaner					750mL)cleaner's room)
Battery, wet cell			8	III	4 x small, 8 x large (store), 2 x large (machine shop), 1 x small (instrument room), 1 x small (weighbridge), 2 x large (generator room)
Bestobell Graphite			3		500mL (lime plant maintenance)
Black & Gold Brown Vinegar					2 x 1L (cleaner's room)
Brake Fluid	[				2 x 20L (machine shop)
Brickies Mud					1 tonne (store), 3 x 20kg (builder's workshop)
C					
Calcium carbonate	[				1kg (wet lab)
Calcium sulfate	[	Y			3kg (lab store), 2 x 2.5kg (lab wash area)
Caltex 464 Gear Oil					1000L (machine shop)
Caltex Automatic Transmission and Power Steering Fluid Dexron III					1L (lab store), 4 x 20L (store), 20L (machine shop), 20L (fettler's shed)
Caltex Brake and Clutch					4L (store)

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
Fluid					
Caltex EP Grease C2					62 x 450g (store)
Caltex Kwik-D-Grease					2 x 20L (store)
Caltex Synthetic Oil 220					205L (oil store), 205L (secondary crusher)
Caltex Torque Fluid 434					1000L (machine shop), 100L (service truck), 3 x 205L (oil store)
Caltex Torque Fluid 454					7 x 205L (oil store)
Carbon Monoxide in Nitrogen (3.61%)		Y	2.3		1 x E size (depot 5)
Case Hy-Tran Ultra					20L (machine shop), 20L (bottom store room machine shop), 4 x 20L (fettler's shed)
Castor Oil (Refined)					3 x 5L (store)
Centron MP-0105 Flush Liquid					7 x 1L
Checkmate MB-1563 Microbiocide					10L (store)
Chemsearch Lubrease Clear			2.1		24 x 368g (store), 400g (generator room)
Chemsearch Met Kool			2.1		12 x 368g (store)
Chemsearch Kermite Premium Gear Oil Additive					12 x 946mL (store)
Chemsearch NC 123 Extra Lubrease Clear					3 x 300g (lime plant maintenance)
Citric acid					2 x 5kg (lab store)
Clipsal Jointing Cement	[				5 x 250mL (store), 250mL (builder's workshop)
Clorofos					20kg (rear of bowling club)
Comweld 965 Soldering Flux					2 x 125mL (store), 125mL (Cat room), 125mL (electrical workshop store), 125mL (lime plant maintenance)
Comweld Bronze Tinning					3 x 375g (store)

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
Flux					
Comweld Cast Iron Welding Flux					5 x 375g (store)
Comweld Copper and Brass Flux					2 x 250g (store)
Comweld Silver Brazing Flux No 2					3 x 200g (store), 500g (lime plant maintenance)
Comweld Silver Solder Flux					1 x 200g (welding bay)
Conduit Glue Blue					200g (electrical workshop)
Contrac? Rat and Mouse Bait					100 x 50g baits (builder's workshop)
Copper sulfate		Y			5kg (lab store), 7 x 3kg (acid store)
Corena Oil S68					20L (fettler's shed)
CRC Aerostart			2.1		12 x 450g (store), 2 x 450g (welding bay), 450g (electrical workshop store), 400g (lime plant maintenance)
CRC Belt Grip			2.1		4 x 400g (store)
CRC CO Contact Cleaner			2.1		48 x 350g (store), 350g (builder's workshop), 350g (Cat room), 2 x 350g (bottom store room machine shop), 350g (welding bay), 350g (electrical engineering), 350g (electrical workshop), 2 x 350g (lime plant maintenance)
CRC Liquid Armour			2.1		9 x 250mL (store)
CRC NF Contact Cleaner			2.1		5 x 400g (store), 2 x 400g (Cat room)
CRC Zinc It			2.1		12 x 450g (store), 5 x 450g (welding bay),

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
					450g (electrical workshop)
Cyndan Specialised Acid Wash					20L (electrical workshop mezzanine)
D					
Deb Protect					5 x 4L (store), 2 x 4L (cleaner's room)
Deb Restore					4 x 4L (store), 2 x 4L (cleaner's room)
Deb Supreja Plus					8 x 4L (store), 4 x 4L (cleaner's room)
Delo 400					10 000L (machine shop), 300L (service truck)
Delo Silver 30					20L (machine shop)
Derkit					205L (outside lime plant maintenance)
Desxidine? 624			8, 6.1	III	2 x 5L (painter's workshop)
Diala B					4 x 205L (oil store)
Diazinon		Y	6.1	III	200mL (gardener's shed)
Diazinon Ant Killer Dust		Y	6.1	III	500g (gardener's shed)
Diesel		Y			4 x tanks (diesel tank farm), 200L (machine shop), 2500L (service truck)
Diggers Bycol Clear					1L (builder's workshop)
Diggers Kerosene		Y	3	III	1L (gardener's shed)
Dixon Graphite S????		Y			4 x 500g (store)
Dixon No 2 Flake Graphite		Y			6 x 200g (store), 200g (electrical workshop)
Dixon Pipe Joint Compound					750g (store)
Donax TD 80W					20L (bottom store room machine shop)
Dow Garlon 600					20L (gardener's shed)
Dulux Enamel Pressure Pack			2.1		70 x 325g, 31 x 250g, 53 x 750g, 60 x 350g (painter's workshop), 250g (electrical engineering)

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
Dulux Prepcoat			3		19 x 4L (store)
Dulux Prepcoat Acrylic					11 x 4L (store)
Dulux Semigloss Enamel			3		5 x 4L (store)
Dulux Super Enamel			3		4 x 4L (store), 7 x 4L, 10 x 1L (painter's workshop)
Dulux Wash & Wear					11 x 4L (store)
Dulux Weathershield					20 x 4L (store)
Dura-Gard			2.1		12 x 350g
Dye Off					750mL (back room machine shop)
Dy Mark Spray Mark			2.1		8 x 350g (painter's workshop), 350g (builder's workshop), 350g (electrical engineering)
Dynamic Desealer Free Flo 34					2 x 20L (machine shop office), 20L (outside lime plant maintenance), 6 x 20L (generator room)
E					
Eadi Invertible Air Duster					5 x 200mL (electrical engineering)
Eaton Silicone					450g (back room machine shop)
Electra Saf-95		Y	6.1	III	4 x 25L (electrical workshop mezzanine)
Electrolube Anti-Static Foam Cleaner					400mL (electrical engineering), 400mL (electrical workshop store)
Electrolube Safewash 2001			2.1		400g (shipping container)
Emulsa Bond					3 x 4L, 1 x 1L (painter's workshop)
Epirez					4L (painter's workshop)
EP Grease C0					5 x 180kg (oil store)

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
Epoxanweld? Type V	[				2 x 3.38kg, 1 x 845g (store)
Estapol 7008 hardener					1L (bowling club shed)
Ethylenediaminetetraacetic acid	[	N			2 x 500g, 100g (wet lab), 2 x 1kg (acid store)
Exaderm					5kg (Cat room)
Extended Life Coolant					1000L (machine shop)
F					
Fiberfrax Pumpable					2 x 20kg, 20 x 2kg (lime plant maintenance)
Floorclean 3					22kg (store)
Fluoro Trace					6 x 2kg (store)
Foamclene					300mL (electrical engineering)
Fuchs Ceplattyn KG10 HMF 1000					2 x 205L (hydrating plant)
G					
Galmet Spray Paint			2.1		2 x 350g (builder's workshop), 250g (electrical engineering)
Gap Filla					6 x 450g (painter's workshop)
Gearlube SP 1000					205L (oil store)
Gex Plus			2.1		12 x 400g (store)
Glade			2.1		550g (cleaner's room), 550g (admin cleaner's room)
Glen 20			2.1		300g (cleaner's room), 300g (admin cleaner's room)
Glyphosate CT		Y			20L (fettler's shed), 2 x 20L (gardener's shed)
GP Cement					26 x 40kg (store), 40kg (builder's workshop)
Grazon		Y			20L (gardener's shed)
Gro Plus Bulb Food					750g (gardener's shed)

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
Grout					4 x 20kg (builder's workshop)
H					
Handigas	[	Y	2.1		5 x large (depot 4), 6 x G size (outside welding bay), 2 x G size (fettler's shed), 2 x G size (fettler's truck), 9kg (gardener's shed)
Hardener UT-R 20			6.1	III	40g (lime plant maintenance)
Heavy Duty Open Gear & ???					400g (shipping container)
High Temperature Manifold Sealer					500g (back room machine shop)
Hortico Rose Dust					500g (gardener's shed)
Hospital Skin Care Lotion					500mL (electrical workshop store)
Hydraulic Oil 69					1000L (jaw crusher)
Hydrochloric acid	[	Y	3	II	3 x 2.5L (wet lab), 2.5L (acid store)
Hydrogen		N	2.1		1 x G size (depot 5)
I					
Isonel? 300 Red					4L (back room machine shop)
J					
Jaques Bond Pack A & B					2 x 10kg (electrical workshop mezzanine)
Jet-Lube Kopr-Kote					500g (Cat room)
K					
Kleenzit Dishwashing Liquid					20L (wet lab)
L					

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
Lanoshield					350g (builder's workshop)
Lanthanum oxide	[				in solution (wet lab)
Liebherr Slew Ring Grease					12 x 1L (store)
Lime-Sulfur Spray					pump pack , 500mL (gardener's shed)
Liquid Dishwashing Detergent					20L (admin cleaner's room)
Liquid Nails					450g (painter's workshop), 2 x 320g (builder's workshop)
Liquid Sugar Soap					5 x 750mL (painter's workshop)
Lithium tetraborate					1kg (lab store)
Loctite 242					50mL (back room machine shop)
Loctite 243					50mL (lime plant maintenance)
Loctite 406	[				50mL (Cat room)
Loctite 567					50mL (builder's workshop)
Loctite 569					2 x 50mL (Cat room), 50mL (back room machine shop), 50mL (lime plant maintenance)
Loctite 575					50mL (lime plant maintenance)
Loctite 609					50mL (Cat room)
Loctite 680					50mL (Cat room)
LPG	[	N	2.1		bullet (store)
M					
Magnetic Black Ink					3 x 500g (bottom store room machine shop)
Malleus GL 400					205L (hydrating plant)
Marsh WP Cleaning Solvent	[		3		18.9L (store)
Matthews JAM-1001 Ink Black	[				1L, 19L (store), 3 x 1L (electrical workshop)

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
Matthews JAM-2005 Cleaner	[				3 x 1L (store), 5 x 1L (electrical workshop)
Maxsolve 152					20L (store)
Maxiplug					25kg (builder's workshop)
MCPA		Y			20L (gardener's shed)
Meropa 220					205L (machine shop), 4 x 205L (oil store), 205L (secondary crusher)
Meropa 320					2 x 205L (oil store)
Meropa 460					205L (below retaining wall)
Meropa 680					205L (below retaining wall)
Meropa 1000					3 x 205L (below retaining wall)
Methane in argon			2.1		3 x G size (depot 4)
Methane in nitrogen (4%)			2.1		1 x E size (depot)
Methanol	[	Y	3, 6.1	II	1L (wet lab), 2.5L (lab store)
Methylated Spirits		N	3	III	4L (painter's workshop), 20L (lime plant maintenance), 1L (bowling club shed)
2-Methyl-2,4-pentanediol		Y			2.5L (lab store)
Methyl red					2 x 100mL (wet lab)
Mineral Turpentine		Y	3	III	200L (paint store), 20L (painter's workshop)
Moly Grease EP 2					6 x 20kg (store), 180kg (machine shop), 20kg (service truck), 4 x 180kg (oil store)
Molykote FS 3452					100g tub (lime plant maintenance)
Mortein Fast Knockdown Fly & Insect Killer			2.1		300g (electrical engineering)
Mr Muscle					7 x 750mL (cleaner's room), 750mL (lime plant maintenance), 750mL (admin cleaner's

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
					room)
Mr Sheen			2.1		400g (painter's workshop), 400g (cleaner's room)
Multi Mist					9kg (store), 5 x 510g (builder's workshop)
My-T-Hard? Pink Priming Fluid					125mL (builder's workshop)
N					
Nitric acid	[	Y	8, 5.1	II	2.5L (wet lab), 2 x 2.5L (lab store), 6 x 2.5L (acid store)
Nitrogen	[	N	2.2		60 x G size (truck refuelling area), 7 x G size (gas store), 2 x G size (outside lime plant maintenance), 2 x G size (kiln control room)
Nitrous oxide		Y	2.2		1 x G size (depot)
Nu-Kote					25L (store)
O					
Off White Cement					30 x 40kg (store)
Oil based paints			3	III	136 x 4L, 33 x 1L (paint store), 6 x 4L, 1 x 1L, 1 x 500mL (bowling club shed)
Orthophosphoric acid 85%	[	Y	8	III	3 x 2.5L (acid store)
Osmocote Plus					2 x 500g (gardener's shed)
Oxygen	[	N	2.2, 5.1		5 x G size, 6 x C size (gas store), 1 x E size (fettler's shed), 2 x G size (fettler's truck), 1 x E size (electrical

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
					workshop), 1 x G size (outside lime plant maintenance)
Oxygen in nitrogen (7.62%)			2.2		1 x E size (depot)
Oxygen in nitrogen (7.53%)			2.2		1 x E size (depot)
P					
Paint Stripper					4L (painter's workshop)
Pale Terebin					4L (paint store), 4L (painter's workshop)
Petrol	[	Y	3	II	underground tank (store), 2 x 20L (fettler's truck), 100L (gardener's shed)
Phenolphthalein	[	N			10mL (wet lab), 2.5L (lab store)
Pledge			2.1		400g (cleaner's room)
Potassium chloride	[	N			2 x 500g (wet lab), 500g (lab store)
Potassium hydroxide	[	Y	8	II	2.5kg, 500g (wet lab), 5 x 1kg (acid store)
Premium Wood Working Adhesive					500mL (builder's workshop)
Q					
Quicklime	[	Y	8	III	across site
R					
R12			2.2		2 x 13kg (back room machine shop)
R134A refrigerant gas			2.2		3 x 22kg (Cat room)
Raid Fly and Insect Killer			2.1		5 x 400g (store), 400g (painter's workshop), 400g (cleaner's room), 400g (admin cleaner's room)
Ramset 801					495g (builder's workshop)

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
Rando HD 32					205L (oil store)
Rando HD 68					1000L (machine shop), 400L (service truck), 2 x 205L (oil store), 205L (generator room)
Rapid Set No Mix Concrete					10 x 20kg (store)
Refractory					1 tonne (store)
Refrigeration Lubricant 9068010G Ester Oil					1L (back room machine shop)
Rock Drill Lube 100					205L (machine shop), 205L (oil store)
Rock lime	[				across site
Rocol Baker's Mate					4 x 20L (store)
Rocol Switch Plate Spray			2.1		24 x 600g (fettler's shed)
Rogor					400mL (gardener's shed)
Roundup		Y			2 x 825mL (gardener's shed)
RPM FR Fluid 46					2 x 20L (preheater), 11 x 20L (below retaining wall)
Rust Converter	[	Y	8	III	2 x 20L (paint store)
S					
Safe-T-Cool					25L (store)
SC2000 Cement?					2 x 1kg (lime plant maintenance)
Septone C-Thru Glass Cleaner					11 x 750mL (store)
Septone Contact Adhesive					400g (builder's workshop)
Septone Lemon X-5 Disinfectant					3 x 20L (store), 20L (cleaner's room), 20L (fettler's shed), 20L (electrical workshop store), 20L (rear of bowling club), 20L (admin cleaner's room)
Septone Protector Plus					12 x 500mL (store)
Septone Spray and Wipe					3 x 750mL (store),

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
					750mL (cleaner’s room)
Septone Wash Up Dishwashing Liquid					2 x 20L (store)
Serins? 500 Glass Cleaner					750mL (cleaner’s room)
Shell Donax TC 30					3 x 20L (store)
Shell Donax TC 50					20L (store), 205L, 20L (oil store)
Shell Helix Plus 15W/50					20L (store), 20L (fettler’s shed), 20L (gardener’s shed)
Shell Morlina 10					2 x 20L (store), 20L (weighbridge)
Shell Omala Oil 150					20L (store), 20L (outside lime plant maintenance)
Shell Omala Oil 320					205L (hydrating plant)
Shell Omala Oil 460					20L (store), 205L (below retaining wall)
Shell Omala Oil 680					20L (lime plant maintenance)
Shell Omala Oil HD 680					205L (generator room)
Shell Omala Oil 800					205L (jaw crusher), 3 x 205L (oil store), 2 x 205L (below retaining wall)
Shell Tellus Oil 32					20L (store)
Sigma X-ray Flux	[				1kg (lab store), 1 kg (lab wash area), 10 x 2kg (acid store)
Silica gel	[	Y			bag (lab store), 2 containers (electrical workshop), 13kg (shipping container)
Simple? Green Line Descaler					20L (cleaner’s room)
Sodium carbonate	[	Y			2 x 500g (wet lab), 2 x 500g (lab store)
Sodium hydroxide	[	Y	8	II	2 x 500g (wet lab),

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
					500g (lab store)
Sodium hypochlorite solution		Y	8	III	2 x 205L (filtration shed)
So Easy					750mL (cleaner's room)
Spotlite R???????? Dishwash					20L (store)
Spraymarker Dye					6 x 5L (gardener's shed)
"Stag" Jointing Paste					2 x 400g (store), 400g (lime plant maintenance)
Static Free Plast-n-Glas					400mL (electrical engineering)
Sulfuric acid	[	Y	8	II	2.5L (wet lab), 5L (lab store)
Super Ardea C68					8 x 20L (store)
Super Ardea CT68					20L (machine shop), 20L (oil store)
Super Ardea S68					4 x 20L (store)
Super Chem-Zyme IV Plus					5 x 25L (store), 2 x 20L (cleaner's room)
Surfactant 600					20L (gardener's shed)
T					
Tarn Off			6.1, 8	III	500mL (wet lab)
Task Force Water Soluble Herbicide					20L (gardener's shed)
Thermit Welding Portion	[				10 x 60kg, 6 x 47kg (fettler's shed)
Thinners			3		7 x 20L, 16 x 4L (paint store), 2 x 4L (painter's workshop)
Thread-Eze Ultra					454g (lime plant maintenance)
Thuban 80W/90 Gear Oil					205L (machine shop)
Thuban GLS EP 80W/90					205L (oil store), 205L (secondary crusher)
Tin		Y			100g (lab store)

Chemical	MSDS	Haz Sub	DG Class	PG	Quantity
Tints					34 x 1L (painter’s workshop)
Traffic Wax Liquid			3		20L (rear of bowling club)
Trefolex					4 x 500mL (store), 500mL (Cat room), 2 x 500mL (lime plant maintenance)
Triethanolamine	[	Y			5 x 2.5L (wet lab), 4 x 2.5L (acid store)
True Blue BC Crete Wash			8		20L (wet lab), 2 x 25L (store)
True Blue Trifecta					25L (cleaner’s room)
Two Stroke Oil	[				5L (fettler’s truck)
U					
Urinal Blocks					box (store)
V					
Vacuum Pump R31					3 x 1L (back room machine shop)
Valve Grinding Paste					500g (bowling club shed)
Vehicle Wash					180 kg (acid store)
W					
Waste oil					2 x 205L (below retaining wall)
Water Storage Crystals					1kg (gardener’s shed)
WD 40					14 x 425g, 8 x 350g (store), 2 x 425g (painter’s workshop), 425g (builder’s workshop), 425g (Cat room), 425g (electrical engineering), 425g (electrical workshop), 425g (weighbridge)
Weed n Feed					2 x 10kg (gardener’s shed)
Wicks					container (fettler’s shed)
Windex					2.5L (wet lab),

Chemical	**MSDS**	**Haz Sub**	**DG Class**	**PG**	**Quantity**
					750mL (cleaner's room), 750mL (admin cleaner's room)
Window and Glass Sealant					450g (painter's workshop)
Wynn's Automatic Transmission Stop Leak					750mL (back room machine shop)
X					
Y					
Yates Blitzem Snail and Slug Pellets					2 x 1kg (gardener's shed)
Yates Camellia and Azalea Food					5kg (gardener's shed)
Yates White Oil	[				500mL (gardener's shed)
Yield					2 x 20L (Cat room)
Z					

Date: 10 July 2014
Report number: R14333cc

CLEARANCE CERTIFICATE

SECTION A – CLEARANCE INSPECTION DETAILS

Client details	
Name of client:	Divall's Earthmoving & Bulk Haulage Goulburn Carrick Road Goulburn NSW 2580
Client contact details	Peter Waugh (02) 4829 8200
Removal work details	
Date removal work carried out:	9 July 2014
Site address where removal work carried out:	Boral Cement Marulan Mine Site Marulan South Road Marulan NSW 2579
Details of the specific asbestos removal work area(s):	Removal of two soil stockpiles impacted by AC cement sheeting.
Name of licensed asbestos removalist:	Byrne Demolition and Asbestos Removal Licence: AD211372
Inspection details	
Date of clearance inspection:	9 July 2014
Time of clearance inspection:	11:30

SECTION B – ASBESTOS REMOVAL WORK PAPERWORK

	Yes	No
Do you have a copy of the asbestos removal control plan?		✓
Do you have a copy of the notification form?		✓
Is the removal work consistent with the control plan and the notification form? (eg. Use of enclosures, decontamination facilities, waste facilities)		NA

SECTION C – ASBESTOS REMOVAL WORK AREA

1. Visual Inspection

	Yes	No
Inspection of the specific area detailed in Section A **found no visible asbestos** remaining as a result of the asbestos removal work carried out.	✓	
Is air monitoring required? (if no, proceed to Section E)		✓
Can the area be reoccupied?	✓	
Has additional information been attached? (eg. photos, drawings, plans)	✓ (Appendix 1)	
Other comments: Trace building rubble remains in investigation area but is free of any visible asbestos.		

2. Air monitoring

	Yes	No
Air monitoring was carried out as part of the clearance inspection. **The result was below 0.01f/ml**	NA	
Has the air monitoring sample been analysed by a NATA-accredited laboratory?	NA	
Is the air monitoring report attached?	NA	
Can the area be reoccupied?	NA	

SECTION D – ENCLOSURES

1. Prior to dismantling the enclosure

Prior to dismantling the enclosure	Yes	No
The area within the enclosure and the area immediately surrounding the enclosure was inspected and **no visible asbestos was found**	NA	
Air monitoring was carried out as part of the clearance inspection. **The result was below 0.01f/ml.**	NA	
Is the air monitoring report attached?	NA	
Can the enclosure be dismantled?	NA	

2. After the enclosure was dismantled and removed

	Yes	No
An inspection of the area in which the enclosure was erected and the area immediately surrounding the area where the enclosure was erected was inspected and **no visible asbestos was found.**	NA	
Air monitoring was carried out as part of the clearance inspection. **The result was below 0.01f/ml.**	NA	
Is the air monitoring report attached?	NA	
Can the area be reoccupied?	NA	

SECTION E – LIMITATIONS

Clearance limitations are described in Appendix 2.

SECTION F – CLEARANCE DECLARATION

☑ I declare that:

- the former asbestos removal work area and the surround area are free form any visible asbestos.
- the transit route and waste routes are free from any asbestos, and
- all asbestos in the scope of the removal work has been removed and any known asbestos is intact.

JKing

Signature of competent person

Jeremy King

Name of competent person

Attachments:

Appendix 1. Photographs of work area
Appendix 2. Report limitations

Appendix 1. Photographs of work area

Soil stockpiles prior to removal

Work area after removal

Appendix 2. Report limitations and intellectual property

The visual clearance inspection has been undertaken in accordance with the WorkCover (2011) *Code of Practice for the Safe Removal of Asbestos*. The accessible areas were inspected and the clearance is not intended to certify that removal of all asbestos containing material (ACM) has occurred. Envirowest Consulting Pty Ltd does not guarantee that the visual clearance inspection has confirmed, warranted or certified the identification and/or removal of all ACM previously identified or may be present on the site.

This report has been prepared for the use of the client to achieve the objectives given the client requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data and within the budget available. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no investigation, no matter how comprehensive, can reveal what is hidden by building materials, earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. No liability will be accepted for undetected asbestos on the surface on in the soil. Actual conditions in areas not sampled may differ from predictions. It is thus import to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report including data contained and its findings and conclusions remain the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted after full payment for the services involved in preparation of the report. This report should not be used by other persons or purposes than stated the scope and not reproduced without the permission of Envirowest Consulting Pty Ltd.

Envirowest Consulting *Pty Ltd* ABN 18 103 955 246
• 9 Cameron Place, PO Box 8158, Orange NSW 2800 • Tel (02) 6361 4954 •
• Fax (02) 6360 3960 • Email admin@envirowest.net.au • Web www.envirowest.net.au •

Environmental
Geotechnical
Asbestos
Services

Asbestos monitoring report – Boral Cement Marulan Mine Site, Marulan South Road, Marulan NSW 2579

Client: Divall's Earthmoving & Bulk Haulage Goulburn
Carrick Road
Goulburn NSW 2580

Date: 10/07/2014
Ref: R14333m

1. Background

Two soil stockpiles located on-site contain AC cement sheeting. Soil stockpiles impacted by AC cement sheeting require removal.

Situation: Removal **Building:** NA

2. Objective

Undertake static control monitoring during removal works outside the work area.

3. Site identification

Description	Removal of soil stockpiles impacted by AC cement sheeting
Address	Boral Cement Marulan Mine Site Marulan South Road Marulan NSW 2579
Investigation area	Two soil stockpiles
Photographs	Nil
ACM removal	Removal of two soil stockpiles impacted by AC cement sheeting

4. Work program

Removalist	Byrne Demolition and Asbestos Removal Licence No: AD211372
Date of works	9 July 2014
Cleanup	Excavation of topsoil

5. Inspection/assessment

Date	9 July 2014
Investigator(s)	Jeremy King (Competent person) Greg Madafiglio (Asbestos Assessor Licence LAA 000146)
Sampling	Air sampling was undertaken on 9 July 2014 attached as Appendix 1.

6. Criteria

Less than 0.01 fibres per millilitre - continue work,
Between 0.01-0.02 fibres per millilitre - stop work and review controls,
More than 0.02 fibres per millilitre - stop work modify controls, advise WorkCover

7. Results

09/07/14 All three monitors had a level of airborne asbestos fibres that was less than 0.01 fibres per millilitres

The level of airborne asbestos fibres was less than 0.01 fibres per millilitre at the monitoring locations outside the work area.

The sampling record (Appendix 1) and laboratory analysis report (Appendix 3) are attached. Risk to people in the work area from airborne asbestos was less than the WorkCover guidelines.

Report limitations are contained in Appendix 2.

8. Conclusions

The result indicates the control measures are adequate and comply with WorkCover NSW guidelines.

Authorised by: Greg Madafiglio (Asbestos assessor Licence LAA 000146)

Attachments:

Appendix 1.	Air monitoring sampling records (09/07/2014)
Appendix 2.	Report limitations
Appendix 3.	Envirowest Testing Services Laboratory reports

Appendix 1. Air monitoring sampling record

Client	Divall's Earthmoving & Bulk Haulage Goulburn
Contact	Peter Waugh
Job Number	14333
Location	Boral Cement Marulan Mine Site Marulan South Road Marulan NSW 2579
Date	09/07/2014
Investigator(s)	Jeremy King
Weather conditions	Sunny and cool with a slight breeze

Works: Removal of soil stockpiles impacted by AC cement sheeting

Sampling Details

Sample location	Sample ID	Pump no.	Time		Flow Rate (Lmin)		Air Volume(L)	Results (Fibres/mL)
			Start	Finish	Start	Finish		
Eastern boundary of works	0907-101	S4	08:20	11:00	4.5	4.5	720	<0.01
Western boundary of works	0907-102	S11	08:22	11:02	4.5	4.5	720	<0.01
Loader cab	0907-103	S5	08:24	11:04	4.5	4.5	720	<0.01

Laboratory report number: LR14333fc

Sampling pump type and number	SKC Aircheck sampler model 224 PCXR4
Filter	SKC MCE 0.8um 25mm filters with grids in preloaded cassettes
Sampling strategy used	Static around work area and cab of loader
Number of filters	3

Sampling Environment Details

Designation	Friable
Harmful Substances	AC sheet
Brief description of working process	Removal
Variable parameters which may influence	Air circulation
Work practices	Removal by wetting and excavation
- Working conditions	According to the asbestos removal control plan
- Material	Unknown
- Airflow	NA
- Influence on adjoining areas	No
Methods of dust control	Water spray
Visual impression of work	Clean
Personal protection	P2 respirators, coveralls, gloves, dry decontamination

Appendix 2. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the client requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data and within the budget available. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no investigation, no matter how comprehensive, can reveal what is hidden by building materials, earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. No liability will be accepted for undetected asbestos on the surface on in the soil. Actual conditions in areas not sampled may differ from predictions. It is thus import to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report including data contained and its findings and conclusions remain the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted after full payment for the services involved in preparation of the report. This report should not be used by other persons or purposes than stated the scope and not reproduced without the permission of Envirowest Consulting Pty Ltd.

Appendix 3. Envirowest Testing Services Laboratory report LR14333fc

Envirowest Consulting Pty Ltd ABN 18 103 955 246 trading as
Envirowest Testing Services
• 9 Cameron Place, PO Box 8158, Orange NSW 2800 • Tel (02) 6361 4954 •
• Fax (02) 6360 3960 • Email admin@envirowest.net.au • Web www.envirowest.net.au •

Environmental
Geotechnical
Asbestos
Services

CERTIFICATE OF AIR MONITORING

Client	Divall's Earthmoving & Bulk Haulage Goulburn	Report number	LR14333fc
Contact	Peter Waugh		
Address	Carrick Road Goulburn NSW 2580	Date	10/07/2014

Site location	Boral Cement Marulan Mine Site Marulan South Road Marulan NSW 2579
Sampled by	Jeremy King
Date received	10/07/2014
Date counted	10/07/2014
Test method	Filters examined in accordance with Guidance note on the membrane Filter Method for Estimating Airborne Asbestos Fibres 2nd Edition [NOHSC:3003(2005)]

Sample id	Result (fibres/field)	Notes
0907-101	0/100	Nil
0907-102	0/100	Nil
0907-103	0/100	Nil

JKing
Counter signature

Jeremy King
Name of counter

New South Wales

WorkCover NSW

Asbestos & Demolition

Online Notification System

Home

My Notifications

Home>> >>

A A A

'Amend' button below.

Read Only

FRM07: Notification of Class A Work

Licence Details

Reference Number: 943R-00063274-01

Licence Name: Byrne Demolition Pty Ltd

Status: Accepted

Licence No:

Class(es): Class A / ASA Class B / ASB

Date Lodged: 24/06/2014 06:12:53

Expiry Date:

Start Date of Work: 31/07/2014

Byrne Demolition Pty Ltd

A.B.N:

[Air Monitoring Result] [Amend] [Withdraw]

Tasks:	Details:	Action Required:
	Byrne Demolition Pty Ltd	———
Work Site Owner	Boral Cement Ltd	———
Site Details	1 Hume Street, Marulan South, NSW 2579	———
Clearance Certificate Details	Greg Madafilglio	———
Supervisor	MR BYRNE, JOHN CLEMENT	———
Type of Work - Asbestos	A selection has been made - see details	———
Asbestos Removal Control Plan (Safe Work Method Statement)	Details have been entered - see details	———
Declaration	JOHN BYRNE, SOLE DIRECTOR	———

FRIABLE ASBESTOS REMOVAL LICENCE

Issued under the *Work Health and Safety Regulation 2011* (NSW). This licence is not transferable.

Licence: AD211372

Licence class: Class A

Licence period: From: 18/03/2013 To: 17/03/2018

Licence holder name: Byrne Demolition Pty Ltd

ABN: 88 125 904 109

ACN: 125 904 109

Address: 20 Watson St YOUNG NSW 2594

Description of the work that can be undertaken under this licence

- All friable asbestos removal work.
- All non friable asbestos removal work.

Licence Holder Obligations

A nominated supervisor must be present at the site whenever licensed friable asbestos removal work is being carried out and is readily available to attend the site when licensednon friable asbestos removal work is being carried out.

This licence document must be available for inspection.

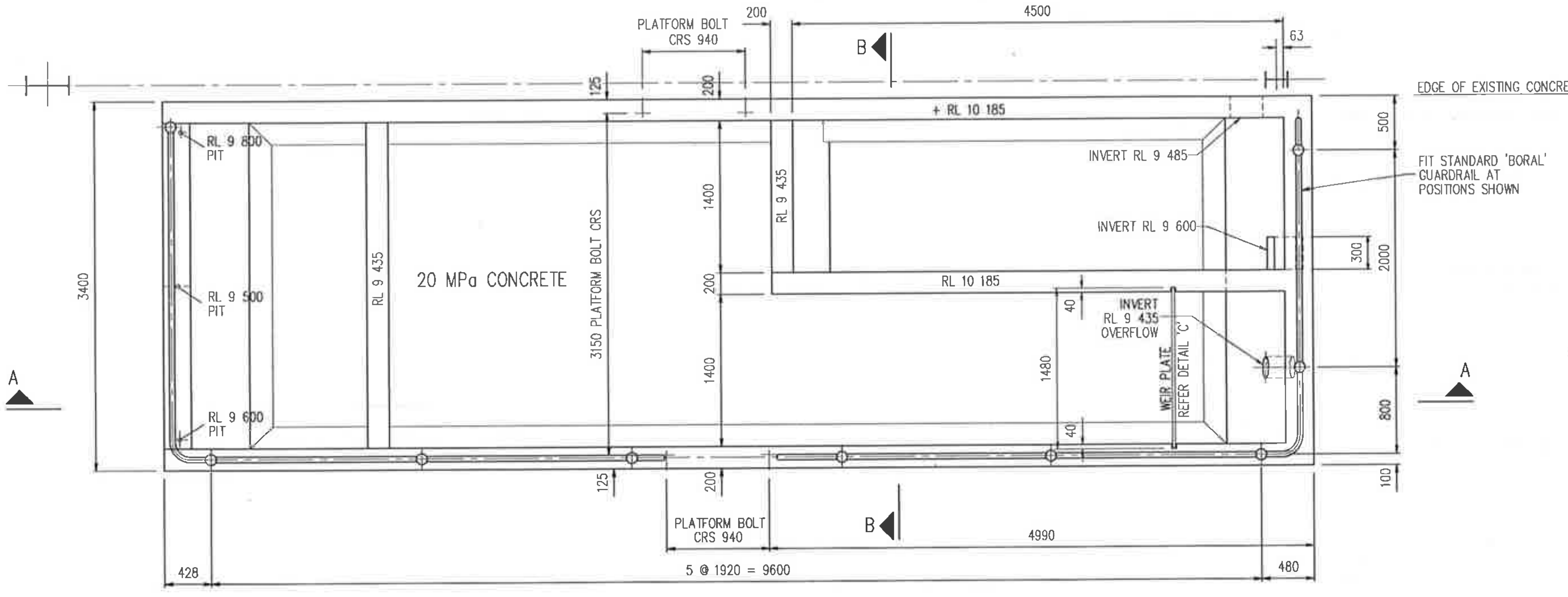
All licensed asbestos removal work is to be notified to WorkCover NSW at least 5 days prior to the work commencing.

The licence holder must notify WorkCover NSW in writing of any changes in licence or supervisor details within 14 days.

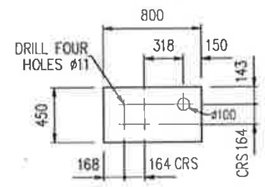
WORK SAFE HOME SAFE

REFERENCE DRAWINGS

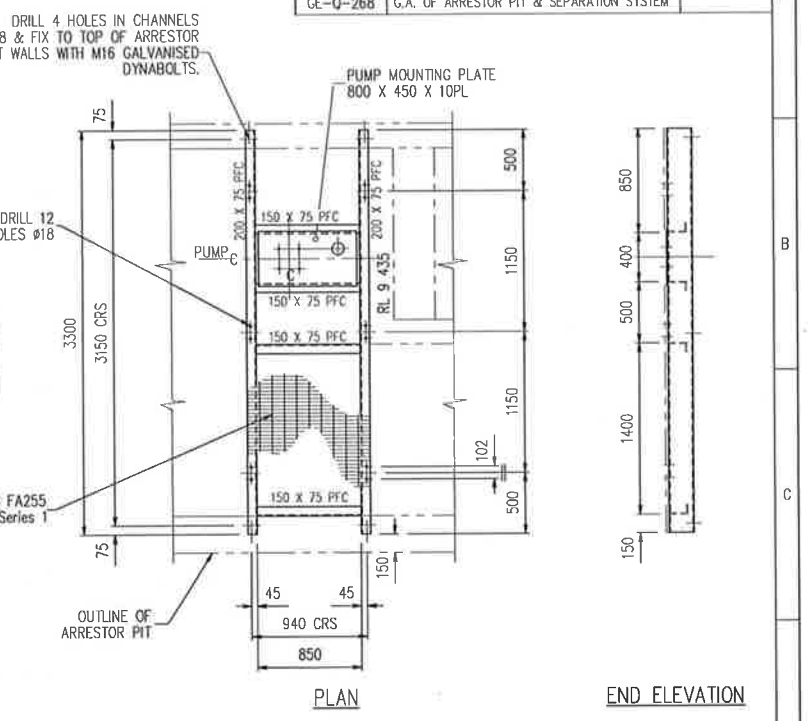
DRAWING No	DESCRIPTION	REMARKS
GE-Q-353	G.A. WORKSHOP DRAINAGE SHEET 1	
GE-Q-354	G.A. WORKSHOP DRAINAGE SHEET 2	
GE-Q-268	G.A. OF ARRESTOR PIT & SEPARATION SYSTEM	



PLAN



PUMP MOUNTING PLATE

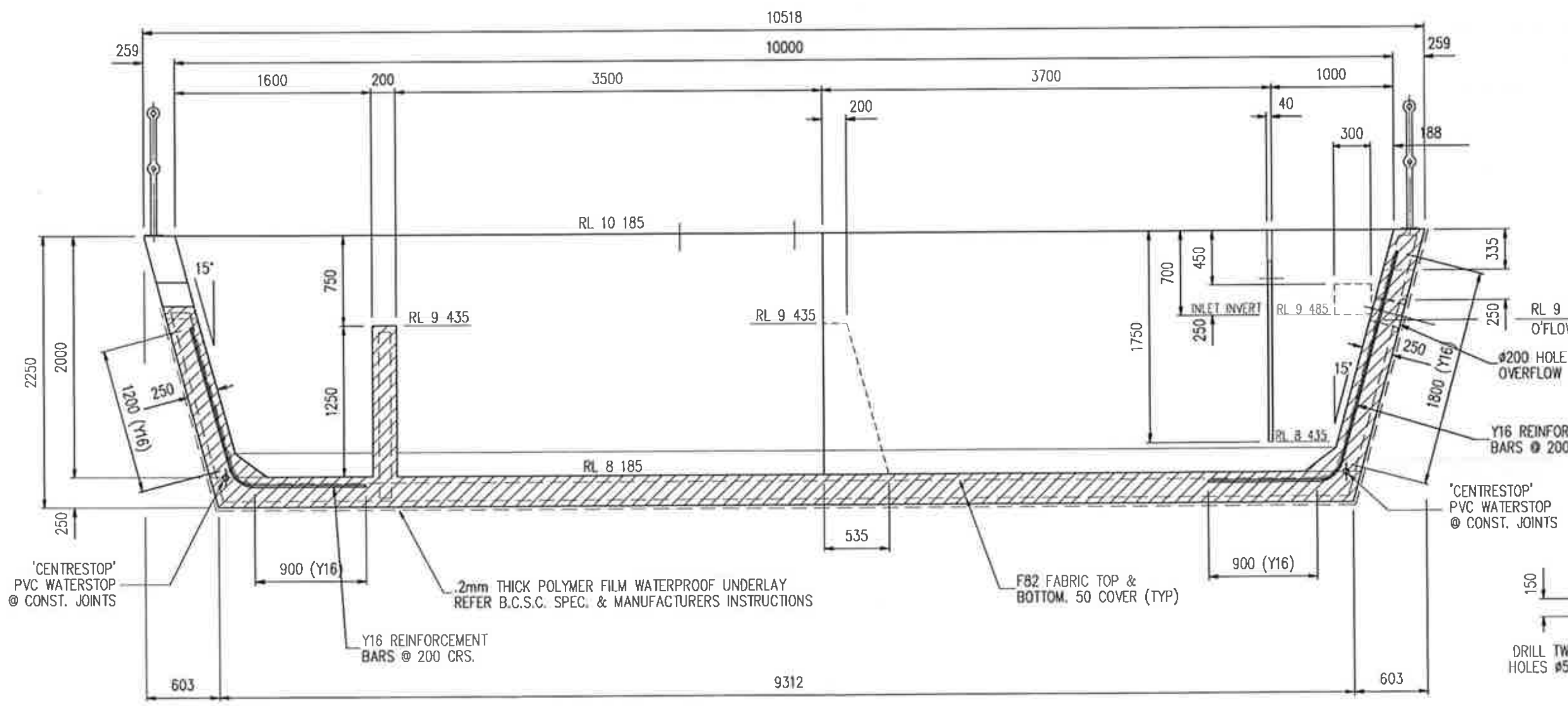


PLAN

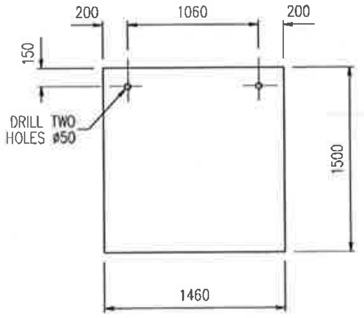
END ELEVATION

⑦ PUMP MOUNTING PLATFORM DETAILS

N.B PLATFORM TO BE HOT DIPPED GALVANISED

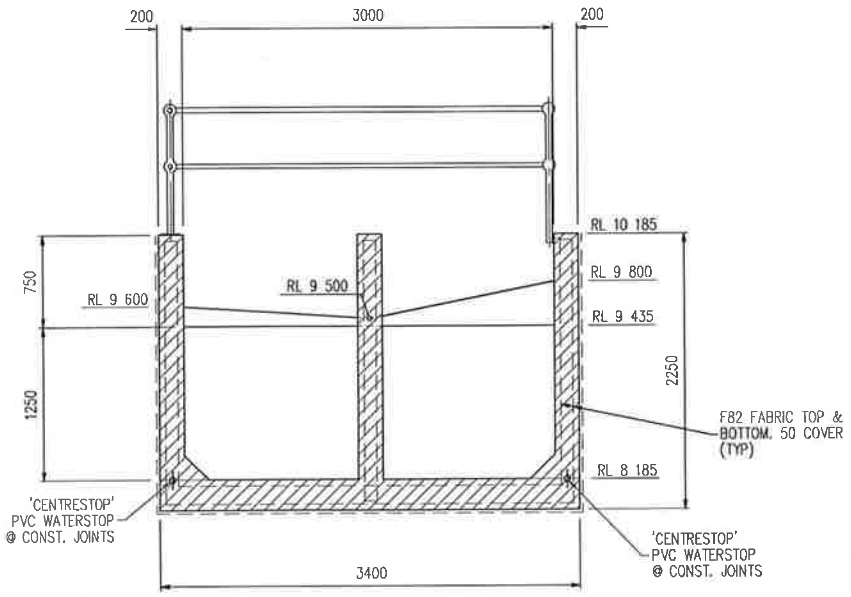


SECTION A-A
① ARRESTOR PIT DETAILS



DETAIL -'C'
WEIR PLATE

ONE REQUIRED AS DRAWN
MATERIAL - 10mm THICK MILD STEEL GALVANISED



SECTION B-B

THIS DRAWING TO BE READ IN CONJUNCTION WITH GE-Q-2

REV.	DATE	REVISION	
C	23-8-1995	DRAWING CHECKED & CORRECTED	L.P.M.
B	27-7-1995	DRAWING REVISED. ARRESTOR PIT WALL WAS 300mm WIDE	L.P.M.
A	19-5-1995	DRAWING REDRAWN	L.P.M.

ITEM No | QTY. | DESCRIPTION | DRAWING No

BLUE CIRCLE SOUTHERN
GROUP ENGINEERING

MARULAN WORKS

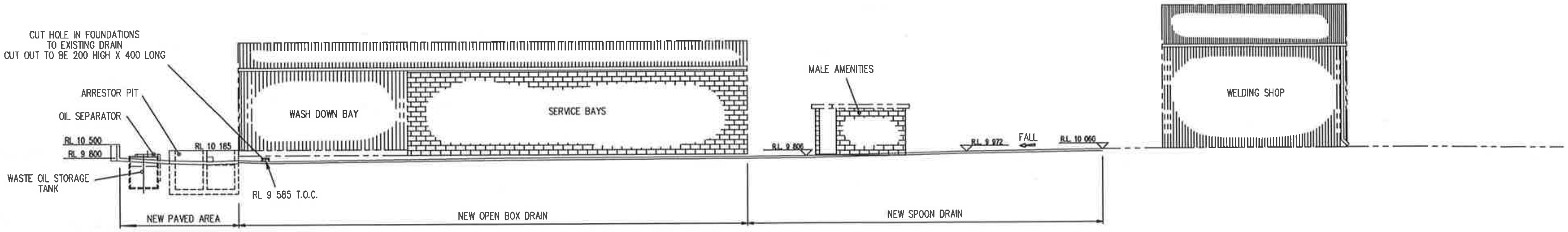
SCALE 1:25
DATE 19-5-95
DRAWN L. P. M^Clntosh.
CHECKED
APPROVED BY

PROJECT. WORKSHOP DRAINAGE

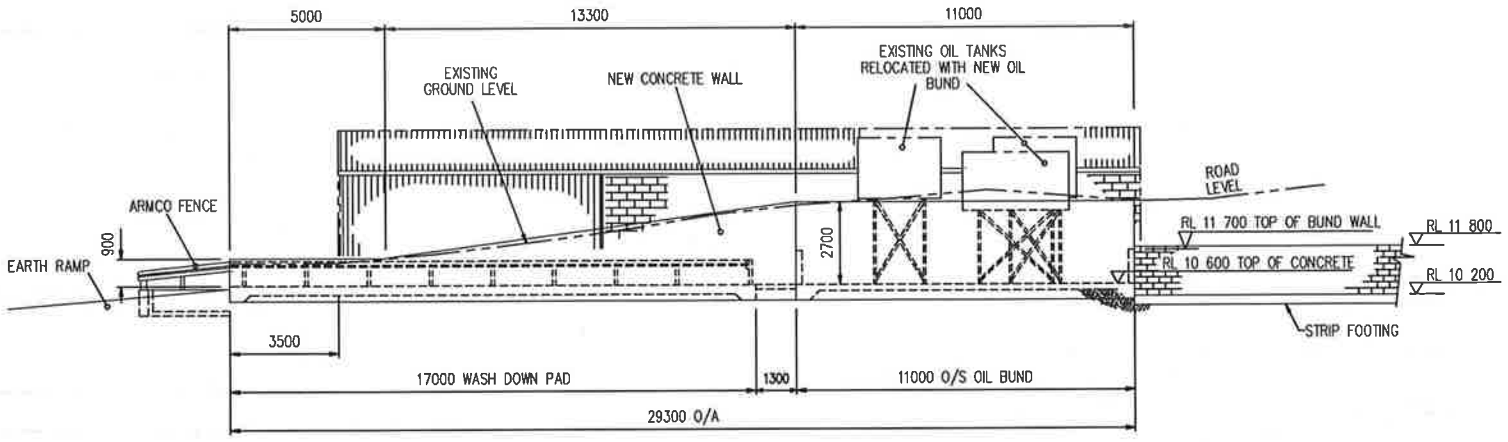
TITLE
ARRESTOR PIT AND PUMP
MOUNTING PLATFORM DETAILS

GROUP ENGINEERING No. GE-Q-271
WORKS No.
REV. C

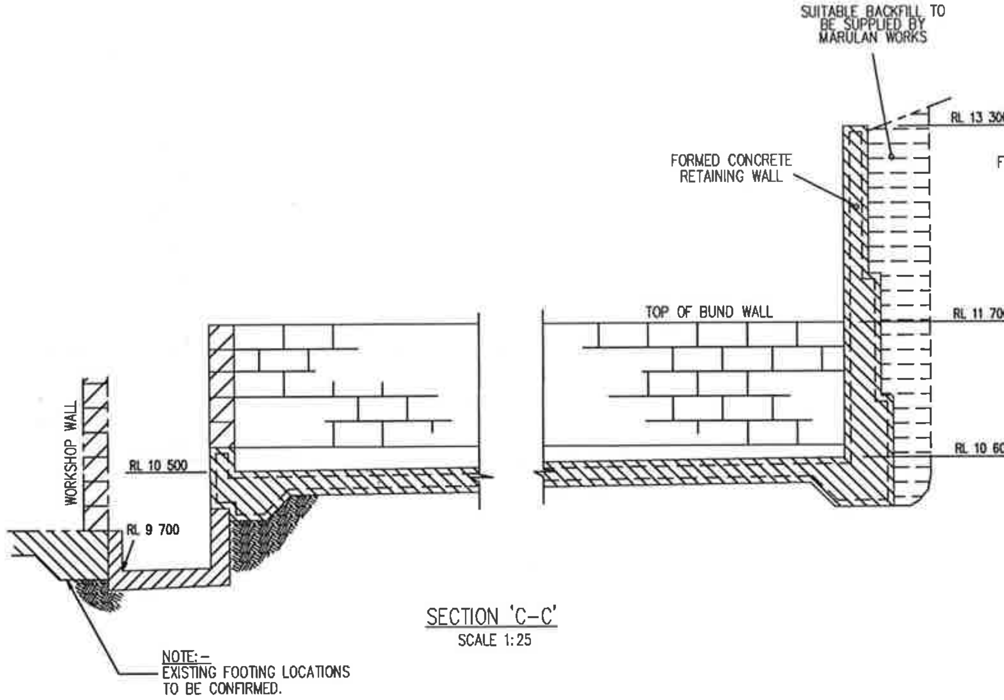
GE-Q-353 WORKSHOP DRAINAGE ARRANGEMENT - PLAN



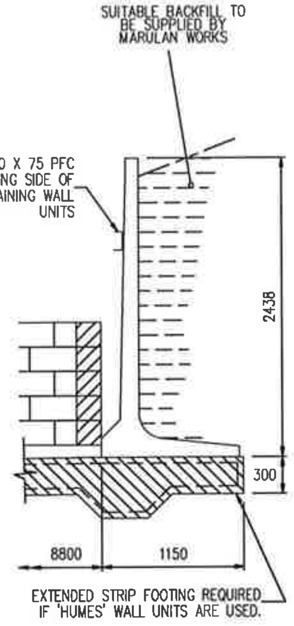
SECTION 'A-A'



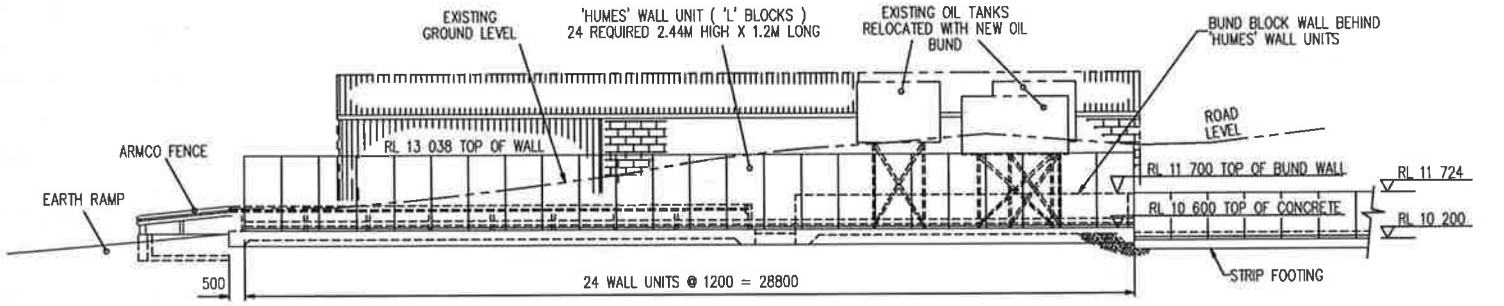
SECTION 'B-B'



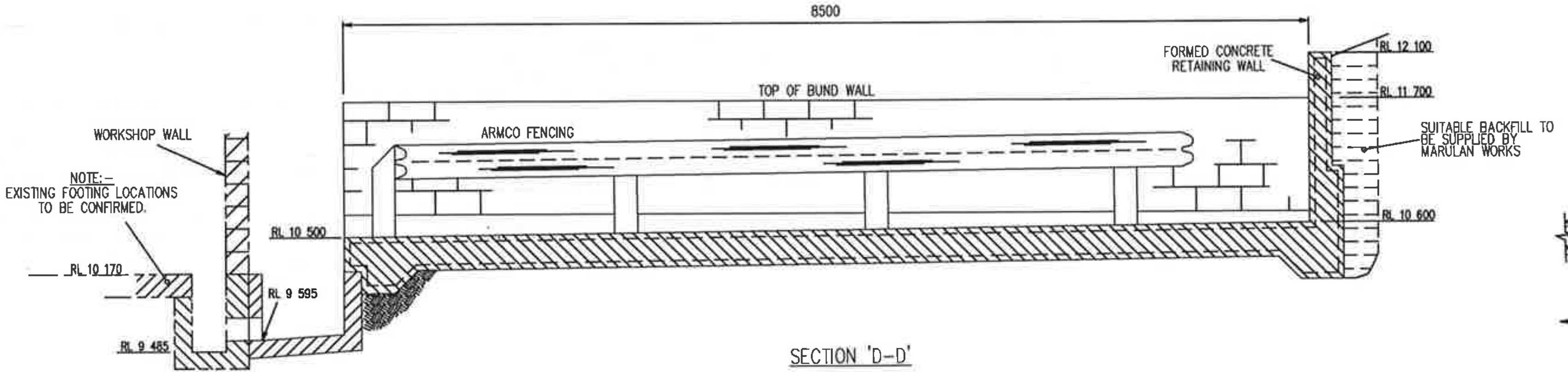
SECTION 'C-C'
SCALE 1:25



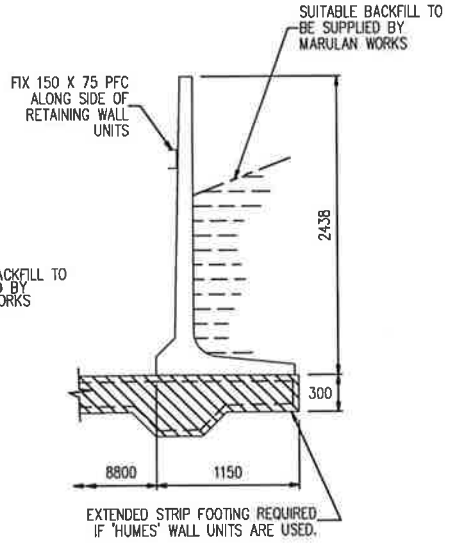
ALTERNATIVE SECTION 'C-C'



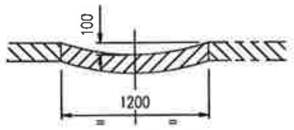
SECTION 'B-B'
ALTERNATIVE 'HUMES' RETAINING WALL UNITS



SECTION 'D-D'
SCALE 1:25



ALTERNATIVE SECTION 'D-D'



SECTION 'E-E'
TYPICAL SPOON DRAIN
SCALE 1:25

THIS DRAWING TO BE READ IN CONJUNCTION WITH GE-Q-353

D	24-8-1995	DRAWING CHECKED & CORRECTED.	L.P.M.
C	27-7-1995	DRAWING REVISED.	L.P.M.
	19-5-1995	DRAWING REVISED	L.P.M.
	16-8 1994	DRAWING CHECKED AND CORRECTED	S.R.P.

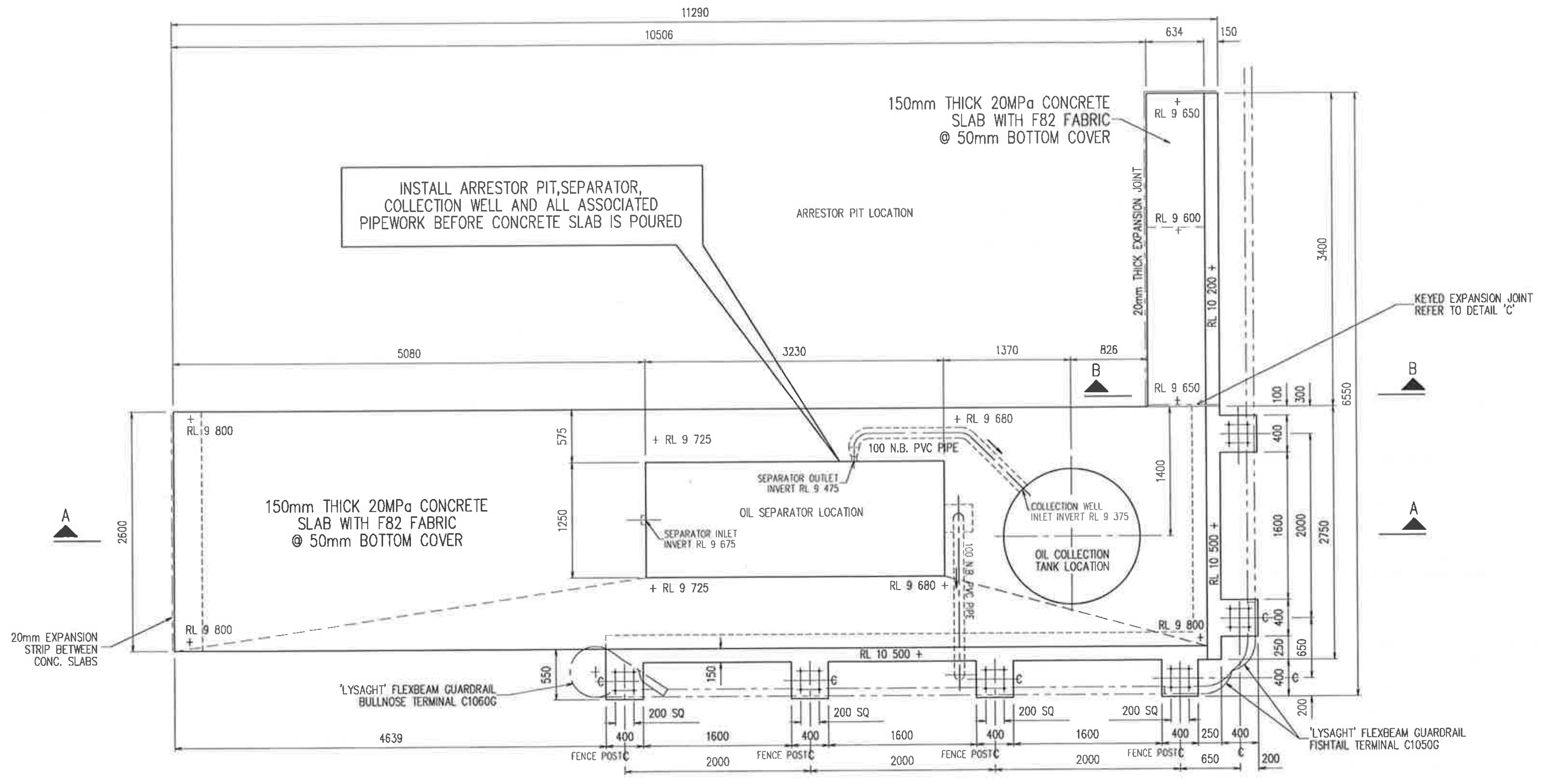
1:100 1:25
4 - 11 - 1992
S. R. Pilt

MARULAN WORKS
WORKSHOP DRAINAGE
WORKSHOP DRAINAGE AND ARRESTOR PIT
SECTIONS SHEET 2 OF 2

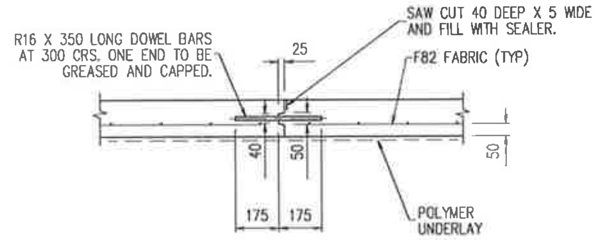
GE-Q-354 D

REFERENCE DRAWINGS

DRAWING No	DESCRIPTION	REMARKS
GE-Q-353	G.A WORKSHOP DRAINAGE - PLAN - SHEET 1	

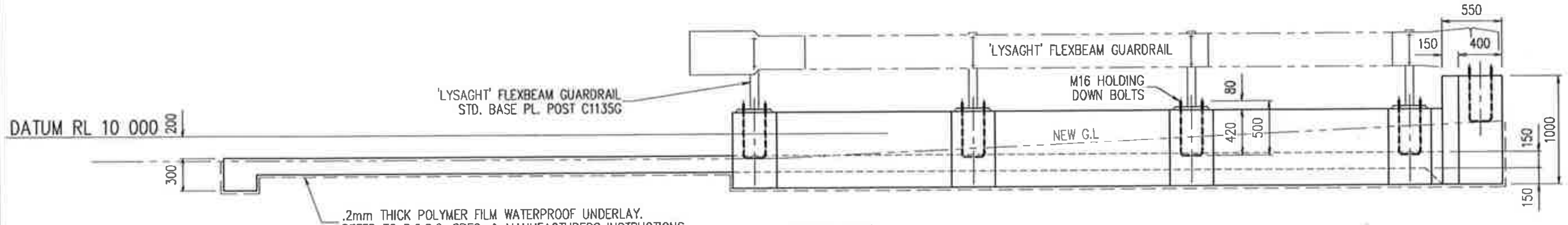


PLAN

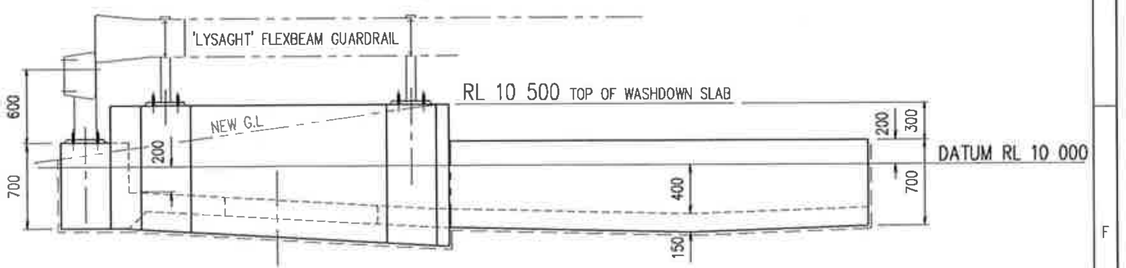


DETAIL 'C'

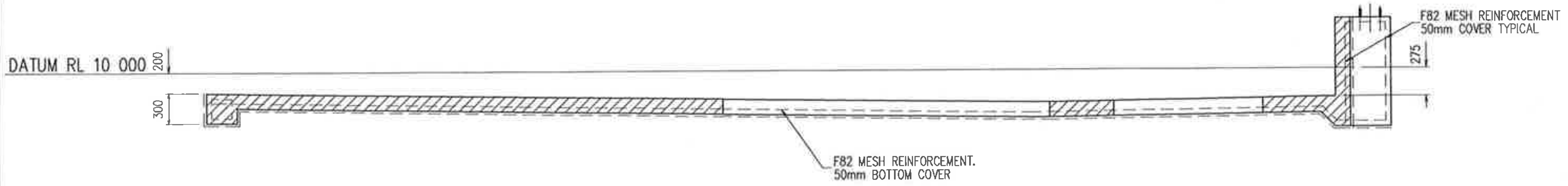
KEYED EXPANSION JOINT



ELEVATION

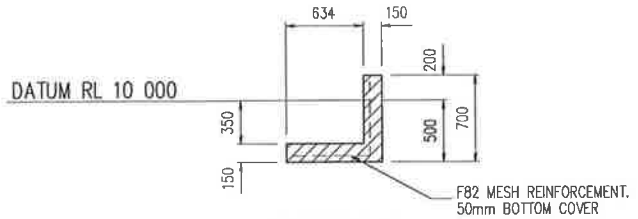


END ELEVATION



SECTION A–A

4/268 SEPARATOR SLAB



SECTION B–B

REV.	DATE	REVISION	
B	23-8-1995	DRAWING CHECKED & CORRECTED	L.P.M.
A	27-7-1995	DRAWING REVISED SLAB WIDENED	L.P.M.

ITEM No	QTY.	DESCRIPTION	DRAWING No

BLUE CIRCLE SOUTHERN
GROUP ENGINEERING

MARULAN WORKS

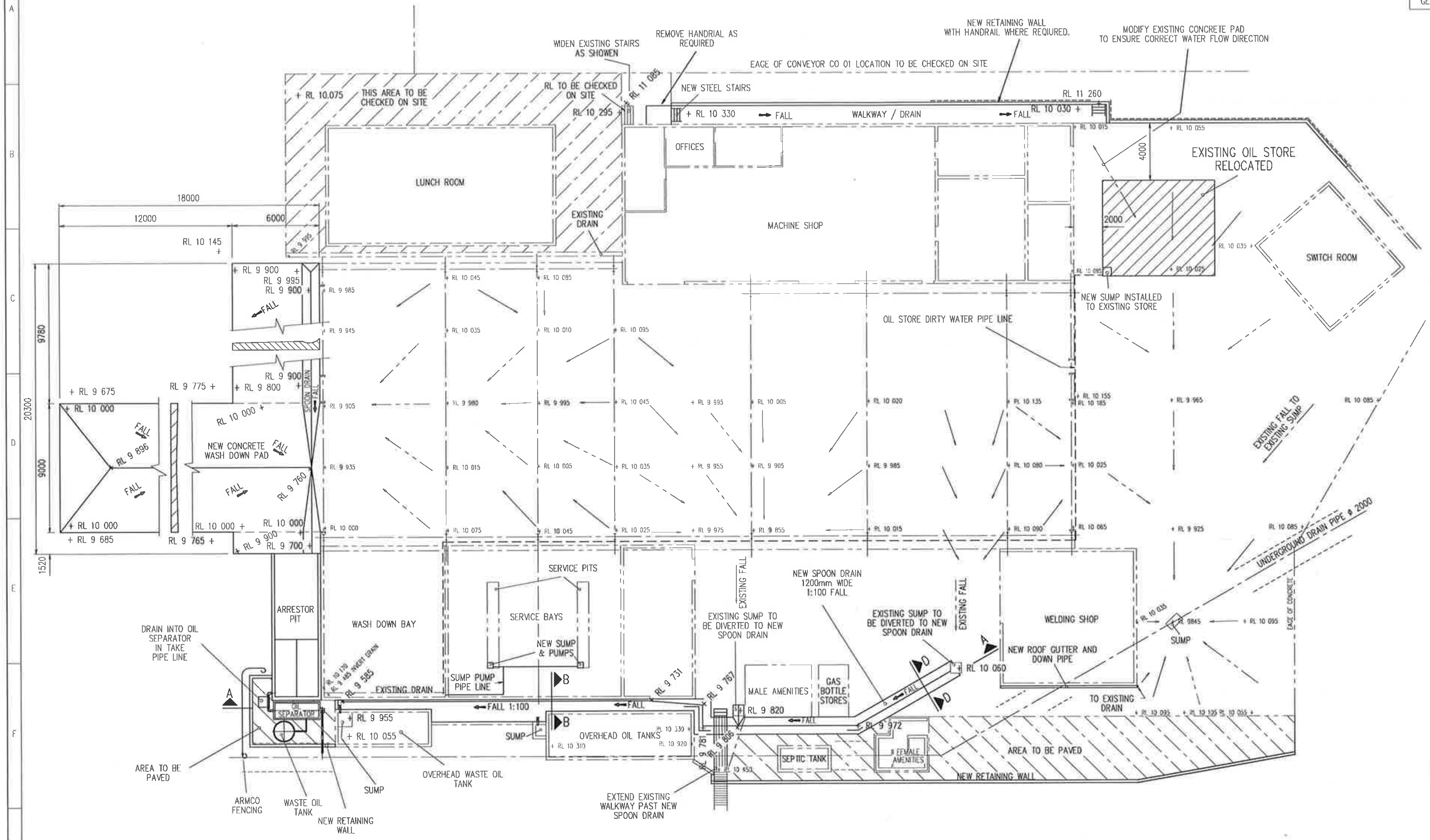
SCALE 1:12.5 1:25
DATE 5-7-95
DRAWN L. P. M^CIntosh.
CHECKED
APPROVED BY

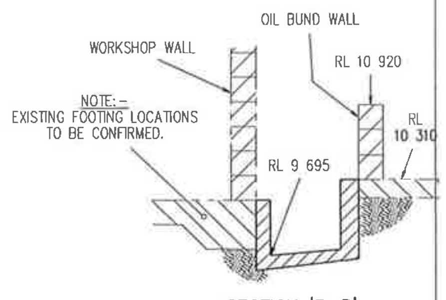
PROJECT WORKSHOP DRAINAGE

TITLE SEPARATOR & COLLECTION WELL CONCRETE SLAB DETAILS

GROUP ENGINEERING No. GE-Q-390
WORKS No.
REV. B

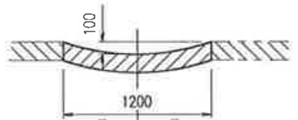
REFERENCE DRAWINGS		
DRAWING No	DESCRIPTION	REMARKS
GE-Q-23	ARRANGEMENT OF WORKSHOP EXTENSIONS	
GE-Q-268	OIL SEPARATION SYSTEM ARRANGEMENT	
GE-Q-271	OIL SEPARATION SYSTEM SECTION , D7L & ARR	



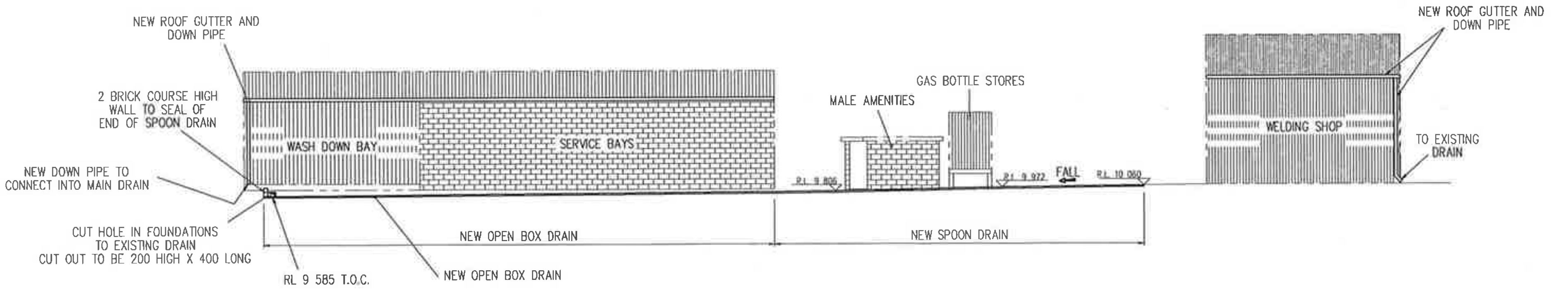


SECTION 'B-B'
OPEN BOX DRAIN
SCALE 1:25

NOTES:-
- CHECK AND CLEAN EXISTING GUTTERS.
- INSTALL NEW ROOF GUTTERS AND DOWN PIPES WHERE REQUIRED.
- ALL DOWN PIPES ARE TO BE CONNECTED INTO MAIN DRAIN.
- PAVE UNPAVED AREA AROUND FEMALE AMENITIES.
- ALL STORAGE BUNDS TO BE DESIGNED TO AS 1940 cl 4.8
- EXISTING OIL STORE TO BE TOTALLY REMOVED AND NEW OIL STORE TO BE INSTALLED.
- NEW RETAINING WALL TO BE INSTALLED AND DRAIN INTO MAIN DRAIN.
- ALL SURFACE WATER TO BE DIVERTED IN TO MAIN DRAIN WHERE POSSIBLE.
- NEW OIL STORE ROOF TO HAVE GUTTERS AND DOWN PIPES IN TO MAIN DRAIN.
- AREA AROUND NEW WASHDOWN PAD IS TO HAVE A FALL AWAY FROM THE PAD TO THE SATISFACTION OF THE PROJECT ENGINEER.



SECTION 'D-D'
TYPICAL SPOON DRAIN
SCALE 1:25



SECTION 'A-A'

ITEM No	QTY	DESCRIPTION	DRAWING No

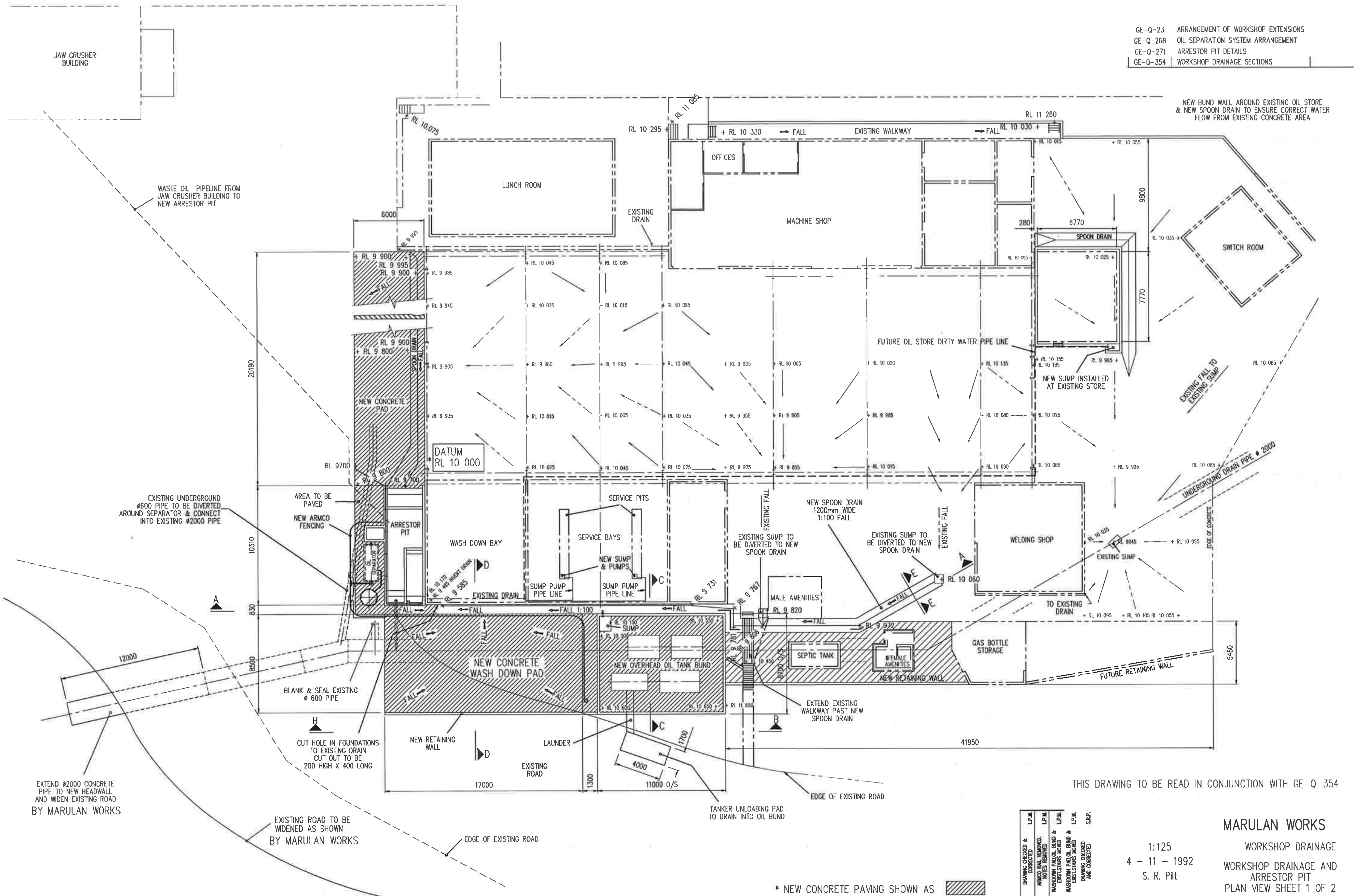
BLUE CIRCLE SOUTHERN
GROUP ENGINEERING

MARULAN WORKS

SCALE	1:125 1:25	PROJECT	WORKSHOP DRAINAGE
DATE	1-9-1992	TITLE	WORKSHOP DRAINAGE, ARRESTOR PIT AND WASHDOWN PAD PLAN VIEW AND SECTIONS.
DRAWN	S. R. Pilt		
CHECKED			
APPROVED BY		GROUP ENGINEERING No	GE-Q-351
		WORKS No.	REV. A

REV.	DATE	REVISION
A	7-9-1992	OIL STORE RELOCATED DRN CHECKED & CORRECTED S.R.P.

GE-Q-23	ARRANGEMENT OF WORKSHOP EXTENSIONS
GE-Q-268	OIL SEPARATION SYSTEM ARRANGEMENT
GE-Q-271	ARRESTOR PIT DETAILS
GE-Q-354	WORKSHOP DRAINAGE SECTIONS



THIS DRAWING TO BE READ IN CONJUNCTION WITH GE-Q-354

* NEW CONCRETE PAVING SHOWN AS ▨

E	23-8-1995	DRAWING CHECKED & CORRECTED	L.P.M.
D	26-7-1995	ARMCO RAIL REMOVED, NOTES REMOVED	L.P.M.
C	27-3-1995	WASHDOWN PAD,OIL BUND & EXIST.STAIRS MOVED	L.P.M.
	1-3-1995	WASHDOWN PAD,OIL BUND & EXIST.STAIRS MOVED	L.P.M.
	16-8-1994	DRAWING CHECKED AND CORRECTED	S.R.P.

1:125
4 - 11 - 1992
S. R. Pilt

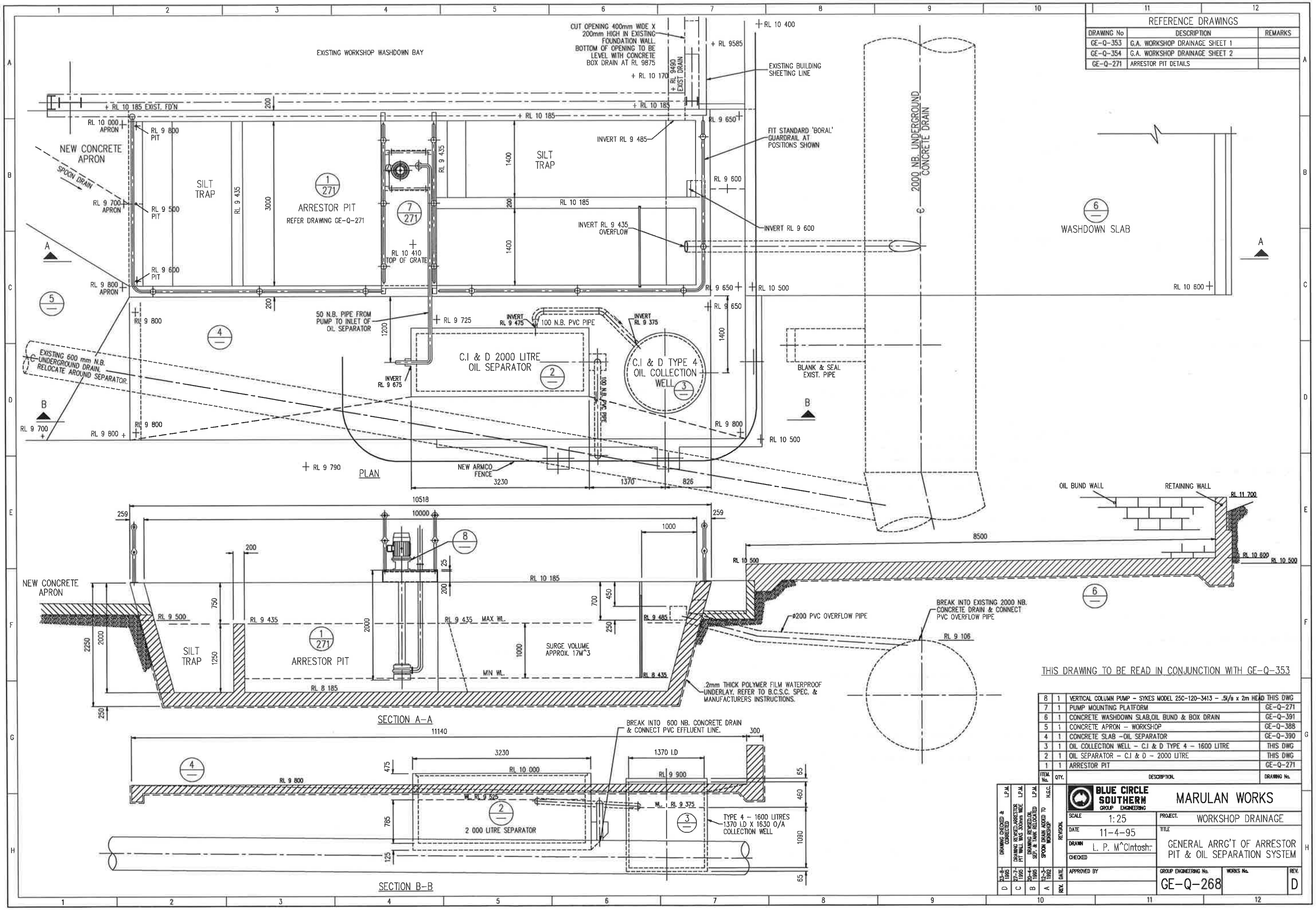
MARULAN WORKS
WORKSHOP DRAINAGE
WORKSHOP DRAINAGE AND
ARRESTOR PIT
PLAN VIEW SHEET 1 OF 2

GE-Q-353

E

PLOTTED ON
<dd-mmm-yyyy>

REFERENCE DRAWINGS		
DRAWING No	DESCRIPTION	REMARKS
GE-Q-353	G.A. WORKSHOP DRAINAGE SHEET 1	
GE-Q-354	G.A. WORKSHOP DRAINAGE SHEET 2	
GE-Q-271	ARRESTOR PIT DETAILS	



THIS DRAWING TO BE READ IN CONJUNCTION WITH GE-Q-353

ITEM No.	QTY.	DESCRIPTION.	DRAWING No.
8	1	VERTICAL COLUMN PUMP - SYKES MODEL 25C-120-3413 - .5l/s x 2m HEAD	THIS DWG
7	1	PUMP MOUNTING PLATFORM	GE-Q-271
6	1	CONCRETE WASHDOWN SLAB,OIL BUND & BOX DRAIN	GE-Q-391
5	1	CONCRETE APRON - WORKSHOP	GE-Q-388
4	1	CONCRETE SLAB -OIL SEPARATOR	GE-Q-390
3	1	OIL COLLECTION WELL - C.I & D TYPE 4 - 1600 LITRE	THIS DWG
2	1	OIL SEPARATOR - C.I & D - 2000 LITRE	THIS DWG
1	1	ARRESTOR PIT	GE-Q-271

REV.	DATE.	REVISION.	
D	23-8-1995	DRAWING CHECKED & CORRECTED	L.P.M.
C	27-7-1995	DRAWING REVISED,ARRESTOR PIT WALL WAS 300mm WIDE	L.P.M.
B	20-4-1995	DRAWING REVISED,OIL SEP. & TANK RELOCATED	L.P.M.
A	12-3-1992	SPOON DRAIN ADDED TO WORKSHOP	H.G.C.

BLUE CIRCLE SOUTHERN
GROUP ENGINEERING

MARULAN WORKS

SCALE 1:25
DATE 11-4-95
DRAWN L. P. M^Clntosh.
CHECKED
APPROVED BY

PROJECT. WORKSHOP DRAINAGE
TITLE GENERAL ARRG'T OF ARRESTOR PIT & OIL SEPARATION SYSTEM

GROUP ENGINEERING No. GE-Q-268
WORKS No.
REV. D

Appendix C - Analytical Results Summary

ZOIC Environmental Pty Ltd

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*	Asbestos	Inorganics	Metals							
								Asbestos (Guidelines not included in table)	Moisture	Lead	Mercury (guidelines mercury - inorganic)	Nickel	Arsenic	Cadmium	Chromium (III+VI) (guidelines chromium VI and III)	Copper	Zinc
								g/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.1	1	5	0.1	2	5	1	2	5	5
NEPM 2013 EIL - Commercial/Industrial								-	-	**1900**	-	**291**	**160**	-	**317**	**280**	**702**
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	1500	730	6000	3000	900	3600	240000	400000
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-
						-	sand										
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	2.5	6	<0.1	6	<5	<1	4	<5	16
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	12.9	8	<0.1	7	7	<1	27	25	45
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	12.3	57	<0.1	7	<5	<1	6	29	87
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	12.2	55	<0.1	8	<5	<1	6	29	84
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	11	30	<0.1	7	6	0.7	6	17	69
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	7.8	10	<0.1	8	15	<1	25	17	62
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	2.7	<5	<0.1	7	<5	<1	6	6	32
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	11.2	<5	<0.1	22	<5	<1	23	21	35
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	-	1.6	6	<0.1	7	<5	<1	5	7	21
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	1.4	5	<0.1	4	<5	<1	4	<5	15
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	5.2	<5	<0.1	7	6	<1	4	8	18
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	-	6.9	7	<0.1	13	6	<1	13	9	32
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	4.1	<5	<0.1	3	<5	<1	<2	<5	10
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	4.6	5	<0.1	14	<5	<1	9	7	30
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	9.2	7	<0.1	6	7	<1	5	<5	18
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	9.9	7	<0.1	10	5	<1	9	6	24
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	8.9	8	<0.1	7	6	<1	8	7	26
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	6.6	10	<0.1	7	5	<1	7	7	24
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	6.7	9	<0.1	7	6	<0.4	7	9	29
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	12.1	8	<0.1	10	5	<1	10	6	25
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	7.4	6	<0.1	5	<5	<1	9	6	23
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	5.6	<5	<0.1	6	<5	<1	16	18	44
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	7.8	6	<0.1	6	<5	<1	15	13	35
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	3.6	10	<0.1	8	9	<1	23	20	49
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	ND	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAG	ASB01 FR	-	15/01/2015	Fragment	-	sand	Yes	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	ND	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	ND	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	Yes	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAG	ASB05 FR	-	15/01/2015	Fragment	-	sand	Yes	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	ND	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	ND	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAG	ASB08 FR	-	15/01/2015	Fragment	-	sand	ND	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAG	ASB09 FR	-	15/01/2015	Fragment	-	sand	Yes	-	-	-	-	-	-	-	-	-
						-	sand										
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample Code	BTEX					TRH NEPM 2013						MAH			
	Benzene	Toluene	Ethylbenzene	Xylene (m & p) (guideline xylene total)	Xylene (o) (guideline xylene total)	C6-C10	>C10-C16	>C16-C34	>C34-C40	F1 (C6-C10 less BTEX)	F2 (>C10-C16 less Naphthalene)	Styrene	n-propylbenzene	n-butylbenzene	1,3,5-trimethylbenzene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.2	0.5	0.5	0.5	0.5	10	50	100	100	10	50	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial	75	135	165	180	180	-	170	1700	3300	215	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse	-	-	-	-	-	700	1000	3500	10000	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m	3	NL	NL	230	230	-	-	-	-	260	NL	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m	3	NL	NL	NL	NL	-	-	-	-	370	NL	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m	3	NL	NL	NL	NL	-	-	-	-	630	NL	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m	3	NL	NL	NL	NL	-	-	-	-	NL	NL	-	-	-	-
ES1501013026	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013031	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013035	0.4	<0.5	<0.5	<0.5	<0.5	19	<50	210	140	19	<50	-	-	-	-
ES1501013036	0.5	<0.5	<0.5	<0.5	<0.5	32	<50	390	240	32	<50	-	-	-	-
122227-2	<0.2	<0.5	<1	<2	<1	<25	<50	350	310	<25	<50	-	-	-	-
ES1501013037	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013002	<0.2	<0.5	<0.5	<0.5	<0.5	<10	330	3060	1400	<10	330	<0.5	<0.5	<0.5	<0.5
ES1501013004	<0.2	<0.5	<0.5	<0.5	<0.5	<10	350	3290	1590	<10	350	<0.5	<0.5	<0.5	<0.5
ES1501013005	<0.2	<0.5	<0.5	<0.5	<0.5	<10	80	570	260	<10	80	<0.5	<0.5	<0.5	<0.5
ES1501013007	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	<0.5	<0.5	<0.5	<0.5
ES1501013008	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	300	170	<10	<50	<0.5	<0.5	<0.5	<0.5
ES1501013009	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	<0.5	<0.5	<0.5	<0.5
ES1501013010	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	<0.5	<0.5	<0.5	<0.5
ES1501013011	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	<0.5	<0.5	<0.5	<0.5
ES1501013012	<0.2	<0.5	<0.5	<0.5	<0.5	<10	50	1030	230	<10	50	-	-	-	-
ES1501013013	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013016	<0.2	<0.5	<0.5	<0.5	<0.5	<10	1090	7300	1410	<10	1090	-	-	-	-
ES1501013017	<0.2	<0.5	<0.5	<0.5	<0.5	<10	1170	8500	1860	<10	1170	-	-	-	-
122227-1	<0.2	<0.5	<1	<2	<1	<25	1100	8200	1700	<25	1100	-	-	-	-
ES1501013018	<0.2	<0.5	<0.5	<0.5	<0.5	<10	150	1070	250	<10	150	-	-	-	-
ES1501013019	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	1300	480	<10	<50	-	-	-	-
ES1501013021	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013022	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013023	<0.2	<0.5	<0.5	<0.5	<0.5	<10	<50	<100	<100	<10	<50	-	-	-	-
ES1501013038	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

	Asbestos	Moisture	Lead	Mercury	Nickel	Arsenic	Cadmium	Chromium	Copper	Zinc	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	C6-C10	>C10-C16	>C16-C34	>C34-C40	F1	F2	Styrene	n-propylbenzene	n-butylbenzene	1,3,5-trimethylbenzene
Number of Results	0	24	24	24	24	24	24	24	24	24	26	26	26	26	26	26	24	24	24	26	24	8	8	8	8
Number of Detects	0	24	19	0	24	12	1	23	20	24	2	2	2	2	2	4	8	13	13	4	8	0	0	0	0
Maximum Detect	-	12.9	57	-	22	15	0.7	27	29	87	0.5	5.5	0.9	5	2.1	32	1170	8500	1860	32	1170	-	-	-	-
Maximum Concentration (including non-detects)	0	12.9	57	0.1	22	15	1	27	29	87	0.5	5.5	1	5	2.1	32	1170	8500	1860	32	1170	0.5	0.5	0.5	0.5
Average Concentration (including non-detects)	-	7.3	11.9	0.1	8.0	6.0	1.0	10.4	12.0	35.5	0.2	0.9	0.6	1.0	0.7	13.8	213.3	1,527.9	464.2	12.8	213.3	0.5	0.5	0.5	0.5
Median Concentration (including non-detects)	-	7.15	7	0.1	7	5	1	7.5	7.5	29.5	0.2	0.5	0.5	0.5	0.5	10	50	255	155	10	50	0.5	0.5	0.5	0.5
Standard Deviation (including non-detects)	-	3.5	14.2	0.0	3.8	2.1	0.1	7.2	7.8	20.6	0.1	1.3	0.2	1.2	0.4	7.3	352.2	2,595.5	590.9	5.8	352.2	0.0	0.0	0.0	0.0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

ZOIC Environmental Pty Ltd

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

													PAH											
								sec-butylbenzene	1,2,4-trimethylbenzene	tert-butylbenzene	Isopropylbenzene	p-isopropyltoluene	Anthracene	Pyrene	Benzo(g,h,i)perylene	Indeno(1,2,3-c,d)pyrene	Benzo[b+j]fluoranthene	Fluoranthene	Benzo(k)fluoranthene	Acenaphthylene	Benzo(b,j,k)fluoranthene	Chrysene	Benzo(a)pyrene	Dibenz(a,h)anthracene
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																	
						-	sand																	
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	-	<0.1	-	<0.1	<0.2	<0.1	<0.05	<0.1
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<1	<0.5	<0.5	<0.5
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	2.3	<0.5	<0.5	<0.5	1.2	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	3.1	<0.5	<0.5	<0.5	1.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	0.7	3.3	0.3	0.2	-	0.7	-	0.3	0.6	0.9	0.66	0.1
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAG	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAG	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAG	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAG	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	8	8	8	8	8	24	24	24	24	14	24	14	24	10	24	24	24
Number of Detects	0	0	0	0	0	1	3	1	1	0	3	0	1	1	1	1	1
Maximum Detect	-	-	-	-	-	0.7	3.3	0.3	0.2	-	1.5	-	0.3	0.6	0.9	0.66	0.1
Maximum Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.7	3.3	0.5	0.5	0.5	1.5	0.5	0.5	1	0.9	0.66	0.5
Average Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.5	0.5	0.9	0.5	0.5	0.5
Median Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5
Standard Deviation (including non-detects)	0.0	0.0	0.0	0.0	0.0	0.1	0.8	0.1	0.1	0.0	0.3	0.0	0.1	0.3	0.1	0.1	0.1
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

	2-(acetylamino) fluorene	3-methylcholanthrene	Benz(a)anthracene	7,12-dimethylbenz(a)anthracene	Acenaphthene	Phenanthrene	Fluorene	Naphthalene	2-methylnaphthalene	2-chloronaphthalene	Carcinogenic PAHs as B(a)P TEQ	Total PAHs	Phenolics 2,4-dimethylphenol	3-&4-methylphenol	Phenol	2,4-dichlorophenol	4-chloro-3-methylphenol	2,6-dichlorophenol	Pentachlorophenol	2,4,6-trichlorophenol	2-nitrophenol	2-methylphenol	2-chlorophenol	2,4,5-trichlorophenol
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial	-	-	-	-	-	-	-	370	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial	-	-	-	-	-	-	-	-	-	-	40	4000	-	-	240000	-	-	-	660	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m	-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m	-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m	-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m	-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*	2-(acetylamino) fluorene	3-methylcholanthrene	Benz(a)anthracene	7,12-dimethylbenz(a)anthracene	Acenaphthene	Phenanthrene	Fluorene	Naphthalene	2-methylnaphthalene	2-chloronaphthalene	Carcinogenic PAHs as B(a)P TEQ	Total PAHs	2,4-dimethylphenol	3-&4-methylphenol	Phenol	2,4-dichlorophenol	4-chloro-3-methylphenol	2,6-dichlorophenol	Pentachlorophenol	2,4,6-trichlorophenol	2-nitrophenol	2-methylphenol	2-chlorophenol	2,4,5-trichlorophenol
						-	sand																								
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	<0.1	-	<0.1	<0.1	<0.1	<1	-	-	<0.5	0	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	6.8	<0.5	<1	-	-	<0.5	11.1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	6.3	<0.5	0.9	-	-	<0.5	11.8	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	0.8	-	1.2	6	1.7	<1	-	-	0.9	18	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	<0.5	-	<0.5	1.1	<0.5	<0.5	-	-	<0.5	1.1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAG	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAG	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAG	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAG	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																								
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

	2-(acetylamino) fluorene	3-methylcholanthrene	Benz(a)anthracene	7,12-dimethylbenz(a)anthracene	Acenaphthene	Phenanthrene	Fluorene	Naphthalene	2-methylnaphthalene	2-chloronaphthalene	Carcinogenic PAHs as B(a)P TEQ	Total PAHs	2,4-dimethylphenol	3-&4-methylphenol	Phenol	2,4-dichlorophenol	4-chloro-3-methylphenol	2,6-dichlorophenol	Pentachlorophenol	2,4,6-trichlorophenol	2-nitrophenol	2-methylphenol	2-chlorophenol	2,4,5-trichlorophenol
Number of Results	8	8	24	8	24	24	24	26	8	8	24	24	17	17	17	17	17	17	17	17	17	17	17	17
Number of Detects	0	0	1	0	1	4	1	1	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0
Maximum Detect	-	-	0.8	-	1.2	6.8	1.7	0.9	-	-	0.9	18	-	-	-	-	-	-	-	-	-	-	-	-
Maximum Concentration (including non-detects)	0.5	0.5	0.8	0.5	1.2	6.8	1.7	1	0.5	0.5	0.9	18	0.5	1	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5	0.5
Average Concentration (including non-detects)	0.5	0.5	0.495833	0.5	0.5125	1.241667	0.533333	0.784615	0.5	0.5	0.516667	2.145833	0.5	0.764706	0.5	0.5	0.5	0.5	1.529412	0.5	0.5	0.5	0.5	0.5
Median Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5	0.5
Standard Deviation (including non-detects)	0.0	0	0.101977	0	0.164095	1.946132	0.256038	0.244465	0	0	0.079931	4.480976	0	0.249567	0	0	0	0	0.499134	0	0	0	0	0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

Appendix
Soil Results Summary

14071, Marulan Limestone Mine Continued Operations, Marulan NSW
3/02/2015

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

								Organophosphorous Pesticides							Organochlorine Pesticides																Pesticides		
								Chlorpyrifos	Diazinon	Prothiofos	Chlorfenvinphos	Chlorpyrifos-methyl (guideline chlorpyrifos)	Ethion	Dimethoate	Heptachlor epoxide	Endosulfan sulphate	Hexachlorobenzene	Aldrin (guideline aldrin+dieldrin)	a-BHC	b-BHC	d-BHC	Endosulfan II (guideline endosulfan)	DDT (guideline DDT+DDE+DDD)	g-BHC (Lindane)	Dieldrin (guideline aldrin+dieldrin)	Endrin	DDD (guideline DDT+DDE+DDD)	DDE (guideline DDT+DDE+DDD)	Heptachlor	Endosulfan I (guideline endosulfan)	Malathion	Pirimphos-ethyl	Chlorobenzilate
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**640**	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								2000	-	-	-	2000	-	-	-	-	80	45	-	-	-	2000	3600	-	45	100	3600	-	50	2000	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																										
						-	sand																										
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAGI	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAGI	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAGI	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAGI	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																										
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum Detect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Average Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Median Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Standard Deviation (including non-detects)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

										Herbicide	Surfactan	Solvents						Chlorinated Hydrocarbons															
								Fenthion	Dichlorvos	Pronamide	Anionic Surfactants as MBAS	Vinyl acetate	4-Methyl-2-pentanone	2-hexanone (MBK)	Carbon disulfide	Isophorone	Methyl Ethyl Ketone	cis-1,3-dichloropropene	trans-1,3-dichloropropene	1,2-dichloroethane	Tetrachloroethene	cis-1,2-dichloroethene	trans-1,2-dichloroethene	Carbon tetrachloride	1,1,1,2-tetrachloroethane	Chloroform	Hexachloroethane	1,1,1-trichloroethane	Chloromethane	Chloroethane	Vinyl chloride	1,1-dichloroethane	1,1-dichloroethene
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	1	5	5	5	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	5	5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																										
						-	sand																										
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	-	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	-	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	-	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	-	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<1	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<200	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<1	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<100	<5	<5	<5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<0.5	<0.5
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAG	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAG	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAG	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAG	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																										
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	8	8	8	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum Detect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum Concentration (including non-detects)	0.5	0.5	0.5	200	5	5	5	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	5	5	0.5	0.5
Average Concentration (including non-detects)	0.5	0.5	0.5	75.5	5	5	5	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	5	5	0.5	0.5
Median Concentration (including non-detects)	0.5	0.5	0.5	50.5	5	5	5	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	5	5	0.5	0.5
Standard Deviation (including non-detects)	0	0	0	82.46363	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

														Halogenated Hydrocarbons									Halogenated Benzenes						
								Hexachlorocyclopentadiene	1,1,2-trichloroethane	Trichloroethene	1,1,2,2-tetrachloroethane	Hexachlorobutadiene	1,2,3-trichloropropane	1,2-dibromoethane	Chlorodibromomethane	Bromomethane	Iodomethane	Dibromomethane	Bromoform	Bromodichloromethane	Trichlorofluoromethane	Dichlorodifluoromethane	1,4-dichlorobenzene	Chlorobenzene	1,2,4-trichlorobenzene	1,3-dichlorobenzene	Pentachlorobenzene	1,2,3-trichlorobenzene	1,2-dichlorobenzene
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								2.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	0.5	0.5	0.5	0.5	5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																						
						-	sand																						
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAG	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAG	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAG	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAG	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																						
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum Detect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum Concentration (including non-detects)	2.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	0.5	0.5	0.5	0.5	5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Average Concentration (including non-detects)	2.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	0.5	0.5	0.5	0.5	5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Median Concentration (including non-detects)	2.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	0.5	0.5	0.5	0.5	5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Standard Deviation (including non-detects)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

								VOCs											SVOCs														
								4-chlorotoluene	Bromobenzene	trans-1,4-Dichloro-2-butene	1,3-dichloropropane	cis-1,4-Dichloro-2-butene	1,1-dichloropropene	2,2-dichloropropane	Pentachloroethane	1,2-dichloropropane	2-chlorotoluene	1,2-dibromo-3-chloropropane	N-nitrosopiperidine	4-bromophenyl phenyl ether	Azobenzene	Bis(2-chloroethyl)ether	Bis(2-chloroethoxy) methane	Bis(2-ethylhexyl) phthalate	Di-n-octyl phthalate	Dimethyl phthalate	Dibenzofuran	Hexachloropropene	4-Nitroquinoline-N-oxide	N-nitrosomorpholine	4-(dimethylamino) azobenzene	Phenacetin	4-chlorophenyl phenyl ether
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																										
						-	sand																										
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAGI	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAGI	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAGI	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAGI	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																										
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum Detect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Average Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Median Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Standard Deviation (including non-detects)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

ZOIC Environmental Pty Ltd

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

															Anilines						Amino Aliphatics				Explosives				Nitroaromatics				Other
								Diethylphthalate	Di-n-butyl phthalate	Butyl benzyl phthalate	Carbazole	Methapyrilene	3,3-Dichlorobenzidine	N-nitrosopyrrolidine	4-nitroaniline	4-chloroaniline	Aniline	2-nitroaniline	3-nitroaniline	2-methyl-5-nitroaniline	N-Nitrosomethylethylamine	N-nitrosodiethylamine	N-nitrosodi-n-propylamine	N-nitrosodi-n-butylamine	2,4-Dinitrotoluene	2,6-dinitrotoluene	Nitrobenzene	1,3,5-Trinitrobenzene	2-Picoline	Pentachloronitrobenzene	4-aminobiphenyl	Acetophenone	N-Nitrosodiphenyl & Diphenylamine
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	1
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																										
						-	sand																										
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013037	BH2 4.0-4.5M	BH2	4.0-4.5	15/01/2015	SOIL	>4m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	SOIL	0-<1m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	SOIL	1-<2m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013022	BH10 0.2-0.5M	BH10	0.2-0.5	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013023	BH10 0.5-1.0M	BH10	0.5-1.0	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013038	ASB01 0-0.1M	ASB01	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013039	ASB01 FRAG	ASB01 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013041	ASB03 0-0.1M	ASB03	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013042	ASB04 0-0.1M	ASB04	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013043	ASB05 0-0.1M	ASB05	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013044	ASB05 FRAG	ASB05 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013046	ASB07 0-0.1M	ASB07	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013047	ASB08 0-0.1M	ASB08	0-0.1	15/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013048	ASB08 FRAG	ASB08 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013049	ASB09 FRAG	ASB09 FR	-	15/01/2015	Fragment	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
						-	sand																										
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum Detect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	1
Average Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	1
Median Concentration (including non-detects)	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	1
Standard Deviation (including non-detects)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding one or more Guidelines (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances (Detects Only) (excluding HSLs for vapour intrusion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Results Exceeding HSLs for vapour intrusion (Residential - Commercial/Industrial)	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0	NA - 0

Appendix
Soil Results Summary

14071, Marulan Limestone Mine Continued Operations, Marulan NSW
3/02/2015

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

	Asbestos	Inorganics	Metals								BTEX					TRH NEPM 2013						MAH			
	Asbestos (Guidelines not included in table)	Moisture	Lead	Mercury (guidelines mercury - inorganic)	Nickel	Arsenic	Cadmium	Chromium (III+VI) (guidelines chromium VI and III)	Copper	Zinc	Benzene	Toluene	Ethylbenzene	Xylene (m & p) (guideline xylene total)	Xylene (o) (guideline xylene total)	C6-C10	>C10-C16	>C16-C34	>C34-C40	F1 (C6-C10 less BTEX)	F2 (>C10-C16 less Naphthalene)	Styrene	n-propylbenzene	n-butylbenzene	1,3,5-trimethylbenzene
	g/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.1	1	5	0.1	2	5	1	2	5	5	0.2	0.5	0.5	0.5	0.5	10	50	100	100	10	50	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial	-	-	**1900**	-	**291**	**160**	-	**317**	**280**	**702**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial	-	-	-	-	-	-	-	-	-	-	75	135	165	180	180	-	170	1700	3300	215	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial	-	-	1500	730	6000	3000	900	3600	240000	400000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	700	1000	3500	10000	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m	-	-	-	-	-	-	-	-	-	-	3	NL	NL	230	230	-	-	-	-	260	NL	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m	-	-	-	-	-	-	-	-	-	-	3	NL	NL	NL	NL	-	-	-	-	370	NL	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m	-	-	-	-	-	-	-	-	-	-	3	NL	NL	NL	NL	-	-	-	-	630	NL	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m	-	-	-	-	-	-	-	-	-	-	3	NL	NL	NL	NL	-	-	-	-	NL	NL	-	-	-	-

QA/QC - RPDs. Relative Percent Differences - shaded where RPD>50% for analytical results >5 x EQL

Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*	Asbestos	Moisture	Lead	Mercury	Nickel	Arsenic	Cadmium	Chromium (III+VI)	Copper	Zinc	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	C6-C10	>C10-C16	>C16-C34	>C34-C40	F1 (C6-C10 less BTEX)	F2 (>C10-C16 less Naphthalene)	Styrene	n-propylbenzene	n-butylbenzene	1,3,5-trimethylbenzene
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	12.3	57	<0.1	7	<5	<1	6	29	87	0.4	<0.5	<0.5	<0.5	<0.5	19	<50	210	140	19	<50	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	12.2	55	<0.1	8	<5	<1	6	29	84	0.5	<0.5	<0.5	<0.5	<0.5	32	<50	390	240	32	<50	-	-	-	-
RPD (%)								**-**	**1**	**4**	**-**	**13**	**-**	**-**	**0**	**0**	**4**	**22**	**-**	**-**	**-**	**-**	**51**	**-**	**60**	**53**	**51**	**-**	**-**	**-**	**-**	**-**
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	12.3	57	<0.1	7	<5	<1	6	29	87	0.4	<0.5	<0.5	<0.5	<0.5	19	<50	210	140	19	<50	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	11	30	<0.1	7	6	0.7	6	17	69	<0.2	<0.5	<1	<2	<1	<25	<50	350	310	<25	<50	-	-	-	-
RPD (%)								**-**	**11**	**62**	**-**	**0**	**18**	**-**	**0**	**52**	**23**	**67**	**-**	**-**	**-**	**-**	**27**	**-**	**50**	**76**	**27**	**-**	**-**	**-**	**-**	**-**
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	8.9	8	<0.1	7	6	<1	8	7	26	<0.2	<0.5	<0.5	<0.5	<0.5	<10	1090	7300	1410	<10	1090	-	-	-	-
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	6.6	10	<0.1	7	5	<1	7	7	24	<0.2	<0.5	<0.5	<0.5	<0.5	<10	1170	8500	1860	<10	1170	-	-	-	-
RPD (%)								**-**	**30**	**22**	**-**	**0**	**18**	**-**	**13**	**0**	**8**	**-**	**-**	**-**	**-**	**-**	**-**	**7**	**15**	**28**	**-**	**7**	**-**	**-**	**-**	**-**
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	6.7	9	<0.1	7	6	<0.4	7	9	29	<0.2	<0.5	<1	<2	<1	<25	1100	8200	1700	<25	1100	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	8.9	8	<0.1	7	6	<1	8	7	26	<0.2	<0.5	<0.5	<0.5	<0.5	<10	1090	7300	1410	<10	1090	-	-	-	-
RPD (%)								**-**	**28**	**12**	**-**	**0**	**0**	**-**	**13**	**25**	**11**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**12**	**19**	**-**	**1**	**-**	**-**	**-**	**-**

QA/QC - Recovery - shaded where recovery <70% or >130%

Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*	Asbestos	Moisture	Lead	Mercury	Nickel	Arsenic	Cadmium	Chromium (III+VI)	Copper	Zinc	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	C6-C10	>C10-C16	>C16-C34	>C34-C40	F1 (C6-C10 less BTEX)	F2 (>C10-C16 less Naphthalene)	Styrene	n-propylbenzene	n-butylbenzene	1,3,5-trimethylbenzene
ES1501013050	TSC (lab)	NA	-	13/01/2015	SOIL	-	sand	-	-	-	-	-	-	-	-	-	-	<0.2	5.5	0.9	5	2.1	30	-	-	-	16	-	-	-	-	-
ES1501013025	TRIP SPIKE 1	TRIP SPIK	-	13/01/2015	SOIL	-	sand	-	-	-	-	-	-	-	-	-	-	<0.2	5.3	0.9	4.9	2.1	29	-	-	-	16	-	-	-	-	-
Recovery (%)								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**104**	**100**	**102**	**100**	**103**	**-**	**-**	**-**	**100**	**-**	**-**	**-**	**-**	**-**

ZOIC Environmental Pty Ltd

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

													PAH											
								sec-butylbenzene	1,2,4-trimethylbenzene	tert-butylbenzene	Isopropylbenzene	p-isopropyltoluene	Anthracene	Pyrene	Benzo(g,h,i)perylene	Indeno(1,2,3-c,d)pyrene	Benzo[b+j]fluoranthene	Fluoranthene	Benzo(k)fluoranthene	Acenaphthylene	Benzo(b,j,k)fluoranthene	Chrysene	Benzo(a)pyrene	Dibenz(a,h)anthracene
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																	
QA/QC - RPDs. Relative Percent Differences - shaded where RPD>50% for analytical results >5																								
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
RPD (%)								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	-	<0.1	-	<0.1	<0.2	<0.1	<0.05	<0.1
RPD (%)								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	2.3	<0.5	<0.5	<0.5	1.2	<0.5	<0.5	-	<0.5	<0.5	<0.5
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	3.1	<0.5	<0.5	<0.5	1.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
RPD (%)								-	-	-	-	-	-	**30**	-	-	-	**22**	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	-	-	-	0.7	3.3	0.3	0.2	-	0.7	-	0.3	0.6	0.9	0.66	0.1
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	-	-	-	<0.5	2.3	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
RPD (%)								-	-	-	-	-	**33**	**36**	**50**	**86**	-	**33**	-	**50**	-	**57**	**28**	**133**
QA/QC - Recovery - shaded where recovery <70% or >130%																								
ES1501013050	TSC (lab)	NA	-	13/01/2015	SOIL	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013025	TRIP SPIKE 1	TRIP SPIK	-	13/01/2015	SOIL	-	sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Recovery (%)								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
* Comparison against HSLs for Vapour Intrusion (NEPM 2013) uses depth and soil type of each sample. Either sample specific data are used or the conservative options in the NEPM: soil type 'sand' sample depth '0 - <1m'. Exceedances are formatted as follows:
For Commercial/Industrial land use - in PURPLE font, double underlined

- NL: 'Not Limiting'
- EILs for lead, nickel, chromium, copper and zinc have been determined based on assumed soil type and background concentration, refer to separate EIL table.

																				Phenolics											
								2-(acetylamino) fluorene	**3-methylcholanthrene**	**Benz(a)anthracene**	**7,12-dimethylbenz(a)anthracene**	**Acenaphthene**	**Phenanthrene**	**Fluorene**	**Naphthalene**	**2-methylnaphthalene**	**2-chloronaphthalene**	**Carcinogenic PAHs as B(a)P TEQ**	**Total PAHs**	**2,4-dimethylphenol**	**3-&4-methylphenol**	**Phenol**	**2,4-dichlorophenol**	**4-chloro-3-methylphenol**	**2,6-dichlorophenol**	**Pentachlorophenol**	**2,4,6-trichlorophenol**	**2-nitrophenol**	**2-methylphenol**	**2-chlorophenol**	**2,4,5-trichlorophenol**
								mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL								0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
NEPM 2013 EIL - Commercial/Industrial								-	-	-	-	-	-	-	**370**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 ESL - coarse - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HIL/HSL D Soil - Commercial/Industrial								-	-	-	-	-	-	-	-	-	-	40	4000	-	-	240000	-	-	-	660	-	-	-	-	-
NEPM 2013 Commercial/Industrial - Management limits - coarse								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 0-<1m								-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 1-<2m								-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand 2-<4m								-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM 2013 HSL D Soil - Commercial/Industrial. Sand >4m								-	-	-	-	-	-	-	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Code	Field ID	Location	Depth	Date	Matrix*	Depth Cat.*	Soil*																								
QA/QC - RPDs. Relative Percent Differences - shaded where RPD>50% for analytical results >5																															
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
RPD (%)								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	SOIL	2-<4m	sand	-	-	<0.5	-	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	soil	2-<4m	sand	-	-	<0.1	-	<0.1	<0.1	<0.1	<1	-	-	<0.5	0	-	-	-	-	-	-	-	-	-	-	-	-
RPD (%)								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	6.8	<0.5	<1	-	-	<0.5	11.1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	6.3	<0.5	0.9	-	-	<0.5	11.8	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
RPD (%)								-	-	-	-	-	**8**	-	-	-	-	-	**6**	-	-	-	-	-	-	-	-	-	-	-	-
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	soil	0-<1m	sand	-	-	0.8	-	1.2	6	1.7	<1	-	-	0.9	18	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	SOIL	0-<1m	sand	-	-	<0.5	-	<0.5	6.8	<0.5	<1	-	-	<0.5	11.1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5
RPD (%)								-	-	**46**	-	**82**	**13**	**109**	-	-	-	**57**	**47**	-	-	-	-	-	-	-	-	-	-	-	-
QA/QC - Recovery - shaded where recovery <70% or >130%																															
ES1501013050	TSC (lab)	NA	-	13/01/2015	SOIL	-	sand	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES1501013025	TRIP SPIKE 1	TRIP SPIK	-	13/01/2015	SOIL	-	sand	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Recovery (%)								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

ZOIC Environmental Pty Ltd

Appendix
Comparison of Soil Results against EILs

14071, Marulan Limestone Mine Continued Operations, Marulan NSW
2/02/2015

Relevant Land Use Setting:
Commercial and industrial

Notes:
- Criteria are appropriate for aged contamination (>2 years)
- ABC = Ambient Background Concentration
- ID = Insufficient Data
- Cells with pH, CEC, TOC and Clay that have grey shading contain inferred values, not lab results
- ABCs are estimated with algorithms adopted from the EIL calculation spreadsheet by CSIRO (Dec. 2010) developed for NEPC / NEPM 2013, unless stated otherwise. Where site-specific ABCs were inferred, the cells have grey shading.
- Where CEC, TOC and Clay % are <EQL, the EQL is used.

ABCs are based on	State:	NSW
(used for Cr, Zn, Ni, Cu)	Traffic intensity:	low

									Chromium (III+VI)(guidelines chromium VI and III)					Copper					Lead					Nickel					Zinc				
								Criteria dependent of …			Clay, ABC					pH, ABC					ABC					CEC, ABC					pH, CEC, ABC		
								Criteria not dependant of …			pH, CEC, TOC					CEC, TOC, Clay					pH, CEC, TOC, Clay					pH, TOC, Clay					TOC, Clay		
											Criteria					Criteria, NEPM 2013 Table 1B(2)					Criteria					Criteria					Criteria		
									Analytical Result		National parks and areas of high conservation value	Urban residential and open public space	Commercial and industrial	Analytical Result		National parks and areas of high conservation value	Urban residential and open public space	Commercial and industrial	Analytical Result		National parks and areas of high conservation value	Urban residential and open public space	Commercial and industrial	Analytical Result		National parks and areas of high conservation value	Urban residential and open public space	Commercial and industrial	Analytical Result		National parks and areas of high conservation value	Urban residential and open public space	Commercial and industrial
									mg/kg		mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg
								EQL	2					5					5					2					5				
Sample Code	Field ID	Location	Depth	Date	pH	CEC meq/100g	TOC mg/kg	Clay %		ABC mg/kg					ABC mg/kg					ABC mg/kg					ABC mg/kg					ABC mg/kg			
ES1501013026	BH1 0.3-0.5M	BH1	0.3-0.5	15/01/2015	6	10	1000	1	4	8	68	193	317	<5	18	65	190	280	6	100	570	1200	1900	6	5	34	172	291	16	77	165	479	702
ES1501013031	BH1 3.5-4.0M	BH1	3.5-4.0	15/01/2015	6	10	1000	1	27	8	68	193	317	25	18	65	190	280	8	100	570	1200	1900	7	5	34	172	291	45	77	165	479	702
ES1501013035	BH2 2.1-2.5M	BH2	2.1-2.5	15/01/2015	6	10	1000	1	6	8	68	193	317	29	18	65	190	280	57	100	570	1200	1900	7	5	34	172	291	87	77	165	479	702
ES1501013036	BH2 DUP2	BH2	2.1-2.5	15/01/2015	6	10	1000	1	6	8	68	193	317	29	18	65	190	280	55	100	570	1200	1900	8	5	34	172	291	84	77	165	479	702
122227-2	BH2 TRIP2	BH2	2.1-2.5	15/01/2015	6	10	1000	1	6	8	68	193	317	17	18	65	190	280	30	100	570	1200	1900	7	5	34	172	291	69	77	165	479	702
ES1501013002	BH3 0.5-1.0M	BH3	0.5-1.0	14/01/2015	6	10	1000	1	6	8	68	193	317	6	18	65	190	280	<5	100	570	1200	1900	7	5	34	172	291	32	77	165	479	702
ES1501013004	BH3 1.5-2.0M	BH3	1.5-2.0	14/01/2015	6	10	1000	1	23	8	68	193	317	21	18	65	190	280	<5	100	570	1200	1900	22	5	34	172	291	35	77	165	479	702
ES1501013005	BH4 0-0.45M	BH4	0-0.45	14/01/2015	6	10	1000	1	5	8	68	193	317	7	18	65	190	280	6	100	570	1200	1900	7	5	34	172	291	21	77	165	479	702
ES1501013007	BH4 1.5-2.0M	BH4	1.5-2.0	14/01/2015	6	10	1000	1	4	8	68	193	317	<5	18	65	190	280	5	100	570	1200	1900	4	5	34	172	291	15	77	165	479	702
ES1501013008	BH5 0-0.5M	BH5	0-0.5	14/01/2015	6	10	1000	1	4	8	68	193	317	8	18	65	190	280	<5	100	570	1200	1900	7	5	34	172	291	18	77	165	479	702
ES1501013009	BH5 1-1.3M	BH5	1-1.3	14/01/2015	6	10	1000	1	13	8	68	193	317	9	18	65	190	280	7	100	570	1200	1900	13	5	34	172	291	32	77	165	479	702
ES1501013010	BH6 0-0.5M	BH6	0-0.5	14/01/2015	6	10	1000	1	<2	8	68	193	317	<5	18	65	190	280	<5	100	570	1200	1900	3	5	34	172	291	10	77	165	479	702
ES1501013011	BH6 1.5-2.0M	BH6	1.5-2.0	14/01/2015	6	10	1000	1	9	8	68	193	317	7	18	65	190	280	5	100	570	1200	1900	14	5	34	172	291	30	77	165	479	702
ES1501013012	BH7 0-0.5M	BH7	0-0.5	14/01/2015	6	10	1000	1	5	8	68	193	317	<5	18	65	190	280	7	100	570	1200	1900	6	5	34	172	291	18	77	165	479	702
ES1501013013	BH7 1.0-1.5M	BH7	1.0-1.5	14/01/2015	6	10	1000	1	9	8	68	193	317	6	18	65	190	280	7	100	570	1200	1900	10	5	34	172	291	24	77	165	479	702
ES1501013016	BH8 0.5-0.9M	BH8	0.5-0.9	14/01/2015	6	10	1000	1	8	8	68	193	317	7	18	65	190	280	8	100	570	1200	1900	7	5	34	172	291	26	77	165	479	702
ES1501013017	BH8 DUP1	BH8	0.5-0.9	14/01/2015	6	10	1000	1	7	8	68	193	317	7	18	65	190	280	10	100	570	1200	1900	7	5	34	172	291	24	77	165	479	702
122227-1	BH8 TRIP1	BH8	0.5-0.9	14/01/2015	6	10	1000	1	7	8	68	193	317	9	18	65	190	280	9	100	570	1200	1900	7	5	34	172	291	29	77	165	479	702
ES1501013018	BH8 1.0-1.5M	BH8	1.0-1.5	14/01/2015	6	10	1000	1	10	8	68	193	317	6	18	65	190	280	8	100	570	1200	1900	10	5	34	172	291	25	77	165	479	702
ES1501013019	BH9 0-0.5M	BH9	0-0.5	14/01/2015	6	10	1000	1	9	8	68	193	317	6	18	65	190	280	6	100	570	1200	1900	5	5	34	172	291	23	77	165	479	702
ES1501013021	BH9 1.5-2.0M	BH9	1.5-2.0	14/01/2015	6	10	1000	1	16	8	68	193	317	18	18	65	190	280	<5	100	570	1200	1900	6	5	34	172	291	44	77	165	479	702
ES1501013022	BH10 0.2-0.5	BH10	0.2-0.5	14/01/2015	6	10	1000	1	15	8	68	193	317	13	18	65	190	280	6	100	570	1200	1900	6	5	34	172	291	35	77	165	479	702
ES1501013023	BH10 0.5-1.0	BH10	0.5-1.0	14/01/2015	6	10	1000	1	23	8	68	193	317	20	18	65	190	280	10	100	570	1200	1900	8	5	34	172	291	49	77	165	479	702
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	23				23				23				23				23			
Maximum Concentration	27.0				29.0				57.0				22.0				87.0			
Average Concentration (including non-detects)	9.7				11.7				12.0				8.0				34.4			
Median Concentration (including non-detects)	7.0				7.0				7.0				7.0				29.0			
Standard Deviation (including non-detects)	6.6				7.9				14.5				3.8				20.3			
Number of Results for which criteria are available	23				23				23				23				23			
Number of Exceedances for NP / High Conservation Value		0				0				0				0				0		
Number of Exceedances for Urban Residential			0				0				0				0				0	
Number of Exceedances for Commercial/Industrial				0				0				0				0				0

Appendix D – Photographic Log

PHOTOGRAPH LOG

Client Name	**Site Location**	**Project No.**
Element Environment / Boral	Marulan South Limestone Mine	14071

Photo No.	***Date***
1	30 September 2014

Description

AEC1 Former refuse tip location on eastern flank of Mount Fuji (Mixed Waste)

Photo No.	**Date**
2	30 September 2014

Description

AEC2 Waste oil drum disposal area

Photo No.	Date
3	30 September 2014

Description

AEC3 Former bulk fuel storage area in North Pit (3 x UST Diesel: 140,000L and 1 x AGST Petrol: 10,000L)

Photo No.	Date
4	30 September 2014

Description

AEC4 Bulk fuel storage area (95,000L AGST – Diesel)

Photo No.	Date
5	30 September 2014

Description

AEC 5 Bulk fuel storage area (12,000 UST – Petrol)

Photo No.	Date
6	30 September 2014

Description

AEC6 Old workings / kiln / infilled gully to the south west of South Pit

Photo No.	***Date***
7	30 September 2014

Description

AEC7 Processing Plant

Photo No.	**Date**
8	30 September 2014

Description

AEC8 Lime Kiln

PHOTOGRAPH LOG

Client Name	Site Location	Project No.
Element Environment / Boral	Marulan South Limestone Mine	14071

<table>
<tr><th>Photo No.</th><th>Date</th><td rowspan="3">
</td></tr>
<tr><td>9</td><td>30 September 2014</td></tr>
<tr><td colspan="2">Description
AEC9 Hydrate Plant</td></tr>
</table>

<table>
<tr><th>Photo No.</th><th>Date</th><td rowspan="3"></td></tr>
<tr><td>10</td><td>20 March 2014</td></tr>
<tr><td colspan="2">Description
AEC10 Western Emplacement Area</td></tr>
</table>

Photo No.	**Date**
11	30 September 2014

Description

AEC 11 An example of Undisturbed Areas

Photo No.	**Date**
12	30 September 2014

Description

AEC12 Area of Proposed Marulan Creek Dam

Photo No.	***Date***	
13	30 September 2014	
Description AEC13 Workshop / Interceptor		

Photo No.	**Date**	
14	30 September 2014	
Description AEC14 Wash down bays / waste oil tanks		

Photo No.	**Date**
15	30 September 2014

Description

AEC15 Oil storage below retaining wall near Kiln Pre-heater

Photo No.	**Date**
16	15 January 2015

Description

AEC16

Photo No.	Date
17	30 September 2014

Description

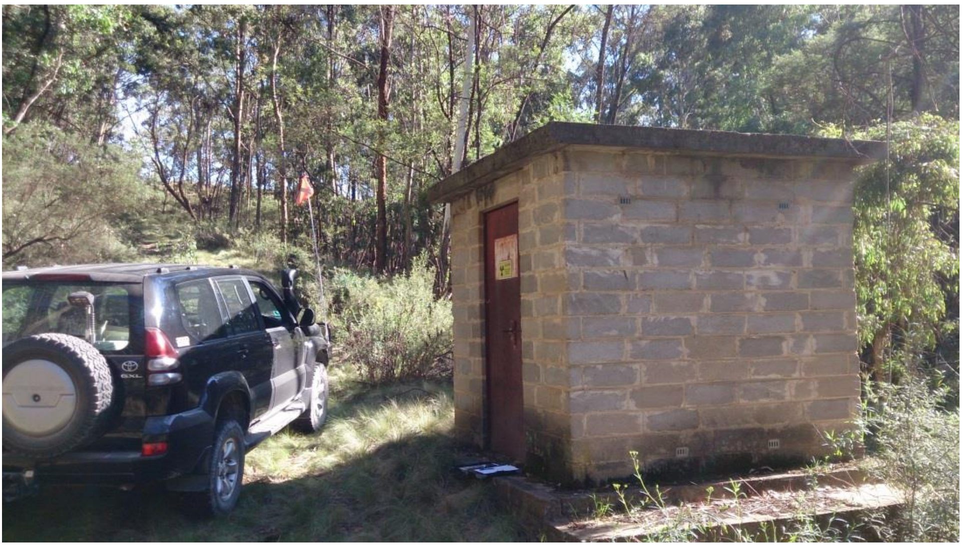
AEC17 Old Machinery Scrap Yard

Photo No.	Date
18	15 January 2015

Description

AEC18 Explosive Store, historically used for temporary storage of low level radioactive source material. According to Boral, no low level radioactive materials are stored on site.

However, a low level radiation gauge is used to facilitate operation of Conveyor 2.



PHOTOGRAPH LOG

Client Name	Site Location	Project No.
Element Environment / Boral	Marulan South Limestone Mine	14071

Photo No.	***Date***
19	15 January 2015

Description

An example of asbestos cement fragments at the surface (ASB01)

Photo No.	**Date**
20	15 January 2015

Description

An example of an asbestos cement fragment at the surface (ASB05)

Photo No.	**Date**
21	15 January 2015

Description

Asbestos containing material comprising the kerb of the westernmost bowling green.

Photo No.	**Date**
22	15 January 2015

Description

Damaged kerb of westernmost bowling green

Appendix E – Data Quality Objectives

Step 1 – Defining the Problem

Concise Description of the Problem

The potential sources of contamination (Section 6.1) required assessment to determine the actual presence of contamination and its associated risks for the ongoing use as a limestone mine.

Planning Team Members and Decision Maker

The project was commissioned by Rod Wallace of Boral. The Zoic project team included:

Zoic Project Manager / Field Scientist:	Graeme Malpass
Zoic Technical Specialist / Reviewer	Rebeka Hall

Summary of Available Resources, Constraints and Relevant Deadlines

The project team was assigned to conduct the Targeted Stage 2 ESA based on them having considerable relevant experience in projects of this nature.

Site inspection and fieldwork were conducted on 30 September 2014 and 14-16 January 2015.

Step 2 – Identify the Decision

Decision Statement Linking the Principal Study Question to Possible Actions that will Solve the Problem

Based on the decision making process for assessing urban redevelopment sites detailed in Appendix I of DEC (2006) and modified to relate to the specific redevelopment requirements for this ESA report, the following decisions were required to be made:

- Do the soils at the site exceed the adopted site criteria detailed in Step 3 below? If this is the case, then additional assessment, management or remedial action will be required;
- Does the groundwater at the site exceed the adopted site criteria detailed in Step 3 below? If this is the case, then additional assessment, management or remedial action will be required;
- Does the surface water exceed the adopted site criteria detailed in Step 3 below? If this is the case, then additional assessment, management or remedial action will be required;
- Are there any aesthetic issues relating to the site? If this is the case, then additional assessment, management or remedial action will be required; and
- Do the concentrations of contamination require notification under NSW EPA 2009 Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997?

What is the Alternative Action

Do nothing – not acceptable, as the site is required to be characterised to answer the study questions above.

Step 3 – Identification of Inputs into the Decision

List of Informational Inputs Needed to Resolve the Decision Statement

Inputs needed to resolve the decision statement include:

- Review of historical and desk study information;
- Walkover survey and interview with site representatives;
- Observations made during the field works;
- Results of field and laboratory testing; and
- Derivation of a conceptual site model.

Identification of the Media to be Assessed

The media that required investigation included the following:

- Soil materials at selected AEC to depths of between 2 and 4.5m bgl;
- Groundwater at selected monitoring locations; and
- Surface Water at selected monitoring locations.

List of Environmental Variables or Characteristics that will be Measured

For soil the following analytical suite was adopted: M8, TPH, BTEX, PAH, phenol, VOC, SVOC, asbestos and surfactants (MBAS) in selected soil samples. Also the composition of soil was described, with any ACM, visual or olfactory signs of contamination recorded (refer to borehole logs in Appendix F).

For groundwater the following analytical suite was adopted: dissolved M8, TPH, BTEX and Phenols. Additionally, field parameters were recorded including temperature, pH, electrical conductivity, dissolved oxygen, oxidation reduction potential and drawdown during purging, and visual or olfactory signs of contamination were recorded by International Environmental Consultants.

For surface water the following analytical suite was adopted: dissolved M8, TPH, BTEX and Phenols. Additionally, visual or olfactory signs of contamination were recorded by International Environmental Consultants, if encountered.

Identification of Site Criteria for Each Medium of Concern

The soil site criteria to be adopted for this study are as follows:

- Ecological Investigation Levels (NEPM 2013 EILs) for a Commercial and Industrial setting;
- Ecological Screening Levels for Hydrocarbons; for coarse soil in a Commercial and Industrial Setting (NEPM 2013 ESLs);
- Health Investigation Levels and Health Screening Levels for Generic Land Use Commercial and Industrial Soil D (NEPM 2013 HILs/HSLs), including asbestos HSLs; and
- Management Limits for Total Petroleum Hydrocarbons for Commercial and Industrial for coarse soil (NEPM 2013).

The surface and groundwater site criteria adopted for this study are as follows:

- Groundwater Investigation Levels for Fresh Waters (NEPM 2013 GILs); and
- Freshwater Ecosystems Trigger Levels Medium-Low Reliability ANZECC (2000).

These adopted values are included in the result summary tables presented within the report text or in Appendix C.

The table below outlines the analytical methods of the NATA accredited primary laboratory ALS Environmental.

Table E1 Soil Analytical Methods

Analyte	Analytical Method
Asbestos	AS 4964 - 2004 Method for the qualitative identification of asbestos in bulk samples. Analysis by Polarised Light Microscopy including dispersion staining
Metals	In house: Referenced to APHA 21st ed., 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Mercury	In house: Referenced to AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM 2013) Schedule B(3)
Surfactants	In house: Referenced to APHA 21st ed., 5540 B & C. MBAS results determined following 1:5 solid / water leach. This method comprises three successive extractions from acid aqueous medium containing excess methylene blue, into chloroform, followed by an aqueous backwash and measurement of the colour by spectrophotometry at 625nm. ALS is not NATA accredited for this analysis.
TPH	(USEPA SW 846 - 8015A) Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C40
VOC	(USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Method 501)
SVOC	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (2013) Schedule B(3) (Method 502)
PAH/Phenol	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS in Selective Ion Mode (SIM) and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Method 502 and 507)
vTPH/BTEX	(USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve

Step 4 – Defining the Study Boundaries

Detailed Description of the Spatial and Temporal Boundaries of the Problem

The lateral study area is presented in Figure 2A and 2B, **Appendix A** noting that investigation was targeted to AECs. The vertical extent of the investigation is to between 0.1 and 4.5m bgl depending on the location.

The assessment considers the current (September 2014 to January 2015) condition of the site. Given the long period without changes to the site is considered to be representative of future conditions as long as no significant changes to the site occur.

Any Practical Constraints that May Interfere with the Study

No practical constraints were encountered during the investigation.

Step 5 – Developing Decision Rules

The decision rules adopted to answer the decisions outlined in Section 2 are summarised in the following table:

Table E2 Summary of Decision Rules

No.	Decision to be Made	Decision Rule
1	Is additional assessment, management or remedial action required to address contamination soils?	YES, if.. ▶ If the soil results (considering a 95% UCL where appropriate) exceed adopted site criteria in Step 3 OR if.. ▶ The investigation notes aesthetic issues including odours, discoloration or deleterious materials in soil. Otherwise NO.
2	Is additional assessment, management or remedial action required to address contamination in groundwater?	YES, if.. ▶ If the groundwater results exceed adopted site criteria in Step 3 OR if.. ▶ The investigation notes aesthetic issues including odours, discoloration or deleterious materials in groundwater. Otherwise NO.
3	Is additional assessment, management or remedial action required to address contamination in surface water?	YES, if.. ▶ If the surface water results exceed adopted site criteria in Step 3 OR if.. ▶ The investigation notes aesthetic issues including odours, discoloration or deleterious materials in surface water. Otherwise NO.
4	Is notification of contamination to the NSW EPA required?	YES, if.. ▶ Soil, groundwater or surface water exceed the criteria specified in NSW EPA (2015) Duty to Report Guidelines. Otherwise NO.

Step 6 – Specify Limits on Decision Errors

Decision-maker's Tolerable Decision Error Rates Based on a Consideration of the Consequences of Making an Incorrect Decision

NSW EPA (1995) states that "Unless a site investigator can demonstrate otherwise, the EPA maintains that all statistical interpretation should be carried out at a confidence level of no lower than 95%". To ensure compliance with this guideline, an overall acceptable error rate of <= 5% was adopted for this Project.

The pre-determined data quality indicators (DQIs) established for the Project are discussed below in relation to precision, accuracy, representativeness, comparability and completeness (PARCC parameters) as required by Step 6 of the DQO process.

Table E3 Data Quality Objectives and Indicators for Soil and Groundwater Samples

Data Quality Objective	Frequency conducted	Data Quality Indicator
Precision		
Intra-laboratory field duplicates	1/20 samples	>5xLOR: 50% RPD as primary sample for asbestos
Inter-laboratory field duplicates	1/20 samples	
Laboratory duplicates (ALS)	1/20 samples	<10xLOR: No Limit >10xLOR: 50% RPD >10xLOR: 20%RPD Not required for asbestos
Laboratory method blanks	1/20 samples	< LOR Not required for asbestos
Accuracy		
Matrix spikes	1/20 samples	Acceptable recoveries: statistically determined between 12.5-149%R depending on determinand Not required for asbestos
Laboratory control spike	1/20 samples	As Matrix spikes Not required for asbestos
Surrogate spike	1/20 samples	As Matrix spikes Not required for asbestos
Representativeness		
Sampling handling storage and transport appropriate for media and analytes	-	Yes
Rinsate blanks	1 per day per equipment	Not required due to sampling protocols to prevent cross contamination
Trip Spike and Trip Blank	1 per event	Yes
Samples extracted and analysed within holding times.	-	Hold Times: 7 days - organics 6 months – inorganics
Comparability		
Standard operating procedures used for sample collection and handling (including decontamination)	All Samples	Yes
Standard analytical methods used for all analyses	All Samples	Yes
Consistent field conditions, sampling staff and laboratory analysis	All Samples	Yes
Limits of reporting appropriate and consistent	All Samples	Yes
Completeness		
Soil description and COCs completed and appropriate	All Samples	Yes
Appropriate documentation for testing	All Samples	Yes
Data set to be 95% complete after validation	All Samples	Yes

[1] - If the RPD between duplicates is greater than the pre-determined data quality indicator, a judgment will be made as to whether the excess is critical in relation to the validation of the data set or unacceptable sampling error is occurring in the field.

Step 7 – Optimise Design

The Optimum Manner in which to Collect the Data Required to meet the Objectives for the Assessment and which will meet the Project DQOs

With consideration to the objectives of the Project; the review of existing environmental data; and, the evaluation of operational decision rules, a resource-effective sampling and analysis plan is presented in Section 7 of the report.

Appendix F – Borelogs

ZF004: Borehole Log Form

DATE:	15 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228414, 6148762 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH1
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1		seepage in gravel				Asphalt overlying gravel sub base (FILL)	NAsb, NO, NS
0.2							
0.3							
0.4			0.9	0.3-0.5		Recovered as light brown fine to coarse sand with occasional fine to medium limestone gravel (FILL – SUB BASE)	NAsb, NS, faint hydrocarbon odour
0.5							
0.6			0.4	0.5-1.0			NAsb, NO, NS
0.7						Recovered as light brown clayey sandy fine to medium limestone gravel (FILL - OVERBURDEN)	
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4							
1.5							
1.6			1.1	1.5-2.0			Faint hydrocarbon odour between 1.5-2.0m
1.7							
1.8							
1.9							
2.0							
2.1						No sample recovery	
2.2							
2.3							
2.4							
2.5							
2.6			0.3	2.5-3.0		Recovered as dark grey clayey angular tabular fine to medium shale and limestone gravel (FILL – OVERBURDEN)	NAsb, NO, NS
2.7							
2.8							
2.9							
3.0							
3.1			1.1	3.0-3.5			Faint hydrocarbon odour between 3.0-3.5
3.2							
3.3							
3.4							
3.5							
3.6			1.0	3.5-4.0		Recovered as dark brown silty slightly clayey sand (SANDSTONE)	NAsb, NO, NS Drill hammer used to make progress
3.7							
3.8							
3.9							
4.0							
4.1						Target depth reached at 4.0m bgl	No groundwater encountered
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ISSUE 1: 20 August 2018

ZF004: Borehole Log Form

DATE:	15 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228415, 6148760 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH2
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1						Concrete	
0.2							
0.3							
0.4			2.6	0.3-0.5		(FILL – SUB BASE)	NAsb, NO, NS
0.5							
0.6			1.8	0.5-1.0			NAsb, NO, NS
0.7						Recovered as brown silty sandy fine to medium limestone gravel (FILL - OVERBURDEN)	
0.8							
0.9							
1.0							
1.1			2.2	1.0-1.5		Recovered as light brown clayey sandy fine to medium limestone gravel (FILL - OVERBURDEN)	NAsb, NS, faint hydrocarbon odour
1.2							
1.3							
1.4							
1.5							
1.6						…becoming very clayey below 1.5m	
1.7							
1.8							
1.9							
2.0							
2.1							
2.2			67.3	2.1-2.5 DUP 2 TRIP 2		Recovered as dark grey clayey angular tabular fine to medium shale and limestone gravel and rare coal fragments (FILL – OVERBURDEN)	NAsb, NS, hydrocarbon odour
2.3							
2.4							
2.5							
2.6							No hydrocarbon odour below 2.5m
2.7							
2.8							
2.9							
3.0							
3.1						…becoming very clayey between 3-3.5m	
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0			2.0	4.0-4.5		Recovered as dark brown slightly clayey sand (SANDSTONE)	NAsb, NO, NS Drill hammer used to make progress
4.1							
4.2							
4.3							
4.4							
4.5							
4.6						Target depth reached at 4.5m bgl	No groundwater encountered

NOTE: This borehole log was prepared for environmental purposes only

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228233, 6148267 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH3
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			2.5	0.0-0.4		Recovered as light brown sand and gravel (FILL – SUB BASE)	NASb, NO, NS
0.2							
0.3							
0.4							
0.5						Recovered as light and dark grey sand and fine to medium limestone gravel (FILL – OVERBURDEN)	NAsb, NO, NS
0.6			14.2	0.5-1.0			
0.7							
0.8							
0.9							
1.0							
1.1							
1.2							
1.3			11.4	1.2-1.5		Recovered as dark brown sand and fine to medium limestone gravel (FILL – OVERBURDEN)	NAsb, NS, faint hydrocarbon odour
1.4							
1.5							
1.6			5.6	1.5-2.0			
1.7							
1.8							
1.9							
2.0							
2.1						Target depth reached at 2.0m bgl	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ISSUE 1: 20 August 2018

ZF004: Borehole Log Form

DATE:	14 January 2014
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228244, 6148273 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH4
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			2	0.0-0.5		Recovered as buff sand and some fine to coarse limestone gravel (FILL - SUB BASE)	NAsb, NS, faint hydrocarbon odour
0.2							
0.3							
0.45							
0.5						Recovered as buff sand and fine to medium gravel (FILL – OVERBURDEN)	NAsb, NO, NS
0.6			1.5	0.5-1.0			
0.7							
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4							
1.5							
1.6			1.4	1.5-2.0			Faint hydrocarbon odour at 1.5-2.0m
1.7						…with cobble / boulder between 1.6-1.8m	
1.8							
1.9							
2.0							
2.1						Target depth reached at 2.0m bgl	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228249, 6148279 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH5
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			0.6	0.0-0.5		Recovered as light brown fine sand and some limestone gravel (FILL – SUB BASE)	NASb, NO, NS
0.2							
0.3							
0.4							
0.5			0.4	-			
0.6						Recovered as dark brown fine sand and fine to medium gravel (FILL - OVERBURDEN)	NASb, NO, NS
0.7							
0.8							
0.9							
1.0							
1.1			0.3	1-1.3		…becoming purplish brown below 1.0m	
1.2							
1.3							
1.4						…with cobble / boulder between 1.3-1.4m	
1.5							
1.6							
1.7							
1.8							
1.9							
2.0							
2.1						Target depth reached at 2.0m bgl	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228255, 6148305 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH6
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			1	0.0-0.5		Recovered as buff fine to coarse sand with some fine to medium limestone gravel (FILL – SUB BASE)	NAsb, NO, NS
0.2							
0.3							
0.4							
0.5							
0.6						Recovered as dark brown fine sand and fine to medium limestone gravel (FILL – OVERBURDEN)	NAsb, NO, NS
0.7							
0.8							
0.9							
1.0							
1.1						…with cobble / boulder between 1.0-1.5m	
1.2							
1.3							
1.4							
1.5							
1.6			0.6	1.5-2.0		…becoming light brown below 1.5m	
1.7							
1.8							
1.9							
2.0							
2.1						Target depth reached at 2.0m bgl	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228239, 6149037 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH7
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			2.2	0.0-0.5		Recovered as buff fine to coarse sand with some gravel (FILL)	NAsb, NO, NS
0.2							
0.3							
0.4							
0.5							
0.6							
0.7							
0.8							
0.9							
1.0							
1.1			9.4	1.0-1.5			
1.2							
1.3							
1.4							
1.5							
1.6			7.5	1.5-2.0			
1.7							
1.8							
1.9							
2.0							
2.1						Target depth reached at 2.0m	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ISSUE 1: 20 August 2018

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228267, 6149043 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH8
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			2.0	0.0-0.5		Recovered as buff fine to coarse sand with some limestone gravel (FILL - SUB BASE)	NAsb, NO, NS
0.2							
0.3							
0.4							
0.5							
0.6			18	0.5-0.9		…becoming dark brown below 0.5m	Strong hydrocarbon odour between 0.5 and 0.9m
0.7				DUP1			
0.8				TRIP1			
0.9							
1.0			9.5	1.0-1.5		Recovered as reddish brown fine to coarse sand and some gravel with occasional cobbles / boulders (FILL - OVERBURDEN)	NAsb, NO, NS
1.1							
1.2							
1.3							
1.4							
1.5							
1.6							
1.7							
1.8							
1.9							
2.0							
2.1						Target depth reached at 2m bgl	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228326, 6149027 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH9
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)		GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
			PID (ppm)	Depth (m)			
0.1			1.4	0.0-0.5		Recovered as dark brown sand with occasional fine gravel (FILL – SUB BASE)	NAsb, NS, faint hydrocarbon odour
0.2							
0.3							
0.4							
0.5							
0.6			0.6	0.5-1.0		Recovered as fine to coarse dark brown sand with tree roots (FILL)	NAsb, NS, faint hydrocarbon odour
0.7							
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4							
1.5							
1.6			1.1	1.5-2.0			
1.7							
1.8							
1.9							
2.0							
2.1						Target depth reached at 2.0m bgl	No groundwater encountered
2.2							
2.3							
2.4							
2.5							
2.6							
2.7							
2.8							
2.9							
3.0							
3.1							
3.2							
3.3							
3.4							
3.5							
3.6							
3.7							
3.8							
3.9							
4.0							
4.1							
4.2							
4.3							
4.4							
4.5							

NOTE: This borehole log was prepared for environmental purposes only

ZF004: Borehole Log Form

DATE:	14 January 2015
JOB NO:	14071
JOB NAME:	Marulan South Limestone Mine
SITE ADDRESS:	Marulan
GPS COORDINATES & UNITS:	0228329, 6149006 (MGA56)
CONTRACTOR:	Full Bore Drilling
METHOD: (min. air flush used)	Rotary Percussive
DIAMETER (mm):	140mm

SHEET NO:	1 OF 1
BOREHOLE NO:	BH10
LOGGED BY:	Graeme Malpass
CHECKED BY:	Rebeka Hall

NAsb	No visual evidence of asbestos
NO	No odour noted
NS	No staining noted

DEPTH (m)	GW Level (m)	SAMPLE		Graphic Log	Soil Description	Observations/Comment
		PID (ppm)	Depth (m)			
0.1					Concrete	
0.2						
0.3		0.6	0.2-0.5		Recovered as brown fine to coarse sand with fine gravel and occasional cobbles (FILL)	NAsb, NO, NS
0.4						
0.5						
0.6		0.4	0.5-1.0			
0.7						
0.8						
0.9						
1.0						
1.1						
1.2						
1.3						
1.4						
1.5						
1.6						
1.7						
1.8						
1.9						
2.0						
2.1					Target depth reached at 2.0m bgl	No groundwater encountered
2.2						
2.3						
2.4						
2.5						
2.6						
2.7						
2.8						
2.9						
3.0						
3.1						
3.2						
3.3						
3.4						
3.5						
3.6						
3.7						
3.8						
3.9						
4.0						
4.1						
4.2						
4.3						
4.4						
4.5						

Appendix G – Calibration Reports

13/01/2015

PID Calibration Certificate

Instrument **MiniRae 3000**
Serial No. **592-902419**

airmet

Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments			
Battery	Charge Condition	✓				
	Fuses	✓				
	Capacity	✓				
	Recharge OK?	✓				
Switch/keypad	Operation	✓				
Display	Intensity	✓				
	Operation (segments)	✓				
Grill Filter	Condition	✓				
	Seal	✓				
Pump	Operation	✓				
	Filter	✓				
	Flow	✓				
	Valves, Diaphragm	✓				
PCB	Condition	✓				
Connectors	Condition	✓				
Sensor	PID	✓	10.6 ev			
Alarms	Beeper	✓	**Low**	**High**	**TWA**	**STEL**
	Settings	✓	50ppm	100ppm	10ppm	25ppm
Software	Version	✓				
Data logger	Operation	✓				
Download	Operation	✓				
Other tests:						

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Calibration gas and concentration	Certified	Gas bottle No		Instrument Reading
PID Lamp		100ppm Isobutylene	NIST	SY35		100.6ppm

Calibrated by: **Alexander Rios**

Calibration date: **13/01/2015**

Next calibration due: **12/02/2015**

Appendix H – QA QC Assessment

Table H1 Soil QA/QC Results Summary

Data Quality Objective	Sampling Frequency	Frequency Achieved?	DQI	DQI Met ?
Precision				
Intra-laboratory field duplicates	1/20	Yes	>5xLOR: 50% RPD	Yes
Inter-laboratory field duplicates	1/20	Yes		Yes noting that a lead and TPH F2 result were 62 and 182%RPD due to sample heterogeneity in TRIP1 and TRIP2 respectively
Laboratory duplicates	1/20	Yes	<10xLOR: No Limit >10xLOR: 50% RPD >10xLOR: 20%RPD	Yes noting that a DEHP was 24%RPD due to sample heterogeneity
Laboratory method blanks	1/10 Primary	Yes	< LOR	Yes
Accuracy				
Matrix spikes	1/10	Yes	Acceptable recoveries: statistically determined between 12.5-149%R depending on determinand	Yes
Laboratory control spike	1/10	Yes		Yes noting that %R for a hexachloropropylene result was below the lower control limit which may indicate the result was under reported.
Surrogate spikes	1/10	Yes		Yes noting that %R for TPH could not be determined in TRIP1 due to matrix interference.
Representativeness				
Sampling handling storage and transport appropriate for media and analytes	All	Yes	Received by laboratory cooled and with container in good condition	All
Rinsate blanks	NA	NA	<LOR	No rinsate samples taken.
Trip Blank	1 per event	Yes	<LOR	Yes
Trip Spike	1 per event	NA	70 to 130% (inorganic) As specified by lab (organic)	Yes
Samples extracted and analysed within holding times.	All	Yes	Hold Times: 7 days - organics 6 months – inorganics	Yes
Comparability				
Standard operating procedures used for sample collection and handling (including decontamination)	All	Yes	Yes	Yes, refer to methodology in main report.
Standard analytical methods used for all analyses	All	Yes	Yes	Yes
Consistent field conditions, sampling staff and laboratory analysis	All	Yes	Yes	Yes
Limits of reporting appropriate and consistent	All	Yes	Yes	Yes noting that the two of the deeper sample results for MBAS had increased detection limits due to matrix interference. The laboratory stated that this could be due to organic (including MBAS) or inorganic in nature.

Data Quality Objective	Sampling Frequency	Frequency Achieved?	DQI	DQI Met ?
<u>Completeness</u>				
Soil description and COCs completed and appropriate	All	Yes	Yes	Yes, borehole logs and laboratory certificates are presented in Appendices F and I respectively.
Appropriate documentation for testing	All	Yes	Yes	Yes

Appendix I – Laboratory Reports

CERTIFICATE OF ANALYSIS

Work Order	: **ES1501013**	Page	: 1 of 32
Client	: **ZOIC ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR GRAEME MALPASS	Contact	: Client Services
Address	: SUITE 4, LEVEL3 105 PITT STREET SYDNEY NSW AUSTRALIA 2000	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: GRAEME.MALPASS@ZOIC.COM.AU	E-mail	: sydney@alsglobal.com
Telephone	: 02 9231 1045	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: MARULAN SOUTH MINE	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 14071		
C-O-C number	: ----	Date Samples Received	: 19-JAN-2015
Sampler	: GM	Issue Date	: 28-JAN-2015
Site	: ----		
		No. of samples received	: 50
Quote number	: SY/014/15	No. of samples analysed	: 35

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Descriptive Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Christopher Owler	Team Leader - Asbestos	Newcastle - Asbestos
Edwandy Fadjar	Organic Coordinator	Sydney Organics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero, for 'TEQ 1/2LOR' are treated as half the reported LOR, and for 'TEQ LOR' are treated as being equal to the reported LOR. Note: TEQ 1/2LOR and TEQ LOR will calculate as 0.6mg/Kg and 1.2mg/Kg respectively for samples with non-detects for all of the eight TEQ PAHs.**
- **EA200 Legend**
- **EA200 'Am' Amosite (brown asbestos)**
- **EA200 'Ch' Chrysotile (white asbestos)**
- **EA200 'Cr' Crocidolite (blue asbestos)**
- **EA200 'Trace' - Asbestos fibres ("Free Fibres") detected by trace analysis per AS4964. The result can be interpreted that the sample contains detectable 'respirable' asbestos fibres**
- **EA200: 'UMF' Unknown Mineral Fibres. "-" indicates fibres detected may or may not be asbestos fibres. Confirmation by alternative techniques is recommended.**
- **EA200: Asbestos Identification Samples were analysed by Polarised Light Microscopy including dispersion staining.**
- **EA200: Negative results for vinyl tiles should be confirmed by an independent analytical technique.**
- **EP050 (Anionic Surfactants as MBAS): Samples BH5 1-1.3M; BH6 0-0.5M; BH6 1.5-2.0M were diluted due to matrix interference. LOR adjusted accordingly.**
- **EP075: Poor duplicate precision due to sample heterogeneity. Confirmed by re-extraction and re-analysis.**
- **EP075: 'Sum of PAH' is the sum of the USEPA 16 priority PAHs**
- **EP080: The TRIP SPIKE and TRIP SPIKE CONTROL have been analysed for volatile TPH and BTEX only. The TRIP SPIKE and TRIP SPIKE CONTROL were prepared in the lab using reagent grade sand spiked with petrol. The TRIP SPIKE was dispatched from the lab and the TRIP SPIKE CONTROL retained. The spike samples were extracted and analysed concurrently with samples reported in this batch.**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**2.7**	**11.2**	**1.6**	**1.4**	**5.2**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	**6**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**6**	**23**	**5**	**4**	**4**
Copper	7440-50-8	5	mg/kg	**6**	**21**	**7**	<5	**8**
Lead	7439-92-1	5	mg/kg	<5	<5	**6**	**5**	<5
Nickel	7440-02-0	2	mg/kg	**7**	**22**	**7**	**4**	**7**
Zinc	7440-66-6	5	mg/kg	**32**	**35**	**21**	**15**	**18**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EP050: Anionic Surfactants as MBAS								
Anionic Surfactants as MBAS	----	1	mg/kg	----	----	----	----	<1
EP074A: Monocyclic Aromatic Hydrocarbons								
Styrene	100-42-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Isopropylbenzene	98-82-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
n-Propylbenzene	103-65-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.3.5-Trimethylbenzene	108-67-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
sec-Butylbenzene	135-98-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2.4-Trimethylbenzene	95-63-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
tert-Butylbenzene	98-06-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
p-Isopropyltoluene	99-87-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
n-Butylbenzene	104-51-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP074B: Oxygenated Compounds								
Vinyl Acetate	108-05-4	5	mg/kg	<5	<5	<5	<5	<5
2-Butanone (MEK)	78-93-3	5	mg/kg	<5	<5	<5	<5	<5
4-Methyl-2-pentanone (MIBK)	108-10-1	5	mg/kg	<5	<5	<5	<5	<5
2-Hexanone (MBK)	591-78-6	5	mg/kg	<5	<5	<5	<5	<5
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2-Dichloropropane	78-87-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	BH3 0.5-1.0M	NH3 1.5-2.0M	BH4 0-0.45M	BH4 1.5-2.0M	BH5 0-0.5M
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
				ES1501013-002	ES1501013-004	ES1501013-005	ES1501013-007	ES1501013-008
EP074D: Fumigants - Continued								
cis-1.3-Dichloropropylene	10061-01-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1.3-Dichloropropylene	10061-02-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2-Dibromoethane (EDB)	106-93-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	5	mg/kg	<5	<5	<5	<5	<5
Chloromethane	74-87-3	5	mg/kg	<5	<5	<5	<5	<5
Vinyl chloride	75-01-4	5	mg/kg	<5	<5	<5	<5	<5
Bromomethane	74-83-9	5	mg/kg	<5	<5	<5	<5	<5
Chloroethane	75-00-3	5	mg/kg	<5	<5	<5	<5	<5
Trichlorofluoromethane	75-69-4	5	mg/kg	<5	<5	<5	<5	<5
1.1-Dichloroethene	75-35-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Iodomethane	74-88-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1.2-Dichloroethene	156-60-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.1-Dichloroethane	75-34-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1.2-Dichloroethene	156-59-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.1.1-Trichloroethane	71-55-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.1-Dichloropropylene	563-58-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride	56-23-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2-Dichloroethane	107-06-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethene	79-01-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromomethane	74-95-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.1.2-Trichloroethane	79-00-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.3-Dichloropropane	142-28-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachloroethene	127-18-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.1.1.2-Tetrachloroethane	630-20-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1.4-Dichloro-2-butene	110-57-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1.4-Dichloro-2-butene	1476-11-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.1.2.2-Tetrachloroethane	79-34-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2.3-Trichloropropane	96-18-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachloroethane	76-01-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2-Dibromo-3-chloropropane	96-12-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Bromobenzene	108-86-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EP074F: Halogenated Aromatic Compounds - Continued								
2-Chlorotoluene	95-49-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chlorotoluene	106-43-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2.3-Trichlorobenzene	87-61-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP074G: Trihalomethanes								
Chloroform	67-66-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane	75-27-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane	124-48-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform	75-25-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP075A: Phenolic Compounds								
Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
3- & 4-Methylphenol	1319-77-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol	87-86-5	1	mg/kg	<1	<1	<1	<1	<1
EP075B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylnaphthalene	91-57-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chloronaphthalene	91-58-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EP075B: Polynuclear Aromatic Hydrocarbons - Continued								
Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg	<1	<1	<1	<1	<1
7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
3-Methylcholanthrene	56-49-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of PAHs**	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Benzo(a)pyrene TEQ (half LOR)**	----	0.5	mg/kg	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**
^ **Benzo(a)pyrene TEQ (LOR)**	----	0.5	mg/kg	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
EP075C: Phthalate Esters								
Dimethyl phthalate	131-11-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Diethyl phthalate	84-66-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Di-n-butyl phthalate	84-74-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Butyl benzyl phthalate	85-68-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
bis(2-ethylhexyl) phthalate	117-81-7	5.0	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0
Di-n-octylphthalate	117-84-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP075D: Nitrosamines								
N-Nitrosomethylethylamine	10595-95-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitrosodiethylamine	55-18-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitrosopyrrolidine	930-55-2	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
N-Nitrosomorpholine	59-89-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitrosodi-n-propylamine	621-64-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitrosopiperidine	100-75-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitrosodibutylamine	924-16-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Methapyrilene	91-80-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP075E: Nitroaromatics and Ketones								
2-Picoline	109-06-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EP075E: Nitroaromatics and Ketones - Continued								
Acetophenone	98-86-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrobenzene	98-95-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Isophorone	78-59-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.6-Dinitrotoluene	606-20-2	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dinitrotoluene	121-14-2	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
1-Naphthylamine	134-32-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Nitroquinoline-N-oxide	56-57-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
5-Nitro-o-toluidine	99-55-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Azobenzene	103-33-3	1	mg/kg	<1	<1	<1	<1	<1
1.3.5-Trinitrobenzene	99-35-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Phenacetin	62-44-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Aminobiphenyl	92-67-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachloronitrobenzene	82-68-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pronamide	23950-58-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dimethylaminoazobenzene	60-11-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorobenzilate	510-15-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP075F: Haloethers								
Bis(2-chloroethyl) ether	111-44-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Bis(2-chloroethoxy) methane	111-91-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chlorophenyl phenyl ether	7005-72-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Bromophenyl phenyl ether	101-55-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP075G: Chlorinated Hydrocarbons								
1.3-Dichlorobenzene	541-73-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.4-Dichlorobenzene	106-46-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2-Dichlorobenzene	95-50-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachloroethane	67-72-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
1.2.4-Trichlorobenzene	120-82-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachloropropylene	1888-71-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene	87-68-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorocyclopentadiene	77-47-4	2.5	mg/kg	<2.5	<2.5	<2.5	<2.5	<2.5
Pentachlorobenzene	608-93-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
EP075H: Anilines and Benzidines								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EP075H: Anilines and Benzidines - Continued								
Aniline	62-53-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloroaniline	106-47-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Nitroaniline	88-74-4	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
3-Nitroaniline	99-09-2	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenzofuran	132-64-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Nitroaniline	100-01-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Carbazole	86-74-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
3.3`-Dichlorobenzidine	91-94-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP075I: Organochlorine Pesticides								
alpha-BHC	319-84-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
EP075J: Organophosphorus Pesticides								
Dichlorvos	62-73-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dimethoate	60-51-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Malathion	121-75-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pirimphos-ethyl	23505-41-1	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EP075J: Organophosphorus Pesticides - Continued								
Prothiofos	34643-46-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg	**150**	**140**	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg	**1700**	**1920**	**390**	<100	**150**
C29 - C36 Fraction	----	100	mg/kg	**2090**	**2320**	**320**	<100	**220**
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	**3940**	**4380**	**710**	<50	**370**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	<10	<10
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	<10	<10	<10	<10
>C10 - C16 Fraction	>C10_C16	50	mg/kg	**330**	**350**	**80**	<50	<50
>C16 - C34 Fraction	----	100	mg/kg	**3060**	**3290**	**570**	<100	**300**
>C34 - C40 Fraction	----	100	mg/kg	**1400**	**1590**	**260**	<100	**170**
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg	**4790**	**5230**	**910**	<50	**470**
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg	**330**	**350**	**80**	<50	<50
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	<1
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**90.8**	**86.7**	**95.9**	**95.9**	**76.3**
Toluene-D8	2037-26-5	0.1	%	**104**	**110**	**122**	**113**	**102**
4-Bromofluorobenzene	460-00-4	0.1	%	**97.2**	**106**	**116**	**112**	**97.9**
EP075S: Acid Extractable Surrogates								
2-Fluorophenol	367-12-4	0.1	%	**51.2**	**49.5**	**82.6**	**93.3**	**92.9**
Phenol-d6	13127-88-3	0.1	%	**71.1**	**72.4**	**61.4**	**68.2**	**57.6**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**

			Client sample ID	**BH3 0.5-1.0M**	**NH3 1.5-2.0M**	**BH4 0-0.45M**	**BH4 1.5-2.0M**	**BH5 0-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-002**	**ES1501013-004**	**ES1501013-005**	**ES1501013-007**	**ES1501013-008**
EP075S: Acid Extractable Surrogates - Continued								
2-Chlorophenol-D4	93951-73-6	0.1	%	**96.8**	**94.1**	**73.7**	**70.5**	**70.2**
2.4.6-Tribromophenol	118-79-6	0.1	%	**82.8**	**81.8**	**67.0**	**47.3**	**68.4**
EP075T: Base/Neutral Extractable Surrogates								
Nitrobenzene-D5	4165-60-0	0.1	%	**99.0**	**90.7**	**75.3**	**66.4**	**61.5**
1.2-Dichlorobenzene-D4	2199-69-1	0.1	%	**76.9**	**78.0**	**66.4**	**64.5**	**59.4**
2-Fluorobiphenyl	321-60-8	0.1	%	**92.8**	**88.7**	**71.8**	**60.5**	**59.9**
Anthracene-d10	1719-06-8	0.1	%	**86.6**	**86.4**	**78.0**	**75.7**	**70.3**
4-Terphenyl-d14	1718-51-0	0.1	%	**99.9**	**101**	**77.9**	**76.0**	**67.3**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**98.3**	**93.2**	**102**	**103**	**82.4**
Toluene-D8	2037-26-5	0.1	%	**106**	**112**	**125**	**115**	**104**
4-Bromofluorobenzene	460-00-4	0.1	%	**94.2**	**110**	**123**	**118**	**105**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**6.9**	**4.1**	**4.6**	**9.2**	**9.9**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**6**	<5	<5	**7**	**5**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**13**	<2	**9**	**5**	**9**
Copper	7440-50-8	5	mg/kg	**9**	<5	**7**	<5	**6**
Lead	7439-92-1	5	mg/kg	**7**	<5	**5**	**7**	**7**
Nickel	7440-02-0	2	mg/kg	**13**	**3**	**14**	**6**	**10**
Zinc	7440-66-6	5	mg/kg	**32**	**10**	**30**	**18**	**24**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EP050: Anionic Surfactants as MBAS								
Anionic Surfactants as MBAS	----	1	mg/kg	<200	<1	<100	----	----
EP074A: Monocyclic Aromatic Hydrocarbons								
Styrene	100-42-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Isopropylbenzene	98-82-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
n-Propylbenzene	103-65-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.3.5-Trimethylbenzene	108-67-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
sec-Butylbenzene	135-98-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2.4-Trimethylbenzene	95-63-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
tert-Butylbenzene	98-06-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
p-Isopropyltoluene	99-87-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
n-Butylbenzene	104-51-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP074B: Oxygenated Compounds								
Vinyl Acetate	108-05-4	5	mg/kg	<5	<5	<5	----	----
2-Butanone (MEK)	78-93-3	5	mg/kg	<5	<5	<5	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	5	mg/kg	<5	<5	<5	----	----
2-Hexanone (MBK)	591-78-6	5	mg/kg	<5	<5	<5	----	----
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2-Dichloropropane	78-87-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP074D: Fumigants - Continued								
cis-1.3-Dichloropropylene	10061-01-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
trans-1.3-Dichloropropylene	10061-02-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2-Dibromoethane (EDB)	106-93-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	5	mg/kg	<5	<5	<5	----	----
Chloromethane	74-87-3	5	mg/kg	<5	<5	<5	----	----
Vinyl chloride	75-01-4	5	mg/kg	<5	<5	<5	----	----
Bromomethane	74-83-9	5	mg/kg	<5	<5	<5	----	----
Chloroethane	75-00-3	5	mg/kg	<5	<5	<5	----	----
Trichlorofluoromethane	75-69-4	5	mg/kg	<5	<5	<5	----	----
1.1-Dichloroethene	75-35-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Iodomethane	74-88-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
trans-1.2-Dichloroethene	156-60-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.1-Dichloroethane	75-34-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
cis-1.2-Dichloroethene	156-59-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.1.1-Trichloroethane	71-55-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.1-Dichloropropylene	563-58-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Carbon Tetrachloride	56-23-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2-Dichloroethane	107-06-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Trichloroethene	79-01-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Dibromomethane	74-95-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.1.2-Trichloroethane	79-00-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.3-Dichloropropane	142-28-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Tetrachloroethene	127-18-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.1.1.2-Tetrachloroethane	630-20-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
trans-1.4-Dichloro-2-butene	110-57-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.1.2.2-Tetrachloroethane	79-34-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2.3-Trichloropropane	96-18-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Pentachloroethane	76-01-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2-Dibromo-3-chloropropane	96-12-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Bromobenzene	108-86-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP074F: Halogenated Aromatic Compounds - Continued								
2-Chlorotoluene	95-49-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Chlorotoluene	106-43-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2.3-Trichlorobenzene	87-61-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP074G: Trihalomethanes								
Chloroform	67-66-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Bromodichloromethane	75-27-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Dibromochloromethane	124-48-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Bromoform	75-25-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	0.5	mg/kg	----	----	----	<0.5	<0.5
2-Chlorophenol	95-57-8	0.5	mg/kg	----	----	----	<0.5	<0.5
2-Methylphenol	95-48-7	0.5	mg/kg	----	----	----	<0.5	<0.5
3- & 4-Methylphenol	1319-77-3	1	mg/kg	----	----	----	<1	<1
2-Nitrophenol	88-75-5	0.5	mg/kg	----	----	----	<0.5	<0.5
2.4-Dimethylphenol	105-67-9	0.5	mg/kg	----	----	----	<0.5	<0.5
2.4-Dichlorophenol	120-83-2	0.5	mg/kg	----	----	----	<0.5	<0.5
2.6-Dichlorophenol	87-65-0	0.5	mg/kg	----	----	----	<0.5	<0.5
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	----	----	----	<0.5	<0.5
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	----	----	----	<0.5	<0.5
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	----	----	----	<0.5	<0.5
Pentachlorophenol	87-86-5	2	mg/kg	----	----	----	<2	<2
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	----	----	----	<0.5	<0.5
Acenaphthylene	208-96-8	0.5	mg/kg	----	----	----	<0.5	<0.5
Acenaphthene	83-32-9	0.5	mg/kg	----	----	----	<0.5	<0.5
Fluorene	86-73-7	0.5	mg/kg	----	----	----	<0.5	<0.5
Phenanthrene	85-01-8	0.5	mg/kg	----	----	----	<0.5	<0.5
Anthracene	120-12-7	0.5	mg/kg	----	----	----	<0.5	<0.5
Fluoranthene	206-44-0	0.5	mg/kg	----	----	----	<0.5	<0.5
Pyrene	129-00-0	0.5	mg/kg	----	----	----	<0.5	<0.5
Benz(a)anthracene	56-55-3	0.5	mg/kg	----	----	----	<0.5	<0.5
Chrysene	218-01-9	0.5	mg/kg	----	----	----	<0.5	<0.5
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	----	----	----	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	----	----	----	<0.5	<0.5
Benzo(a)pyrene	50-32-8	0.5	mg/kg	----	----	----	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	----	----	----	<0.5	<0.5
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	----	----	----	<0.5	<0.5
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	----	----	----	<0.5	<0.5
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	mg/kg	----	----	----	<0.5	<0.5
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	mg/kg	----	----	----	<0.5	<0.5
^ **Benzo(a)pyrene TEQ (half LOR)**	----	0.5	mg/kg	----	----	----	**0.6**	**0.6**
^ **Benzo(a)pyrene TEQ (LOR)**	----	0.5	mg/kg	----	----	----	**1.2**	**1.2**
EP075A: Phenolic Compounds								
Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
3- & 4-Methylphenol	1319-77-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Pentachlorophenol	87-86-5	1	mg/kg	<1	<1	<1	----	----
EP075B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2-Methylnaphthalene	91-57-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2-Chloronaphthalene	91-58-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP075B: Polynuclear Aromatic Hydrocarbons - Continued								
Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg	<1	<1	<1	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
3-Methylcholanthrene	56-49-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
^ **Sum of PAHs**	----	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
^ **Benzo(a)pyrene TEQ (half LOR)**	----	0.5	mg/kg	**0.6**	**0.6**	**0.6**	----	----
^ **Benzo(a)pyrene TEQ (LOR)**	----	0.5	mg/kg	**1.2**	**1.2**	**1.2**	----	----
EP075C: Phthalate Esters								
Dimethyl phthalate	131-11-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Diethyl phthalate	84-66-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Di-n-butyl phthalate	84-74-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Butyl benzyl phthalate	85-68-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
bis(2-ethylhexyl) phthalate	117-81-7	5.0	mg/kg	<5.0	<5.0	<5.0	----	----
Di-n-octylphthalate	117-84-0	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP075D: Nitrosamines								
N-Nitrosomethylethylamine	10595-95-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-Nitrosodiethylamine	55-18-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-Nitrosopyrrolidine	930-55-2	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
N-Nitrosomorpholine	59-89-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-Nitrosodi-n-propylamine	621-64-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-Nitrosopiperidine	100-75-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-Nitrosodibutylamine	924-16-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Methapyrilene	91-80-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP075E: Nitroaromatics and Ketones								
2-Picoline	109-06-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP075E: Nitroaromatics and Ketones - Continued								
Acetophenone	98-86-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Nitrobenzene	98-95-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Isophorone	78-59-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2.6-Dinitrotoluene	606-20-2	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
2.4-Dinitrotoluene	121-14-2	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
1-Naphthylamine	134-32-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Nitroquinoline-N-oxide	56-57-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
5-Nitro-o-toluidine	99-55-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Azobenzene	103-33-3	1	mg/kg	<1	<1	<1	----	----
1.3.5-Trinitrobenzene	99-35-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Phenacetin	62-44-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Aminobiphenyl	92-67-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Pentachloronitrobenzene	82-68-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Pronamide	23950-58-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Dimethylaminoazobenzene	60-11-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Chlorobenzilate	510-15-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP075F: Haloethers								
Bis(2-chloroethyl) ether	111-44-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Bis(2-chloroethoxy) methane	111-91-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Chlorophenyl phenyl ether	7005-72-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Bromophenyl phenyl ether	101-55-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP075G: Chlorinated Hydrocarbons								
1.3-Dichlorobenzene	541-73-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.4-Dichlorobenzene	106-46-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2-Dichlorobenzene	95-50-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Hexachloroethane	67-72-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
1.2.4-Trichlorobenzene	120-82-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Hexachloropropylene	1888-71-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Hexachlorobutadiene	87-68-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Hexachlorocyclopentadiene	77-47-4	2.5	mg/kg	<2.5	<2.5	<2.5	----	----
Pentachlorobenzene	608-93-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Hexachlorobenzene (HCB)	118-74-1	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
EP075H: Anilines and Benzidines								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP075H: Anilines and Benzidines - Continued								
Aniline	62-53-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Chloroaniline	106-47-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
2-Nitroaniline	88-74-4	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
3-Nitroaniline	99-09-2	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Dibenzofuran	132-64-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4-Nitroaniline	100-01-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Carbazole	86-74-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
3.3`-Dichlorobenzidine	91-94-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP075I: Organochlorine Pesticides								
alpha-BHC	319-84-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
beta-BHC	319-85-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
gamma-BHC	58-89-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
delta-BHC	319-86-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Heptachlor	76-44-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Aldrin	309-00-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Heptachlor epoxide	1024-57-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
alpha-Endosulfan	959-98-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4.4`-DDE	72-55-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Dieldrin	60-57-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Endrin	72-20-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4.4`-DDD	72-54-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
4.4`-DDT	50-29-3	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
EP075J: Organophosphorus Pesticides								
Dichlorvos	62-73-7	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Dimethoate	60-51-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Diazinon	333-41-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Malathion	121-75-5	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Fenthion	55-38-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Chlorpyrifos	2921-88-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Pirimphos-ethyl	23505-41-1	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Chlorfenvinphos	470-90-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP075J: Organophosphorus Pesticides - Continued								
Prothiofos	34643-46-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Ethion	563-12-2	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg	<100	<100	<100	**740**	<100
C29 - C36 Fraction	----	100	mg/kg	<100	<100	<100	**410**	<100
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	<50	<50	<50	**1150**	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	<10	<10
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	<10	<10	<10	<10
>C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	<50	**50**	<50
>C16 - C34 Fraction	----	100	mg/kg	<100	<100	<100	**1030**	<100
>C34 - C40 Fraction	----	100	mg/kg	<100	<100	<100	**230**	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg	<50	<50	<50	**1310**	<50
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg	<50	<50	<50	**50**	<50
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	<1
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**84.3**	**83.7**	**81.2**	----	----
Toluene-D8	2037-26-5	0.1	%	**105**	**104**	**101**	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	**105**	**104**	**101**	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	----	----	----	**94.4**	**83.9**
2-Chlorophenol-D4	93951-73-6	0.1	%	----	----	----	**81.6**	**75.3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH5 1-1.3M**	**BH6 0-0.5M**	**BH6 1.5-2.0M**	**BH7 0-0.5M**	**BH7 1.0-1.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-009**	**ES1501013-010**	**ES1501013-011**	**ES1501013-012**	**ES1501013-013**
EP075(SIM)S: Phenolic Compound Surrogates - Continued								
2.4.6-Tribromophenol	118-79-6	0.1	%	----	----	----	**54.8**	**56.3**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	----	----	----	**96.7**	**81.4**
Anthracene-d10	1719-06-8	0.1	%	----	----	----	**93.3**	**89.6**
4-Terphenyl-d14	1718-51-0	0.1	%	----	----	----	**87.4**	**82.8**
EP075S: Acid Extractable Surrogates								
2-Fluorophenol	367-12-4	0.1	%	**81.1**	**98.6**	**98.3**	----	----
Phenol-d6	13127-88-3	0.1	%	**72.5**	**60.4**	**72.5**	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**79.2**	**67.0**	**82.0**	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%	**56.4**	**44.4**	**50.2**	----	----
EP075T: Base/Neutral Extractable Surrogates								
Nitrobenzene-D5	4165-60-0	0.1	%	**71.9**	**62.2**	**76.2**	----	----
1.2-Dichlorobenzene-D4	2199-69-1	0.1	%	**68.5**	**58.8**	**72.8**	----	----
2-Fluorobiphenyl	321-60-8	0.1	%	**72.2**	**57.8**	**78.4**	----	----
Anthracene-d10	1719-06-8	0.1	%	**82.5**	**72.5**	**90.0**	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**81.7**	**70.5**	**90.4**	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**91.0**	**90.4**	**87.6**	**90.4**	**98.5**
Toluene-D8	2037-26-5	0.1	%	**108**	**106**	**103**	**108**	**115**
4-Bromofluorobenzene	460-00-4	0.1	%	**112**	**110**	**105**	**108**	**117**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	**BH8 0.5-0.9M**	**BH8 DUP1**	**BH8 1.0-1.5M**	**BH9 0-0.5M**	**BH9 1.5-2.0M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-016**	**ES1501013-017**	**ES1501013-018**	**ES1501013-019**	**ES1501013-021**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**8.9**	**6.6**	**12.1**	**7.4**	**5.6**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**6**	**5**	**5**	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**8**	**7**	**10**	**9**	**16**
Copper	7440-50-8	5	mg/kg	**7**	**7**	**6**	**6**	**18**
Lead	7439-92-1	5	mg/kg	**8**	**10**	**8**	**6**	<5
Nickel	7440-02-0	2	mg/kg	**7**	**7**	**10**	**5**	**6**
Zinc	7440-66-6	5	mg/kg	**26**	**24**	**25**	**23**	**44**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
3- & 4-Methylphenol	1319-77-3	1	mg/kg	<1	<1	<1	<1	<1
2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol	87-86-5	2	mg/kg	<2	<2	<2	<2	<2
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	**0.8**	**0.9**	<0.5	<0.5	<0.5
Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	85-01-8	0.5	mg/kg	**6.8**	**6.3**	**1.1**	<0.5	<0.5
Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	206-44-0	0.5	mg/kg	**1.2**	**1.5**	<0.5	<0.5	<0.5
Pyrene	129-00-0	0.5	mg/kg	**2.3**	**3.1**	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	**BH8 0.5-0.9M**	**BH8 DUP1**	**BH8 1.0-1.5M**	**BH9 0-0.5M**	**BH9 1.5-2.0M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-016**	**ES1501013-017**	**ES1501013-018**	**ES1501013-019**	**ES1501013-021**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	mg/kg	**11.1**	**11.8**	**1.1**	<0.5	<0.5
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Benzo(a)pyrene TEQ (half LOR)**	----	0.5	mg/kg	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**
^ **Benzo(a)pyrene TEQ (LOR)**	----	0.5	mg/kg	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg	**420**	**440**	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg	**5990**	**7070**	**900**	**830**	<100
C29 - C36 Fraction	----	100	mg/kg	**2360**	**3070**	**330**	**690**	<100
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	**8770**	**10600**	**1230**	**1520**	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	<10	<10
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	<10	<10	<10	<10
>C10 - C16 Fraction	>C10_C16	50	mg/kg	**1090**	**1170**	**150**	<50	<50
>C16 - C34 Fraction	----	100	mg/kg	**7300**	**8500**	**1070**	**1300**	<100
>C34 - C40 Fraction	----	100	mg/kg	**1410**	**1860**	**250**	**480**	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg	**9800**	**11500**	**1470**	**1780**	<50
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg	**1090**	**1170**	**150**	<50	<50
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH8 0.5-0.9M**	**BH8 DUP1**	**BH8 1.0-1.5M**	**BH9 0-0.5M**	**BH9 1.5-2.0M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00	14-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-016**	**ES1501013-017**	**ES1501013-018**	**ES1501013-019**	**ES1501013-021**
EP080: BTEXN - Continued								
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	<1
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**80.8**	**83.6**	**84.9**	**86.3**	**87.4**
2-Chlorophenol-D4	93951-73-6	0.1	%	**80.4**	**84.6**	**85.2**	**90.5**	**97.6**
2.4.6-Tribromophenol	118-79-6	0.1	%	**63.4**	**55.1**	**66.3**	**85.4**	**77.9**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**91.3**	**95.4**	**86.8**	**83.8**	**83.3**
Anthracene-d10	1719-06-8	0.1	%	**86.3**	**86.0**	**92.7**	**91.0**	**83.8**
4-Terphenyl-d14	1718-51-0	0.1	%	**86.2**	**87.0**	**88.9**	**84.9**	**91.0**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**97.1**	**94.2**	**90.3**	**85.5**	**81.4**
Toluene-D8	2037-26-5	0.1	%	**112**	**113**	**107**	**98.8**	**97.0**
4-Bromofluorobenzene	460-00-4	0.1	%	**112**	**118**	**115**	**99.7**	**105**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH10 0.2-0.5M**	**BH10 0.5-1.0M**	**TRIP BLANK 10**	**TRIP SPIKE 10**	**BH1 0.3-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	13-JAN-2015 15:00	13-JAN-2015 15:00	15-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-022**	**ES1501013-023**	**ES1501013-024**	**ES1501013-025**	**ES1501013-026**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**7.8**	**3.6**	----	----	**2.5**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	**9**	----	----	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	<1
Chromium	7440-47-3	2	mg/kg	**15**	**23**	----	----	**4**
Copper	7440-50-8	5	mg/kg	**13**	**20**	----	----	<5
Lead	7439-92-1	5	mg/kg	**6**	**10**	----	----	**6**
Nickel	7440-02-0	2	mg/kg	**6**	**8**	----	----	**6**
Zinc	7440-66-6	5	mg/kg	**35**	**49**	----	----	**16**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	----	----	----
3- & 4-Methylphenol	1319-77-3	1	mg/kg	<1	<1	----	----	----
2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	----	----	----
2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	----	----	----
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	----	----	----
Pentachlorophenol	87-86-5	2	mg/kg	<2	<2	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	----	----	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH10 0.2-0.5M**	**BH10 0.5-1.0M**	**TRIP BLANK 10**	**TRIP SPIKE 10**	**BH1 0.3-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	13-JAN-2015 15:00	13-JAN-2015 15:00	15-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-022**	**ES1501013-023**	**ES1501013-024**	**ES1501013-025**	**ES1501013-026**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	mg/kg	<0.5	<0.5	----	----	<0.5
^ **Benzo(a)pyrene TEQ (half LOR)**	----	0.5	mg/kg	**0.6**	**0.6**	----	----	**0.6**
^ **Benzo(a)pyrene TEQ (LOR)**	----	0.5	mg/kg	**1.2**	**1.2**	----	----	**1.2**
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	**23**	<10
C10 - C14 Fraction	----	50	mg/kg	<50	<50	----	----	<50
C15 - C28 Fraction	----	100	mg/kg	<100	<100	----	----	<100
C29 - C36 Fraction	----	100	mg/kg	<100	<100	----	----	<100
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	<50	<50	----	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	**29**	<10
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	<10	<10	**16**	<10
>C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	----	----	<50
>C16 - C34 Fraction	----	100	mg/kg	<100	<100	----	----	<100
>C34 - C40 Fraction	----	100	mg/kg	<100	<100	----	----	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg	<50	<50	----	----	<50
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg	<50	<50	----	----	<50
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	**5.3**	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	**0.9**	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	**4.9**	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	**2.1**	<0.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH10 0.2-0.5M**	**BH10 0.5-1.0M**	**TRIP BLANK 10**	**TRIP SPIKE 10**	**BH1 0.3-0.5M**
			Client sampling date / time	14-JAN-2015 15:00	14-JAN-2015 15:00	13-JAN-2015 15:00	13-JAN-2015 15:00	15-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-022**	**ES1501013-023**	**ES1501013-024**	**ES1501013-025**	**ES1501013-026**
EP080: BTEXN - Continued								
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	**13.2**	<0.2
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	**7.0**	<0.5
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	<1
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**83.6**	**93.6**	----	----	**85.4**
2-Chlorophenol-D4	93951-73-6	0.1	%	**76.4**	**80.9**	----	----	**79.9**
2.4.6-Tribromophenol	118-79-6	0.1	%	**59.6**	**63.9**	----	----	**70.2**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**81.2**	**86.9**	----	----	**85.6**
Anthracene-d10	1719-06-8	0.1	%	**92.8**	**92.4**	----	----	**96.5**
4-Terphenyl-d14	1718-51-0	0.1	%	**82.4**	**82.4**	----	----	**88.6**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**77.1**	**83.3**	**84.5**	**87.4**	**90.0**
Toluene-D8	2037-26-5	0.1	%	**94.6**	**102**	**96.2**	**102**	**108**
4-Bromofluorobenzene	460-00-4	0.1	%	**102**	**107**	**101**	**108**	**114**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH1 3.5-4.0M**	**BH2 2.1-2.5M**	**BH2 DUP2**	**BH2 4.0-4.5M**	**ASB01 0-0.1M**
			Client sampling date / time	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-031**	**ES1501013-035**	**ES1501013-036**	**ES1501013-037**	**ES1501013-038**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**12.9**	**12.3**	**12.2**	**7.8**	----
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples								
Asbestos Detected	1332-21-4	0.1	g/kg	----	----	----	----	**No**
Asbestos Type	1332-21-4	-	--	----	----	----	----	**-**
Sample weight (dry)	----	0.01	g	----	----	----	----	**367**
APPROVED IDENTIFIER:	----	-	--	----	----	----	----	**C.OWLER**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**7**	<5	<5	**15**	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	**27**	**6**	**6**	**25**	----
Copper	7440-50-8	5	mg/kg	**25**	**29**	**29**	**17**	----
Lead	7439-92-1	5	mg/kg	**8**	**57**	**55**	**10**	----
Nickel	7440-02-0	2	mg/kg	**7**	**7**	**8**	**8**	----
Zinc	7440-66-6	5	mg/kg	**45**	**87**	**84**	**62**	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH1 3.5-4.0M**	**BH2 2.1-2.5M**	**BH2 DUP2**	**BH2 4.0-4.5M**	**ASB01 0-0.1M**
			Client sampling date / time	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-031**	**ES1501013-035**	**ES1501013-036**	**ES1501013-037**	**ES1501013-038**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
^ **Benzo(a)pyrene TEQ (half LOR)**	----	0.5	mg/kg	**0.6**	**0.6**	**0.6**	**0.6**	----
^ **Benzo(a)pyrene TEQ (LOR)**	----	0.5	mg/kg	**1.2**	**1.2**	**1.2**	**1.2**	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	**19**	**30**	<10	----
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	mg/kg	<100	<100	**180**	<100	----
C29 - C36 Fraction	----	100	mg/kg	<100	**180**	**320**	<100	----
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	<50	**180**	**500**	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	**19**	**32**	<10	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	**19**	**32**	<10	----
>C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	<50	<50	----
>C16 - C34 Fraction	----	100	mg/kg	<100	**210**	**390**	<100	----
>C34 - C40 Fraction	----	100	mg/kg	<100	**140**	**240**	<100	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg	<50	**350**	**630**	<50	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg	<50	<50	<50	<50	----
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	**0.4**	**0.5**	<0.2	----
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	**0.4**	**0.5**	<0.2	----
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**101**	**89.6**	**85.0**	**88.0**	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**85.1**	**90.8**	**83.2**	**84.0**	----
2.4.6-Tribromophenol	118-79-6	0.1	%	**64.6**	**76.4**	**76.8**	**78.2**	----
EP075(SIM)T: PAH Surrogates								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH1 3.5-4.0M**	**BH2 2.1-2.5M**	**BH2 DUP2**	**BH2 4.0-4.5M**	**ASB01 0-0.1M**
			Client sampling date / time	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	**ES1501013-031**	**ES1501013-035**	**ES1501013-036**	**ES1501013-037**	**ES1501013-038**
EP075(SIM)T: PAH Surrogates - Continued								
2-Fluorobiphenyl	321-60-8	0.1	%	**83.5**	**83.1**	**88.0**	**84.7**	----
Anthracene-d10	1719-06-8	0.1	%	**83.8**	**93.0**	**89.4**	**98.5**	----
4-Terphenyl-d14	1718-51-0	0.1	%	**90.5**	**83.8**	**79.8**	**86.3**	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**100**	**107**	**113**	**108**	----
Toluene-D8	2037-26-5	0.1	%	**102**	**109**	**113**	**107**	----
4-Bromofluorobenzene	460-00-4	0.1	%	**94.3**	**108**	**115**	**110**	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**ASB01 FRAGMENT**	**ASB03 0-0.1M**	**ASB04 0-0.1M**	**ASB05 0-0.1M**	**ASB05 FRAGMENT**
			Client sampling date / time	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1501013-039**	**ES1501013-041**	**ES1501013-042**	**ES1501013-043**	**ES1501013-044**
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples								
Asbestos Detected	1332-21-4	0.1	g/kg	**Yes**	**No**	**No**	**Yes**	**Yes**
Asbestos Type	1332-21-4	-	--	**Ch + Am + Cr**	**-**	**-**	**Ch**	**Ch**
Sample weight (dry)	----	0.01	g	**42.2**	**319**	**283**	**366**	**10.6**
APPROVED IDENTIFIER:	----	-	--	**C.OWLER**	**C.OWLER**	**C.OWLER**	**C.OWLER**	**C.OWLER**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASB07 0-0.1M	ASB08 0-0.1M	ASB08 FRAGMENT	ASB09 FRAGMENT	TSC
			Client sampling date / time	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	15-JAN-2015 15:00	13-JAN-2015 15:00
Compound	CAS Number	LOR	Unit	ES1501013-046	ES1501013-047	ES1501013-048	ES1501013-049	ES1501013-050
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples								
Asbestos Detected	1332-21-4	0.1	g/kg	No	No	No	Yes	----
Asbestos Type	1332-21-4	-	--	-	-	-	Ch + Am	----
Sample weight (dry)	----	0.01	g	243	333	11.9	48.9	----
APPROVED IDENTIFIER:	----	-	--	C.OWLER	C.OWLER	C.OWLER	C.OWLER	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	----	----	----	----	24
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	----	----	----	----	30
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg	----	----	----	----	16
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	----	----	----	----	<0.2
Toluene	108-88-3	0.5	mg/kg	----	----	----	----	5.5
Ethylbenzene	100-41-4	0.5	mg/kg	----	----	----	----	0.9
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	----	----	----	----	5.0
ortho-Xylene	95-47-6	0.5	mg/kg	----	----	----	----	2.1
^ Sum of BTEX	----	0.2	mg/kg	----	----	----	----	13.5
^ Total Xylenes	1330-20-7	0.5	mg/kg	----	----	----	----	7.1
Naphthalene	91-20-3	1	mg/kg	----	----	----	----	<1
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	----	----	----	88.5
Toluene-D8	2037-26-5	0.1	%	----	----	----	----	102
4-Bromofluorobenzene	460-00-4	0.1	%	----	----	----	----	110

Analytical Results

Descriptive Results

Sub-Matrix: **SOIL**

Method: Compound	*Client sample ID - Client sampling date / time*	*Analytical Results*
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples		
EA200: Description	ASB01 0-0.1M - 15-JAN-2015 15:00	Mid brown sandy soil with some grey rocks
EA200: Description	ASB01 FRAGMENT - 15-JAN-2015 15:00	Five pieces of bonded asbestos cement sheeting approx 55 x 30 x 4mm
EA200: Description	ASB03 0-0.1M - 15-JAN-2015 15:00	Mid brown sandy soil with some grey rocks plus some brick debris
EA200: Description	ASB04 0-0.1M - 15-JAN-2015 15:00	Grey sandy soil
EA200: Description	ASB05 0-0.1M - 15-JAN-2015 15:00	Pale brown clay soil plus some cement sheeting and one small fragment of degraded and friable asbestos fibre board approx 6 x 5 x 3mm
EA200: Description	ASB05 FRAGMENT - 15-JAN-2015 15:00	One piece of bonded asbestos cement sheeting approx 45 x 40 x 4mm
EA200: Description	ASB07 0-0.1M - 15-JAN-2015 15:00	Pale grey-brown sandy soil with some concrete debris and some vegetation
EA200: Description	ASB08 0-0.1M - 15-JAN-2015 15:00	Pale brown sandy soil
EA200: Description	ASB08 FRAGMENT - 15-JAN-2015 15:00	Three pieces of cement sheeting approx 50 x 40 x 4mm
EA200: Description	ASB09 FRAGMENT - 15-JAN-2015 15:00	Two pieces of bonded asbestos cement sheeting approx 135 x 40 x 5mm

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	*CAS Number*	*Recovery Limits (%)*	
		Low	***High***
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	64	130
Toluene-D8	2037-26-5	66	136
4-Bromofluorobenzene	460-00-4	60	122
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	63	123
2-Chlorophenol-D4	93951-73-6	66	122
2.4.6-Tribromophenol	118-79-6	40	138
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	70	122
Anthracene-d10	1719-06-8	66	128
4-Terphenyl-d14	1718-51-0	65	129
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	29.4	149
Phenol-d6	13127-88-3	32	128
2-Chlorophenol-D4	93951-73-6	32	128
2.4.6-Tribromophenol	118-79-6	12.5	121
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	33	125
1.2-Dichlorobenzene-D4	2199-69-1	34	108
2-Fluorobiphenyl	321-60-8	35	121
Anthracene-d10	1719-06-8	35	123
4-Terphenyl-d14	1718-51-0	33	125
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72.8	133.2
Toluene-D8	2037-26-5	73.9	132.1
4-Bromofluorobenzene	460-00-4	71.6	130.0

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ ADELAIDE 21 Burma Road Pooraka SA 5095
Ph: 08 8359 0890 E: adelaide@alsglobal.com
☐ BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
☐ GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

☐ MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com
☐ MELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
☐ MUDGEE 27 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐ NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com
☐ NOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 02 4423 2063 E: nowra@alsglobal.com
☐ PERTH 10 Hod Way Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☑ SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
☐ TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
☐ WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: Marulan South Mine
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS
CONTACT PH: 0488 994 646
SAMPLER: AS ABOVE
SAMPLER MOBILE: AS ABOVE
COC emailed to ALS? ([redacted] YES
EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): (as above)
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: NIL

TURNAROUND REQUIREMENTS :
(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: [✓ 1] 2 3 4 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
GAM	Steven		
DATE/TIME: 16/1/15 1:20pm	DATE/TIME: 19/1/15 1130	DATE/TIME:	DATE/TIME:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).									Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	TPH BTEX S-26 H8 PAH	S-23 SVOC/VOC	TPH BTEX M8 S-27 PAH phenol	EP050 MBAS	EA200 asbestos	S2 8 metals	HOLD	S4 TPH C6-C40 BTEX	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. HC = hydrocarbon.
1	BH3 0-0.4m	14.1.15	SOIL	150mm GLASS JAR	1							✓		—
2	BH3 0.5-1.0m	〃	〃	〃	1		✓				✓		✓	—
3	BH3 1.2-1.5m	〃	〃	〃	1							✓		Faint HC odour
4	BH3 1.5-2.0m	〃	〃	〃	1		✓				✓		✓	—
5	BH4 0-0.45m	〃	〃	〃	1		✓				✓		✓	—
6	BH4 0.5-1.0m	〃	〃	〃	1							✓		—
7	BH4 1.5-2.0m	〃	〃	〃	1		✓				✓		✓	Faint HC odour
8	BH5 0-0.5m	〃	〃	〃	2		✓		✓		✓		✓	—
9	BH5 1-1.3m	〃	〃	〃	2		✓		✓		✓		✓	—
10	BH6 0-0.5m	〃	〃	〃	2		✓		✓		✓		✓	—
11	BH6 1.5-2.0m	〃	〃	〃	2		✓		✓		✓		✓	—
				TOTAL	—	—	8	—	4	—	8	3	8	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass,
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

Environmental Division
Sydney
Work Order
ES1501013

Telephone : +61-2-8784 8555

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994646
SAMPLER: as above SAMPLER MOBILE: as above
COC emailed to ALS? ([redacted] YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY0/14/15

COC SEQUENCE NUMBER (Circle)
COC: 1 [✓ 2] 3 4 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

RELINQUISHED BY: GAM
DATE/TIME: 16/1/15 1:20pm
RECEIVED BY: Steven
DATE/TIME: 19/1/15 1130
RELINQUISHED BY:
DATE/TIME:
RECEIVED BY:
DATE/TIME:

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ~~[illegible]~~ PLEASE SEND TRIPLICATE SAMPLES TO ENVIROLAB SYDNEY

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S26	S-23	S-27	EP050	EA200		HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. hc = hydrocarbon
12	BH7 ~~[illegible]~~ 0 - 0.5m	14.1.15	SOIL	150mm JAR GLASS	1			✓						—
13	BH7 1 - 1.5m	"	"	"	1			✓						—
14	BH7 1.5-2.0m	"	"	"	1							✓		—
15	BH8 0 - 0.5m	"	"	"	1							✓		—
16	BH8 0.5 - 0.9m	"	"	"	1			✓						strong hc odour
17	BH8 DUP1	"	"	"	1			✓						—
	BH8 TRIP1	"	"	"	1			✓					*	PLEASE SEND TO ENVIROLAB SYDNEY *
18	BH8 1.0 - 1.5m	"	"	"	1			✓						—
19	BH9 0 - 0.5m	"	"	"	1			✓						HC odour
20	BH9 0.5 - 1.0m	"	"	"	1							✓		faint hc odour
21	BH9 1.5 - 2.0m	"	"	"	1			✓						faint hc odour
					–	–	–	8	–	–	–	3	–	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass, H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994646
SAMPLER: as above SAMPLER MOBILE: as above
COC emailed to ALS? YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: NIL

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: 1 2 (3) 4 5 6 7
OF: 1 2 3 4 (5) 6 7

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
GAM	Steven		
DATE/TIME: 16/1/15 1:20pm	DATE/TIME: 19/1/15 1130	DATE/TIME:	DATE/TIME:

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	BP050	EA200	TPH C6-C10 and BTEX	HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. HC - hydrocarbon
22	BH10 0.2-0.5m	14.1.15	SOIL	150mm GLASS JAR	1			✓						—
23	BH10 0.5-1.0m	"	"	"	1			✓						—
24	TRIP BLANK (10)	13.1.15	"	"	1						✓			prepared by ALS
25	TRIP SPIKE (10)	13.1.15	"	"	1						✓			"
26	BH1 0.3-0.5m	15.1.15	"	"	1	✓								faint HC odour
27	BH1 0.5-1.0m	"	"	"	1							✓		—
28	BH1 1.5-2.0m	"	"	"	1							✓		faint HC odour
29	BH1 2.5-3.0m	"	"	"	1							✓		—
30	BH1 3.0-3.5m	"	"	"	1							✓		faint HC odour
31	BH1 3.5-4.0m	"	"	"	1	✓								—
					—	2	—	18	—	—	2	4	—	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

[illegible] ✓ [illegible]

CLIENT: 201C ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994646
SAMPLER: as above SAMPLER MOBILE: as above
DOC emailed to ALS? ([redacted]) YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@20ic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above

TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: 1 2 3 [✓ 4] 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
9AM DATE/TIME: 16/1/15 1:20pm	Steven DATE/TIME: 19/1/15 1130	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: Please forward TRIP 2 to Envirolab Sydney

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	EP050	EA200		MO2D		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. HC = hydrocarbon
32	BH2 0.3-0.5m	15.1.15	SOIL	150mm jar glass	1							✓		—
33	BH2 0.5-1.0m	"	"	"	1							✓		—
34	BH2 1.0-1.5m	"	"	"	1							✓		faint HC odor
35	BH2 2.1-2.5m	"	"	"	1	✓								HC odor
36	BH2 DUP 2	"	"	"	1	✓								—
*	BH2 TRIP 2	"	"	"	1	✓								FWD to ENVIROLAB SYDNEY
37	BH2 4.0-4.5	"	"	"	1	✓								—
					—	4	-	-	-	-	-	3	—	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488994646
SAMPLER: AS ABOVE SAMPLER MOBILE: as above
COC emailed to ALS? ([redacted] YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email invoice to (will default to PM if no other addresses are listed): as above

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: 1 2 3 4 [✓ 5] 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY: GAM
DATE/TIME: 16/1/15 1:20pm

RECEIVED BY: Steven
DATE/TIME: 19/1/15 1130

RELINQUISHED BY:
DATE/TIME:

RECEIVED BY:
DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: NIL

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	EP050	EA200		HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
38	ASB01 0-0.1m	15.01.15	SOIL	plastic bag	1					✓				—
39	ASB01 fragment	"	—	"	1					✓				potential asbestos
40	ASB02 0-0.1m	"	SOIL	"	1							✓		—
41	ASB03 0-0.1m	"	"	"	1					✓				—
42	ASB04 0-0.1m	"	"	"	1					✓				—
43	ASB05 0-0.1m	"	"	"	1					✓				—
44	ASB05 fragment	"	—	"	1					✓				potential asbestos
45	ASB06 0-0.1m	"	SOIL	"	1							✓		"
46	ASB07 0-0.1m	"	"	"	1					✓				—
47	ASB08 0-0.1m	"	SOIL	"	1					✓				—
48	ASB08 fragment	"	—	"	1					✓				potential asbestos
49	ASB09 fragment	"		"	1					✓				"
				TOTAL	–	–	–	–	–	10	–	1	–	.

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

From: Graeme Malpass <graeme.malpass@zoic.com.au>
Sent: Monday, 19 January 2015 10:39 AM
To: Fadi Soro
Cc: Cindy Suen
Subject: Marulan Limestone Mine (Zoic Job Number 14071) ALS Quote Number SY/014/15
Attachments: 14071 COC.pdf

Hi Fadi

Further to delivery of samples on Friday and our subsequent discussion, please find attached the completed COC (including required analysis).

I look forward to receiving the sample receipt notice (SRN) in due course.

I would be grateful if you could send triplicate samples to Envirolab Sydney. Please clarify the requested testing to them as I have used your sample suite codes, as requested on the quotation provided.

I have also amended some of the testing from the quote as suites S27 and S23 would have duplicated some determinands (e.g. phenol and PAH). Consequently, where SVOC and VOC (S23) has been specified I have just added TPH C6-C40 / BTEX (S4) and 8 heavy metals (S2) instead of S27.

I trust the above is OK but please do not hesitate to contact me if you have any queries.

Thanks and regards

Graeme Malpass
Principal Environmental Scientist

ZOIC Environmental Pty Ltd

A: Suite 4, Level 3, 105 Pitt St Sydney NSW 2000

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1501013**	Page	: 1 of 29
Client	: **ZOIC ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR GRAEME MALPASS	Contact	: Client Services
Address	: SUITE 4, LEVEL3 105 PITT STREET SYDNEY NSW AUSTRALIA 2000	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: GRAEME.MALPASS@ZOIC.COM.AU	E-mail	: sydney@alsglobal.com
Telephone	: 02 9231 1045	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: MARULAN SOUTH MINE	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 19-JAN-2015
Sampler	: GM	Issue Date	: 28-JAN-2015
Order number	: 14071		
		No. of samples received	: 50
Quote number	: SY/014/15	No. of samples analysed	: 35

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

NATA Accredited
Laboratory 825

Accredited for
compliance with
ISO/IEC 17025.

WORLD RECOGNISED
ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Christopher Owler	Team Leader - Asbestos	Newcastle - Asbestos
Edwandy Fadjar	Organic Coordinator	Sydney Organics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA055: Moisture Content (QC Lot: 3793723)									
ES1500947-003	Anonymous	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	12.9	13.5	4.6	0% - 50%
ES1501010-003	Anonymous	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	73.9	79.2	6.9	0% - 20%
EA055: Moisture Content (QC Lot: 3793724)									
ES1501013-011	BH6 1.5-2.0M	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	4.6	4.4	4.1	No Limit
ES1501013-025	TRIP SPIKE 10	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	6.5	7.2	10.2	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 3795622)									
ES1500753-043	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	<5	<5	0.0	No Limit
ES1500753-037	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	94	90	4.6	0% - 20%
		EG005T: Nickel	7440-02-0	2	mg/kg	87	76	13.9	0% - 20%
		EG005T: Arsenic	7440-38-2	5	mg/kg	9	9	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	42	39	8.6	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	16	18	14.6	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	66	64	1.9	0% - 50%
EG005T: Total Metals by ICP-AES (QC Lot: 3795625)									
ES1501013-009	BH5 1-1.3M	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	13	12	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	13	13	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	6	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	9	8	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	7	7	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	32	30	6.4	No Limit
ES1501013-022	BH10 0.2-0.5M	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	15	17	17.2	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	6	6	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	13	14	9.8	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	6	6	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	35	37	5.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3795623)									
ES1500753-043	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3795626)									
ES1501013-022	BH10 0.2-0.5M	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EP050: Anionic Surfactants as MBAS (QC Lot: 3792115)									
ES1501013-008	BH5 0-0.5M	EP050: Anionic Surfactants as MBAS		1	mg/kg	<1	<1	0.0	No Limit
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: Styrene	100-42-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Isopropylbenzene	98-82-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: n-Propylbenzene	103-65-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.3.5-Trimethylbenzene	108-67-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: sec-Butylbenzene	135-98-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2.4-Trimethylbenzene	95-63-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: tert-Butylbenzene	98-06-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: p-Isopropyltoluene	99-87-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: n-Butylbenzene	104-51-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP074B: Oxygenated Compounds (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: Vinyl Acetate	108-05-4	5	mg/kg	<5	<5	0.0	No Limit
		EP074: 2-Butanone (MEK)	78-93-3	5	mg/kg	<5	<5	0.0	No Limit
		EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	5	mg/kg	<5	<5	0.0	No Limit
		EP074: 2-Hexanone (MBK)	591-78-6	5	mg/kg	<5	<5	0.0	No Limit
EP074C: Sulfonated Compounds (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: Carbon disulfide	75-15-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP074D: Fumigants (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: 2.2-Dichloropropane	594-20-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2-Dichloropropane	78-87-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: cis-1.3-Dichloropropylene	10061-01-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: trans-1.3-Dichloropropylene	10061-02-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2-Dibromoethane (EDB)	106-93-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP074E: Halogenated Aliphatic Compounds (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: 1.1-Dichloroethene	75-35-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Iodomethane	74-88-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: trans-1.2-Dichloroethene	156-60-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.1-Dichloroethane	75-34-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: cis-1.2-Dichloroethene	156-59-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.1.1-Trichloroethane	71-55-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.1-Dichloropropylene	563-58-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Carbon Tetrachloride	56-23-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2-Dichloroethane	107-06-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP074E: Halogenated Aliphatic Compounds (QC Lot: 3791527) - continued									
ES1501013-002	BH3 0.5-1.0M	EP074: Trichloroethene	79-01-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Dibromomethane	74-95-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.1.2-Trichloroethane	79-00-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.3-Dichloropropane	142-28-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Tetrachloroethene	127-18-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.1.1.2-Tetrachloroethane	630-20-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: trans-1.4-Dichloro-2-butene	110-57-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: cis-1.4-Dichloro-2-butene	1476-11-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.1.2.2-Tetrachloroethane	79-34-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2.3-Trichloropropane	96-18-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Pentachloroethane	76-01-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2-Dibromo-3-chloropropane	96-12-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Dichlorodifluoromethane	75-71-8	5	mg/kg	<5	<5	0.0	No Limit
		EP074: Chloromethane	74-87-3	5	mg/kg	<5	<5	0.0	No Limit
		EP074: Vinyl chloride	75-01-4	5	mg/kg	<5	<5	0.0	No Limit
		EP074: Bromomethane	74-83-9	5	mg/kg	<5	<5	0.0	No Limit
		EP074: Chloroethane	75-00-3	5	mg/kg	<5	<5	0.0	No Limit
		EP074: Trichlorofluoromethane	75-69-4	5	mg/kg	<5	<5	0.0	No Limit
EP074F: Halogenated Aromatic Compounds (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: Chlorobenzene	108-90-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Bromobenzene	108-86-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 2-Chlorotoluene	95-49-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 4-Chlorotoluene	106-43-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: 1.2.3-Trichlorobenzene	87-61-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP074G: Trihalomethanes (QC Lot: 3791527)									
ES1501013-002	BH3 0.5-1.0M	EP074: Chloroform	67-66-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Bromodichloromethane	75-27-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Dibromochloromethane	124-48-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP074: Bromoform	75-25-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP075(SIM)A: Phenolic Compounds (QC Lot: 3791561)									
ES1500960-001	Anonymous	EP075(SIM): Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075(SIM)A: Phenolic Compounds (QC Lot: 3791561) - continued									
ES1500960-001	Anonymous	EP075(SIM): 3- & 4-Methylphenol	1319-77-3	1	mg/kg	<1	<1	0.0	No Limit
		EP075(SIM): Pentachlorophenol	87-86-5	2	mg/kg	<2	<2	0.0	No Limit
ES1501013-022	BH10 0.2-0.5M	EP075(SIM): Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): 3- & 4-Methylphenol	1319-77-3	1	mg/kg	<1	<1	0.0	No Limit
		EP075(SIM): Pentachlorophenol	87-86-5	2	mg/kg	<2	<2	0.0	No Limit
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QC Lot: 3791561)									
ES1500960-001	Anonymous	EP075(SIM): Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(a)pyrene TEQ (zero)	----	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
ES1501013-022	BH10 0.2-0.5M	EP075(SIM): Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QC Lot: 3791561) - continued									
ES1501013-022	BH10 0.2-0.5M	EP075(SIM): Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Benzo(a)pyrene TEQ (zero)	----	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP075A: Phenolic Compounds (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 3- & 4-Methylphenol	1319-77-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pentachlorophenol	87-86-5	1	mg/kg	<1	<1	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 3- & 4-Methylphenol	1319-77-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pentachlorophenol	87-86-5	1	mg/kg	<1	<1	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075B: Polynuclear Aromatic Hydrocarbons (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Methylnaphthalene	91-57-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Chloronaphthalene	91-58-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Phenanthrene	85-01-8	0.5	mg/kg	1.9	1.9	0.0	No Limit
		EP075: Anthracene	120-12-7	0.5	mg/kg	0.6	0.6	0.0	No Limit
		EP075: Fluoranthene	206-44-0	0.5	mg/kg	3.8	3.3	14.5	No Limit
		EP075: Pyrene	129-00-0	0.5	mg/kg	4.5	4.0	11.0	No Limit
		EP075: N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benzo(a)pyrene	50-32-8	0.5	mg/kg	0.8	0.8	0.0	No Limit
		EP075: 3-Methylcholanthrene	56-49-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg	1	1	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Methylnaphthalene	91-57-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Chloronaphthalene	91-58-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 3-Methylcholanthrene	56-49-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075B: Polynuclear Aromatic Hydrocarbons (QC Lot: 3791555) - continued									
ES1501013-009	BH5 1-1.3M	EP075: Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg	<1	<1	0.0	No Limit
EP075C: Phthalate Esters (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: Dimethyl phthalate	131-11-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Diethyl phthalate	84-66-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Di-n-butyl phthalate	84-74-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Butyl benzyl phthalate	85-68-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Di-n-octylphthalate	117-84-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: bis(2-ethylhexyl) phthalate	117-81-7	5.0	mg/kg	613	782	# 24.3	0% - 20%
ES1501013-009	BH5 1-1.3M	EP075: Dimethyl phthalate	131-11-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Diethyl phthalate	84-66-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Di-n-butyl phthalate	84-74-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Butyl benzyl phthalate	85-68-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Di-n-octylphthalate	117-84-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: bis(2-ethylhexyl) phthalate	117-81-7	5.0	mg/kg	<5.0	<5.0	0.0	No Limit
EP075D: Nitrosamines (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: N-Nitrosomethylethylamine	10595-95-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosodiethylamine	55-18-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosomorpholine	59-89-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosodi-n-propylamine	621-64-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosopiperidine	100-75-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosodibutylamine	924-16-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Methapyrilene	91-80-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosopyrrolidine	930-55-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: N-Nitrosomethylethylamine	10595-95-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosodiethylamine	55-18-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosomorpholine	59-89-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosodi-n-propylamine	621-64-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosopiperidine	100-75-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosodibutylamine	924-16-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Methapyrilene	91-80-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: N-Nitrosopyrrolidine	930-55-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
EP075E: Nitroaromatics and Ketones (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: 2-Picoline	109-06-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Acetophenone	98-86-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Nitrobenzene	98-95-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075E: Nitroaromatics and Ketones (QC Lot: 3791555) - continued									
ES1500870-007	Anonymous	EP075: Isophorone	78-59-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1-Naphthylamine	134-32-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Nitroquinoline-N-oxide	56-57-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 5-Nitro-o-toluidine	99-55-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.3.5-Trinitrobenzene	99-35-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Phenacetin	62-44-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Aminobiphenyl	92-67-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pentachloronitrobenzene	82-68-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pronamide	23950-58-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dimethylaminoazobenzene	60-11-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorobenzilate	510-15-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Azobenzene	103-33-3	1	mg/kg	<1	<1	0.0	No Limit
		EP075: 2.6-Dinitrotoluene	606-20-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: 2.4-Dinitrotoluene	121-14-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: 2-Picoline	109-06-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Acetophenone	98-86-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Nitrobenzene	98-95-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Isophorone	78-59-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1-Naphthylamine	134-32-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Nitroquinoline-N-oxide	56-57-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 5-Nitro-o-toluidine	99-55-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.3.5-Trinitrobenzene	99-35-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Phenacetin	62-44-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Aminobiphenyl	92-67-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pentachloronitrobenzene	82-68-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pronamide	23950-58-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dimethylaminoazobenzene	60-11-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorobenzilate	510-15-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Azobenzene	103-33-3	1	mg/kg	<1	<1	0.0	No Limit
		EP075: 2.6-Dinitrotoluene	606-20-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: 2.4-Dinitrotoluene	121-14-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
EP075F: Haloethers (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: Bis(2-chloroethyl) ether	111-44-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Bis(2-chloroethoxy) methane	111-91-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Chlorophenyl phenyl ether	7005-72-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Bromophenyl phenyl ether	101-55-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: Bis(2-chloroethyl) ether	111-44-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Bis(2-chloroethoxy) methane	111-91-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Chlorophenyl phenyl ether	7005-72-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Bromophenyl phenyl ether	101-55-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075G: Chlorinated Hydrocarbons (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: 1.3-Dichlorobenzene	541-73-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.4-Dichlorobenzene	106-46-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.2-Dichlorobenzene	95-50-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachloroethane	67-72-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.2.4-Trichlorobenzene	120-82-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachloropropylene	1888-71-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachlorobutadiene	87-68-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pentachlorobenzene	608-93-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachlorobenzene (HCB)	118-74-1	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: Hexachlorocyclopentadiene	77-47-4	2.5	mg/kg	<2.5	<2.5	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: 1.3-Dichlorobenzene	541-73-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.4-Dichlorobenzene	106-46-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.2-Dichlorobenzene	95-50-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachloroethane	67-72-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 1.2.4-Trichlorobenzene	120-82-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachloropropylene	1888-71-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachlorobutadiene	87-68-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pentachlorobenzene	608-93-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Hexachlorobenzene (HCB)	118-74-1	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: Hexachlorocyclopentadiene	77-47-4	2.5	mg/kg	<2.5	<2.5	0.0	No Limit
EP075H: Anilines and Benzidines (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: Aniline	62-53-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Chloroaniline	106-47-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dibenzofuran	132-64-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Nitroaniline	100-01-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Carbazole	86-74-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 3.3`-Dichlorobenzidine	91-94-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Nitroaniline	88-74-4	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: 3-Nitroaniline	99-09-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: Aniline	62-53-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Chloroaniline	106-47-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dibenzofuran	132-64-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4-Nitroaniline	100-01-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Carbazole	86-74-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 3.3`-Dichlorobenzidine	91-94-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 2-Nitroaniline	88-74-4	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EP075: 3-Nitroaniline	99-09-2	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
EP075I: Organochlorine Pesticides (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: alpha-BHC	319-84-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: beta-BHC	319-85-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075I: Organochlorine Pesticides (QC Lot: 3791555) - continued									
ES1500870-007	Anonymous	EP075: gamma-BHC	58-89-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: delta-BHC	319-86-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Heptachlor	76-44-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Aldrin	309-00-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Heptachlor epoxide	1024-57-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: alpha-Endosulfan	959-98-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4.4`-DDE	72-55-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dieldrin	60-57-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Endrin	72-20-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: beta-Endosulfan	33213-65-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4.4`-DDD	72-54-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Endosulfan sulfate	1031-07-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4.4`-DDT	50-29-3	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP075: alpha-BHC	319-84-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: beta-BHC	319-85-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: gamma-BHC	58-89-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: delta-BHC	319-86-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Heptachlor	76-44-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Aldrin	309-00-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Heptachlor epoxide	1024-57-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: alpha-Endosulfan	959-98-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4.4`-DDE	72-55-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dieldrin	60-57-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Endrin	72-20-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: beta-Endosulfan	33213-65-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4.4`-DDD	72-54-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Endosulfan sulfate	1031-07-8	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: 4.4`-DDT	50-29-3	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
EP075J: Organophosphorus Pesticides (QC Lot: 3791555)									
ES1500870-007	Anonymous	EP075: Dichlorvos	62-73-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dimethoate	60-51-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Diazinon	333-41-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorpyrifos-methyl	5598-13-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Malathion	121-75-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Fenthion	55-38-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorpyrifos	2921-88-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pirimphos-ethyl	23505-41-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorfenvinphos	470-90-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Prothiofos	34643-46-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Ethion	563-12-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP075J: Organophosphorus Pesticides (QC Lot: 3791555) - continued									
ES1501013-009	BH5 1-1.3M	EP075: Dichlorvos	62-73-7	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Dimethoate	60-51-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Diazinon	333-41-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorpyrifos-methyl	5598-13-0	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Malathion	121-75-5	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Fenthion	55-38-9	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorpyrifos	2921-88-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Pirimphos-ethyl	23505-41-1	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Chlorfenvinphos	470-90-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Prothiofos	34643-46-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP075: Ethion	563-12-2	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3791526)									
ES1501013-002	BH3 0.5-1.0M	EP080: C6 - C9 Fraction	----	10	mg/kg	<10	<10	0.0	No Limit
ES1501013-016	BH8 0.5-0.9M	EP080: C6 - C9 Fraction	----	10	mg/kg	<10	<10	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3791554)									
ES1500870-007	Anonymous	EP071: C15 - C28 Fraction	----	100	mg/kg	910	980	7.7	No Limit
		EP071: C29 - C36 Fraction	----	100	mg/kg	340	380	9.0	No Limit
		EP071: C10 - C14 Fraction	----	50	mg/kg	<50	<50	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP071: C15 - C28 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: C29 - C36 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: C10 - C14 Fraction	----	50	mg/kg	<50	<50	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3791560)									
ES1500960-001	Anonymous	EP071: C15 - C28 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: C29 - C36 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: C10 - C14 Fraction	----	50	mg/kg	<50	<50	0.0	No Limit
ES1501013-022	BH10 0.2-0.5M	EP071: C15 - C28 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: C29 - C36 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: C10 - C14 Fraction	----	50	mg/kg	<50	<50	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3792148)									
ES1501013-031	BH1 3.5-4.0M	EP080: C6 - C9 Fraction	----	10	mg/kg	<10	<10	0.0	No Limit
ES1501049-005	Anonymous	EP080: C6 - C9 Fraction	----	10	mg/kg	<10	<10	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3791526)									
ES1501013-002	BH3 0.5-1.0M	EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	0.0	No Limit
ES1501013-016	BH8 0.5-0.9M	EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3791554)									
ES1500870-007	Anonymous	EP071: >C16 - C34 Fraction	----	100	mg/kg	1140	1240	8.0	0% - 50%
		EP071: >C34 - C40 Fraction	----	100	mg/kg	180	200	10.2	No Limit
		EP071: >C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	0.0	No Limit
ES1501013-009	BH5 1-1.3M	EP071: >C16 - C34 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit

Sub-Matrix: **SOIL**				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3791554) - continued									
ES1501013-009	BH5 1-1.3M	EP071: >C34 - C40 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: >C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3791560)									
ES1500960-001	Anonymous	EP071: >C16 - C34 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: >C34 - C40 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: >C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	0.0	No Limit
ES1501013-022	BH10 0.2-0.5M	EP071: >C16 - C34 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: >C34 - C40 Fraction	----	100	mg/kg	<100	<100	0.0	No Limit
		EP071: >C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	<50	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3792148)									
ES1501013-031	BH1 3.5-4.0M	EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	0.0	No Limit
ES1501049-005	Anonymous	EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	0.0	No Limit
EP080: BTEXN (QC Lot: 3791526)									
ES1501013-002	BH3 0.5-1.0M	EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Naphthalene	91-20-3	1	mg/kg	<1	<1	0.0	No Limit
ES1501013-016	BH8 0.5-0.9M	EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Naphthalene	91-20-3	1	mg/kg	<1	<1	0.0	No Limit
EP080: BTEXN (QC Lot: 3792148)									
ES1501013-031	BH1 3.5-4.0M	EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Naphthalene	91-20-3	1	mg/kg	<1	<1	0.0	No Limit
ES1501049-005	Anonymous	EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP080: BTEXN (QC Lot: 3792148) - continued									
ES1501049-005	Anonymous	EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	0.0	No Limit
		EP080: Naphthalene	91-20-3	1	mg/kg	<1	<1	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EG005T: Total Metals by ICP-AES (QCLot: 3795622)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	100	92	130
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	95.1	87	121
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	101	80	136
EG005T: Copper	7440-50-8	5	mg/kg	<5	32.0 mg/kg	99.2	93	127
EG005T: Lead	7439-92-1	5	mg/kg	<5	40.0 mg/kg	91.2	86	124
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55.0 mg/kg	103	93	131
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	100	81	133
EG005T: Total Metals by ICP-AES (QCLot: 3795625)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	108	92	130
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	98.7	87	121
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	104	80	136
EG005T: Copper	7440-50-8	5	mg/kg	<5	32.0 mg/kg	99.1	93	127
EG005T: Lead	7439-92-1	5	mg/kg	<5	40.0 mg/kg	94.0	86	124
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55.0 mg/kg	105	93	131
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	106	81	133
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3795623)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.57 mg/kg	81.5	70	105
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3795626)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.57 mg/kg	84.1	70	105
EP050: Anionic Surfactants as MBAS (QCLot: 3792115)								
EP050: Anionic Surfactants as MBAS		1	mg/kg	<1	----	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 3791527)								
EP074: Styrene	100-42-5	0.5	mg/kg	<0.5	1 mg/kg	92.5	64	126
EP074: Isopropylbenzene	98-82-8	0.5	mg/kg	<0.5	1 mg/kg	94.3	66	128
EP074: n-Propylbenzene	103-65-1	0.5	mg/kg	<0.5	1 mg/kg	89.9	63	129
EP074: 1.3.5-Trimethylbenzene	108-67-8	0.5	mg/kg	<0.5	1 mg/kg	89.6	63	129
EP074: sec-Butylbenzene	135-98-8	0.5	mg/kg	<0.5	1 mg/kg	92.6	64	130
EP074: 1.2.4-Trimethylbenzene	95-63-6	0.5	mg/kg	<0.5	1 mg/kg	91.2	63	129
EP074: tert-Butylbenzene	98-06-6	0.5	mg/kg	<0.5	1 mg/kg	91.3	63	129
EP074: p-Isopropyltoluene	99-87-6	0.5	mg/kg	<0.5	1 mg/kg	87.0	62	130
EP074: n-Butylbenzene	104-51-8	0.5	mg/kg	<0.5	1 mg/kg	83.4	61	131
EP074B: Oxygenated Compounds (QCLot: 3791527)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP074B: Oxygenated Compounds (QCLot: 3791527) - continued								
EP074: Vinyl Acetate	108-05-4	1	mg/kg	<5	10 mg/kg	74.7	29.6	156
EP074: 2-Butanone (MEK)	78-93-3	1	mg/kg	<5	10 mg/kg	112	58	136
EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	1	mg/kg	<5	10 mg/kg	106	54	138
EP074: 2-Hexanone (MBK)	591-78-6	1	mg/kg	<5	10 mg/kg	107	54	136
EP074C: Sulfonated Compounds (QCLot: 3791527)								
EP074: Carbon disulfide	75-15-0	0.5	mg/kg	<0.5	1 mg/kg	87.0	54	126
EP074D: Fumigants (QCLot: 3791527)								
EP074: 2.2-Dichloropropane	594-20-7	0.5	mg/kg	<0.5	1 mg/kg	94.0	55	133
EP074: 1.2-Dichloropropane	78-87-5	0.5	mg/kg	<0.5	1 mg/kg	98.1	69	127
EP074: cis-1.3-Dichloropropylene	10061-01-5	0.5	mg/kg	<0.5	1 mg/kg	92.6	54	124
EP074: trans-1.3-Dichloropropylene	10061-02-6	0.5	mg/kg	<0.5	1 mg/kg	97.8	51	125
EP074: 1.2-Dibromoethane (EDB)	106-93-4	0.5	mg/kg	<0.5	1 mg/kg	94.9	66	126
EP074E: Halogenated Aliphatic Compounds (QCLot: 3791527)								
EP074: Dichlorodifluoromethane	75-71-8	1	mg/kg	<5	10 mg/kg	66.4	30	148
EP074: Chloromethane	74-87-3	1	mg/kg	<5	10 mg/kg	78.8	41	141
EP074: Vinyl chloride	75-01-4	1	mg/kg	<5	10 mg/kg	113	43	147
EP074: Bromomethane	74-83-9	1	mg/kg	<5	10 mg/kg	99.9	47	141
EP074: Chloroethane	75-00-3	1	mg/kg	<5	10 mg/kg	83.2	49	143
EP074: Trichlorofluoromethane	75-69-4	1	mg/kg	<5	10 mg/kg	70.8	49	135
EP074: 1.1-Dichloroethene	75-35-4	0.5	mg/kg	<0.5	1 mg/kg	84.8	54	126
EP074: Iodomethane	74-88-4	0.5	mg/kg	<0.5	1 mg/kg	69.2	43	129
EP074: trans-1.2-Dichloroethene	156-60-5	0.5	mg/kg	<0.5	1 mg/kg	89.2	62	130
EP074: 1.1-Dichloroethane	75-34-3	0.5	mg/kg	<0.5	1 mg/kg	90.6	66	132
EP074: cis-1.2-Dichloroethene	156-59-2	0.5	mg/kg	<0.5	1 mg/kg	96.1	66	132
EP074: 1.1.1-Trichloroethane	71-55-6	0.5	mg/kg	<0.5	1 mg/kg	96.9	62	126
EP074: 1.1-Dichloropropylene	563-58-6	0.5	mg/kg	<0.5	1 mg/kg	91.3	64	128
EP074: Carbon Tetrachloride	56-23-5	0.5	mg/kg	<0.5	1 mg/kg	109	59	125
EP074: 1.2-Dichloroethane	107-06-2	0.5	mg/kg	<0.5	1 mg/kg	90.6	65	123
EP074: Trichloroethene	79-01-6	0.5	mg/kg	<0.5	1 mg/kg	96.2	64	120
EP074: Dibromomethane	74-95-3	0.5	mg/kg	<0.5	1 mg/kg	98.0	65	127
EP074: 1.1.2-Trichloroethane	79-00-5	0.5	mg/kg	<0.5	1 mg/kg	110	70	130
EP074: 1.3-Dichloropropane	142-28-9	0.5	mg/kg	<0.5	1 mg/kg	104	72	128
EP074: Tetrachloroethene	127-18-4	0.5	mg/kg	<0.5	1 mg/kg	117	67	143
EP074: 1.1.1.2-Tetrachloroethane	630-20-6	0.5	mg/kg	<0.5	1 mg/kg	117	62	122
EP074: trans-1.4-Dichloro-2-butene	110-57-6	0.5	mg/kg	<0.5	1 mg/kg	126	54	128
EP074: cis-1.4-Dichloro-2-butene	1476-11-5	0.5	mg/kg	<0.5	1 mg/kg	100	55	129

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP074E: Halogenated Aliphatic Compounds (QCLot: 3791527) - continued								
EP074: 1.1.2.2-Tetrachloroethane	79-34-5	0.5	mg/kg	<0.5	1 mg/kg	110	56	132
EP074: 1.2.3-Trichloropropane	96-18-4	0.5	mg/kg	<0.5	1 mg/kg	107	65	135
EP074: Pentachloroethane	76-01-7	0.5	mg/kg	<0.5	1 mg/kg	105	19.8	134
EP074: 1.2-Dibromo-3-chloropropane	96-12-8	0.5	mg/kg	<0.5	1 mg/kg	124	53	129
EP074F: Halogenated Aromatic Compounds (QCLot: 3791527)								
EP074: Chlorobenzene	108-90-7	0.5	mg/kg	<0.5	1 mg/kg	101	70	128
EP074: Bromobenzene	108-86-1	0.5	mg/kg	<0.5	1 mg/kg	95.3	67	127
EP074: 2-Chlorotoluene	95-49-8	0.5	mg/kg	<0.5	1 mg/kg	90.6	64	130
EP074: 4-Chlorotoluene	106-43-4	0.5	mg/kg	<0.5	1 mg/kg	87.8	62	130
EP074: 1.2.3-Trichlorobenzene	87-61-6	0.5	mg/kg	<0.5	1 mg/kg	84.2	60	132
EP074G: Trihalomethanes (QCLot: 3791527)								
EP074: Chloroform	67-66-3	0.5	mg/kg	<0.5	1 mg/kg	91.5	62	120
EP074: Bromodichloromethane	75-27-4	0.5	mg/kg	<0.5	1 mg/kg	106	61	121
EP074: Dibromochloromethane	124-48-1	0.5	mg/kg	<0.5	1 mg/kg	120	63	121
EP074: Bromoform	75-25-2	0.5	mg/kg	<0.5	1 mg/kg	93.1	60	126
EP075(SIM)A: Phenolic Compounds (QCLot: 3791561)								
EP075(SIM): Phenol	108-95-2	0.5	mg/kg	<0.5	4 mg/kg	88.7	74	116
EP075(SIM): 2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	4 mg/kg	89.5	74	116
EP075(SIM): 2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	4 mg/kg	83.8	72	116
EP075(SIM): 3- & 4-Methylphenol	1319-77-3	1.0	mg/kg	<1	8 mg/kg	84.1	69	123
EP075(SIM): 2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	4 mg/kg	81.3	60.3	117
EP075(SIM): 2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	4 mg/kg	86.1	69	117
EP075(SIM): 2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	4 mg/kg	85.8	68	112
EP075(SIM): 2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	4 mg/kg	86.3	73	117
EP075(SIM): 4-Chloro-3-Methylphenol	59-50-7	0.5	mg/kg	<0.5	4 mg/kg	85.9	76.4	114
EP075(SIM): 2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	4 mg/kg	83.9	57	111
EP075(SIM): 2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	4 mg/kg	93.5	68.9	112
EP075(SIM): Pentachlorophenol	87-86-5	1.0	mg/kg	<1	8 mg/kg	28.0	10	57
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791561)								
EP075(SIM): Naphthalene	91-20-3	0.5	mg/kg	<0.5	4 mg/kg	98.1	80	124
EP075(SIM): Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	4 mg/kg	97.7	77	123
EP075(SIM): Acenaphthene	83-32-9	0.5	mg/kg	<0.5	4 mg/kg	107	79	123
EP075(SIM): Fluorene	86-73-7	0.5	mg/kg	<0.5	4 mg/kg	98.6	77	123
EP075(SIM): Phenanthrene	85-01-8	0.5	mg/kg	<0.5	4 mg/kg	102	79	123
EP075(SIM): Anthracene	120-12-7	0.5	mg/kg	<0.5	4 mg/kg	108	79	123
EP075(SIM): Fluoranthene	206-44-0	0.5	mg/kg	<0.5	4 mg/kg	106	79	123

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791561) - continued								
EP075(SIM): Pyrene	129-00-0	0.5	mg/kg	<0.5	4 mg/kg	106	79	125
EP075(SIM): Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	4 mg/kg	95.8	73	121
EP075(SIM): Chrysene	218-01-9	0.5	mg/kg	<0.5	4 mg/kg	102	81	123
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg	<0.5	4 mg/kg	95.6	70	118
EP075(SIM): Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<0.5	4 mg/kg	104	77	123
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	4 mg/kg	109	76	122
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	4 mg/kg	86.5	71	113
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	4 mg/kg	87.2	71.7	113
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	4 mg/kg	84.2	72.4	114
EP075A: Phenolic Compounds (QCLot: 3791555)								
EP075: Phenol	108-95-2	0.5	mg/kg	<0.5	1.25 mg/kg	77.5	64	114
EP075: 2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	1.25 mg/kg	81.6	57	115
EP075: 2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	1.25 mg/kg	73.9	41	119
EP075: 3- & 4-Methylphenol	1319-77-3	1.0	mg/kg	<1.0	2.5 mg/kg	93.2	46	122
EP075: 2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	1.25 mg/kg	60.6	47	117
EP075: 2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	1.25 mg/kg	95.0	13.7	108
EP075: 2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	1.25 mg/kg	78.2	47	105
EP075: 2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	1.25 mg/kg	65.5	48	110
EP075: 4-Chloro-3-Methylphenol	59-50-7	0.5	mg/kg	<0.5	1.25 mg/kg	72.3	57	113
EP075: 2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	1.25 mg/kg	73.0	42	106
EP075: 2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	1.25 mg/kg	85.7	47	113
EP075: Pentachlorophenol	87-86-5	1.0	mg/kg	<1	2.5 mg/kg	35.3	10	81
EP075B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791555)								
EP075: Naphthalene	91-20-3	0.5	mg/kg	<0.5	1.25 mg/kg	78.1	62	118
EP075: 2-Methylnaphthalene	91-57-6	0.5	mg/kg	<0.5	1.25 mg/kg	67.1	58	116
EP075: 2-Chloronaphthalene	91-58-7	0.5	mg/kg	<0.5	1.25 mg/kg	71.5	54	112
EP075: Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	1.25 mg/kg	67.9	56	114
EP075: Acenaphthene	83-32-9	0.5	mg/kg	<0.5	1.25 mg/kg	67.1	62	112
EP075: Fluorene	86-73-7	0.5	mg/kg	<0.5	1.25 mg/kg	76.1	59	115
EP075: Phenanthrene	85-01-8	0.5	mg/kg	<0.5	1.25 mg/kg	70.0	63	113
EP075: Anthracene	120-12-7	0.5	mg/kg	<0.5	1.25 mg/kg	71.0	57	111
EP075: Fluoranthene	206-44-0	0.5	mg/kg	<0.5	1.25 mg/kg	71.2	58	114
EP075: Pyrene	129-00-0	0.5	mg/kg	<0.5	1.25 mg/kg	76.2	57	117
EP075: N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg	<0.5	1.25 mg/kg	67.3	58	114
EP075: Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	1.25 mg/kg	77.4	59	115
EP075: Chrysene	218-01-9	0.5	mg/kg	<0.5	1.25 mg/kg	76.6	61	117

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP075B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791555) - continued								
EP075: Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg	<1	2.5 mg/kg	64.1	57	119
EP075: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg	<0.5	1.25 mg/kg	63.1	48.1	106
EP075: Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	1.25 mg/kg	68.5	56	116
EP075: 3-Methylcholanthrene	56-49-5	0.5	mg/kg	<0.5	1.25 mg/kg	57.8	50	116
EP075: Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	1.25 mg/kg	67.0	55	117
EP075: Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	1.25 mg/kg	71.7	53	119
EP075: Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	1.25 mg/kg	67.5	56	120
EP075C: Phthalate Esters (QCLot: 3791555)								
EP075: Dimethyl phthalate	131-11-3	0.5	mg/kg	<0.5	1.25 mg/kg	74.0	60	118
EP075: Diethyl phthalate	84-66-2	0.5	mg/kg	<0.5	1.25 mg/kg	71.9	65	115
EP075: Di-n-butyl phthalate	84-74-2	0.5	mg/kg	<0.5	1.25 mg/kg	83.6	65	121
EP075: Butyl benzyl phthalate	85-68-7	0.5	mg/kg	<0.5	1.25 mg/kg	85.4	62	116
EP075: bis(2-ethylhexyl) phthalate	117-81-7	5	mg/kg	<5.0	1.25 mg/kg	95.2	69	133
EP075: Di-n-octylphthalate	117-84-0	0.5	mg/kg	<0.5	1.25 mg/kg	82.1	62	124
EP075D: Nitrosamines (QCLot: 3791555)								
EP075: N-Nitrosomethylethylamine	10595-95-6	0.5	mg/kg	<0.5	1.25 mg/kg	90.7	39.4	124
EP075: N-Nitrosodiethylamine	55-18-5	0.5	mg/kg	<0.5	1.25 mg/kg	76.0	59	117
EP075: N-Nitrosopyrrolidine	930-55-2	0.5	mg/kg	<1.0	1.25 mg/kg	68.7	53	125
EP075: N-Nitrosomorpholine	59-89-2	0.5	mg/kg	<0.5	1.25 mg/kg	68.0	65	121
EP075: N-Nitrosodi-n-propylamine	621-64-7	0.5	mg/kg	<0.5	1.25 mg/kg	73.4	59	123
EP075: N-Nitrosopiperidine	100-75-4	0.5	mg/kg	<0.5	1.25 mg/kg	69.3	57	115
EP075: N-Nitrosodibutylamine	924-16-3	0.5	mg/kg	<0.5	1.25 mg/kg	76.6	57	119
EP075: N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1.0	mg/kg	<1.0	2.5 mg/kg	56.1	42	112
EP075: Methapyrilene	91-80-5	0.5	mg/kg	<0.5	1.25 mg/kg	99.9	16.3	123
EP075E: Nitroaromatics and Ketones (QCLot: 3791555)								
EP075: 2-Picoline	109-06-8	0.5	mg/kg	<0.5	1.25 mg/kg	99.8	27.3	129
EP075: Acetophenone	98-86-2	0.5	mg/kg	<0.5	1.25 mg/kg	65.0	60	116
EP075: Nitrobenzene	98-95-3	0.5	mg/kg	<0.5	1.25 mg/kg	86.5	65	119
EP075: Isophorone	78-59-1	0.5	mg/kg	<0.5	1.25 mg/kg	88.0	62	116
EP075: 2.6-Dinitrotoluene	606-20-2	0.5	mg/kg	<1.0	1.25 mg/kg	71.6	58	118
EP075: 2.4-Dinitrotoluene	121-14-2	0.5	mg/kg	<1.0	1.25 mg/kg	68.4	59	115
EP075: 1-Naphthylamine	134-32-7	0.5	mg/kg	<0.5	1.25 mg/kg	42.1	17.3	111
EP075: 4-Nitroquinoline-N-oxide	56-57-5	0.5	mg/kg	<0.5	1.25 mg/kg	67.8	10	87
EP075: 5-Nitro-o-toluidine	99-55-8	0.5	mg/kg	<0.5	1.25 mg/kg	57.9	48.3	98.5
EP075: Azobenzene	103-33-3	1	mg/kg	<1	1.25 mg/kg	70.2	62	118

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP075E: Nitroaromatics and Ketones (QCLot: 3791555) - continued								
EP075: 1.3.5-Trinitrobenzene	99-35-4	0.5	mg/kg	<0.5	1.25 mg/kg	73.3	36	114
EP075: Phenacetin	62-44-2	0.5	mg/kg	<0.5	1.25 mg/kg	71.5	62	114
EP075: 4-Aminobiphenyl	92-67-1	0.5	mg/kg	<0.5	1.25 mg/kg	68.4	36.1	102
EP075: Pentachloronitrobenzene	82-68-8	0.5	mg/kg	<0.5	1.25 mg/kg	70.6	56	110
EP075: Pronamide	23950-58-5	0.5	mg/kg	<0.5	1.25 mg/kg	60.5	54	110
EP075: Dimethylaminoazobenzene	60-11-7	0.5	mg/kg	<0.5	1.25 mg/kg	61.0	48	108
EP075: Chlorobenzilate	510-15-6	0.5	mg/kg	<0.5	1.25 mg/kg	66.5	57.4	112
EP075F: Haloethers (QCLot: 3791555)								
EP075: Bis(2-chloroethyl) ether	111-44-4	0.5	mg/kg	<0.5	1.25 mg/kg	76.6	63	121
EP075: Bis(2-chloroethoxy) methane	111-91-1	0.5	mg/kg	<0.5	1.25 mg/kg	81.7	59	115
EP075: 4-Chlorophenyl phenyl ether	7005-72-3	0.5	mg/kg	<0.5	1.25 mg/kg	76.0	58	112
EP075: 4-Bromophenyl phenyl ether	101-55-3	0.5	mg/kg	<0.5	1.25 mg/kg	60.9	58	110
EP075G: Chlorinated Hydrocarbons (QCLot: 3791555)								
EP075: 1.3-Dichlorobenzene	541-73-1	0.5	mg/kg	<0.5	1.25 mg/kg	70.6	58	112
EP075: 1.4-Dichlorobenzene	106-46-7	0.5	mg/kg	<0.5	1.25 mg/kg	69.9	58	116
EP075: 1.2-Dichlorobenzene	95-50-1	0.5	mg/kg	<0.5	1.25 mg/kg	69.1	57	115
EP075: Hexachloroethane	67-72-1	0.5	mg/kg	<0.5	1.25 mg/kg	64.7	54	116
EP075: 1.2.4-Trichlorobenzene	120-82-1	0.5	mg/kg	<0.5	1.25 mg/kg	71.2	62.9	108
EP075: Hexachloropropylene	1888-71-7	0.5	mg/kg	<0.5	1.25 mg/kg	# 33.4	39.1	110
EP075: Hexachlorobutadiene	87-68-3	0.5	mg/kg	<0.5	1.25 mg/kg	69.3	59	117
EP075: Hexachlorocyclopentadiene	77-47-4	0.5	mg/kg	<2.5	1.25 mg/kg	103	17.2	106
EP075: Pentachlorobenzene	608-93-5	0.5	mg/kg	<0.5	1.25 mg/kg	61.2	57	109
EP075: Hexachlorobenzene (HCB)	118-74-1	0.5	mg/kg	<1.0	1.25 mg/kg	76.1	59	111
EP075H: Anilines and Benzidines (QCLot: 3791555)								
EP075: Aniline	62-53-3	0.5	mg/kg	<0.5	1.25 mg/kg	96.0	13.2	108
EP075: 4-Chloroaniline	106-47-8	0.5	mg/kg	<0.5	1.25 mg/kg	69.7	19.9	114
EP075: 2-Nitroaniline	88-74-4	0.5	mg/kg	<1.0	1.25 mg/kg	70.9	52	112
EP075: 3-Nitroaniline	99-09-2	0.5	mg/kg	<1.0	1.25 mg/kg	50.0	31.5	93.7
EP075: Dibenzofuran	132-64-9	0.5	mg/kg	<0.5	1.25 mg/kg	65.0	60	110
EP075: 4-Nitroaniline	100-01-6	0.5	mg/kg	<0.5	1.25 mg/kg	52.2	42	112
EP075: Carbazole	86-74-8	0.5	mg/kg	<0.5	1.25 mg/kg	77.7	59	111
EP075: 3.3`-Dichlorobenzidine	91-94-1	0.5	mg/kg	<0.5	1.25 mg/kg	70.0	23.1	113
EP075I: Organochlorine Pesticides (QCLot: 3791555)								
EP075: alpha-BHC	319-84-6	0.5	mg/kg	<0.5	1.25 mg/kg	74.3	63	113
EP075: beta-BHC	319-85-7	0.5	mg/kg	<0.5	1.25 mg/kg	73.9	57	113
EP075: gamma-BHC	58-89-9	0.5	mg/kg	<0.5	1.25 mg/kg	71.5	61	117

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP075I: Organochlorine Pesticides (QCLot: 3791555) - continued								
EP075: delta-BHC	319-86-8	0.5	mg/kg	<0.5	1.25 mg/kg	77.2	64	118
EP075: Heptachlor	76-44-8	0.5	mg/kg	<0.5	1.25 mg/kg	74.3	55	115
EP075: Aldrin	309-00-2	0.5	mg/kg	<0.5	1.25 mg/kg	70.2	61	115
EP075: Heptachlor epoxide	1024-57-3	0.5	mg/kg	<0.5	1.25 mg/kg	57.8	56	118
EP075: alpha-Endosulfan	959-98-8	0.5	mg/kg	<0.5	1.25 mg/kg	69.2	65	125
EP075: 4.4`-DDE	72-55-9	0.5	mg/kg	<0.5	1.25 mg/kg	74.9	60	116
EP075: Dieldrin	60-57-1	0.5	mg/kg	<0.5	1.25 mg/kg	77.5	64	118
EP075: Endrin	72-20-8	0.5	mg/kg	<0.5	1.25 mg/kg	55.4	53	117
EP075: beta-Endosulfan	33213-65-9	0.5	mg/kg	<0.5	1.25 mg/kg	76.0	65	115
EP075: 4.4`-DDD	72-54-8	0.5	mg/kg	<0.5	1.25 mg/kg	78.9	62	118
EP075: Endosulfan sulfate	1031-07-8	0.5	mg/kg	<0.5	1.25 mg/kg	75.8	63	129
EP075: 4.4`-DDT	50-29-3	0.5	mg/kg	<1.0	1.25 mg/kg	96.1	46	122
EP075J: Organophosphorus Pesticides (QCLot: 3791555)								
EP075: Dichlorvos	62-73-7	0.5	mg/kg	<0.5	1.25 mg/kg	90.2	46	112
EP075: Dimethoate	60-51-5	0.5	mg/kg	<0.5	1.25 mg/kg	77.3	63	119
EP075: Diazinon	333-41-5	0.5	mg/kg	<0.5	1.25 mg/kg	90.3	68	134
EP075: Chlorpyrifos-methyl	5598-13-0	0.5	mg/kg	<0.5	1.25 mg/kg	79.0	60	130
EP075: Malathion	121-75-5	0.5	mg/kg	<0.5	1.25 mg/kg	72.4	66	130
EP075: Fenthion	55-38-9	0.5	mg/kg	<0.5	1.25 mg/kg	63.2	60	116
EP075: Chlorpyrifos	2921-88-2	0.5	mg/kg	<0.5	1.25 mg/kg	74.3	63	113
EP075: Pirimphos-ethyl	23505-41-1	0.5	mg/kg	<0.5	1.25 mg/kg	76.1	65	115
EP075: Chlorfenvinphos	470-90-6	0.55	mg/kg	<0.5	1.375 mg/kg	70.9	59	103
EP075: Prothiofos	34643-46-4	0.5	mg/kg	<0.5	1.25 mg/kg	65.0	59	119
EP075: Ethion	563-12-2	0.5	mg/kg	<0.5	1.25 mg/kg	73.1	62	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791526)								
EP080: C6 - C9 Fraction	----	10	mg/kg	<10	26 mg/kg	103	68.4	128
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791554)								
EP071: C10 - C14 Fraction	----	50	mg/kg	<50	200 mg/kg	117	71	131
EP071: C15 - C28 Fraction	----	100	mg/kg	<100	300 mg/kg	118	74	138
EP071: C29 - C36 Fraction	----	100	mg/kg	<100	200 mg/kg	97.9	64	128
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791560)								
EP071: C10 - C14 Fraction	----	50	mg/kg	<50	200 mg/kg	93.9	71	131
EP071: C15 - C28 Fraction	----	100	mg/kg	<100	300 mg/kg	110	74	138
EP071: C29 - C36 Fraction	----	100	mg/kg	<100	200 mg/kg	114	64	128
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3792148)								
EP080: C6 - C9 Fraction	----	10	mg/kg	<10	26 mg/kg	115	68.4	128

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791526)								
EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	31 mg/kg	102	68.4	128
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791554)								
EP071: >C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	250 mg/kg	125	70	130
EP071: >C16 - C34 Fraction	----	100	mg/kg	<100	350 mg/kg	109	74	138
EP071: >C34 - C40 Fraction	----	50	mg/kg	<100	150 mg/kg	90.6	63	131
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791560)								
EP071: >C10 - C16 Fraction	>C10_C16	50	mg/kg	<50	250 mg/kg	105	70	130
EP071: >C16 - C34 Fraction	----	100	mg/kg	<100	350 mg/kg	111	74	138
EP071: >C34 - C40 Fraction	----	50	mg/kg	<100	150 mg/kg	104	63	131
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3792148)								
EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	31 mg/kg	116	68.4	128
EP080: BTEXN (QCLot: 3791526)								
EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	1 mg/kg	104	62	116
EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	1 mg/kg	98.9	62	128
EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	1 mg/kg	98.0	58	118
EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	2 mg/kg	97.3	60	120
EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	1 mg/kg	100	60	120
EP080: Naphthalene	91-20-3	1	mg/kg	<1	1 mg/kg	93.0	62	138
EP080: BTEXN (QCLot: 3792148)								
EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	1 mg/kg	104	62	116
EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	1 mg/kg	106	62	128
EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	1 mg/kg	103	58	118
EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	2 mg/kg	103	60	120
EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	1 mg/kg	109	60	120
EP080: Naphthalene	91-20-3	1	mg/kg	<1	1 mg/kg	93.9	62	138

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	*SpikeRecovery(%)*	*Recovery Limits (%)*	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG005T: Total Metals by ICP-AES (QCLot: 3795622)							
ES1500753-043	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	104	70	130

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG005T: Total Metals by ICP-AES (QCLot: 3795622) - continued							
ES1500753-043	Anonymous	EG005T: Cadmium	7440-43-9	50 mg/kg	101	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	102	70	130
		EG005T: Copper	7440-50-8	250 mg/kg	103	70	130
		EG005T: Lead	7439-92-1	250 mg/kg	95.8	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	101	70	130
		EG005T: Zinc	7440-66-6	250 mg/kg	99.0	70	130
EG005T: Total Metals by ICP-AES (QCLot: 3795625)							
ES1501013-009	BH5 1-1.3M	EG005T: Arsenic	7440-38-2	50 mg/kg	114	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	97.8	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	100	70	130
		EG005T: Copper	7440-50-8	250 mg/kg	110	70	130
		EG005T: Lead	7439-92-1	250 mg/kg	91.8	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	95.8	70	130
		EG005T: Zinc	7440-66-6	250 mg/kg	92.4	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3795623)							
ES1500753-043	Anonymous	EG035T: Mercury	7439-97-6	5 mg/kg	108	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3795626)							
ES1501013-009	BH5 1-1.3M	EG035T: Mercury	7439-97-6	5 mg/kg	104	70	130
EP074E: Halogenated Aliphatic Compounds (QCLot: 3791527)							
ES1501013-002	BH3 0.5-1.0M	EP074: 1.1-Dichloroethene	75-35-4	2.5 mg/kg	72.5	70	130
		EP074: Trichloroethene	79-01-6	2.5 mg/kg	88.1	70	130
EP074F: Halogenated Aromatic Compounds (QCLot: 3791527)							
ES1501013-002	BH3 0.5-1.0M	EP074: Chlorobenzene	108-90-7	2.5 mg/kg	94.3	70	130
EP075(SIM)A: Phenolic Compounds (QCLot: 3791561)							
ES1500960-001	Anonymous	EP075(SIM): Phenol	108-95-2	10 mg/kg	80.2	70	130
		EP075(SIM): 2-Chlorophenol	95-57-8	10 mg/kg	77.8	70	130
		EP075(SIM): 2-Nitrophenol	88-75-5	10 mg/kg	94.9	60	130
		EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	10 mg/kg	87.3	70	130
		EP075(SIM): Pentachlorophenol	87-86-5	10 mg/kg	58.4	20	130
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791561)							
ES1500960-001	Anonymous	EP075(SIM): Acenaphthene	83-32-9	10 mg/kg	93.1	70	130
		EP075(SIM): Pyrene	129-00-0	10 mg/kg	94.1	70	130
EP075A: Phenolic Compounds (QCLot: 3791555)							
ES1500870-007	Anonymous	EP075: Phenol	108-95-2	5 mg/kg	73.8	60	130
		EP075: 2-Chlorophenol	95-57-8	5 mg/kg	74.6	60	130

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	*SpikeRecovery(%)*	*Recovery Limits (%)*	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EP075A: Phenolic Compounds (QCLot: 3791555) - continued							
ES1500870-007	Anonymous	EP075: 2-Nitrophenol	88-75-5	5 mg/kg	63.9	50	130
		EP075: 4-Chloro-3-methylphenol	59-50-7	5 mg/kg	79.2	50	130
		EP075: Pentachlorophenol	87-86-5	10 mg/kg	39.9	10	130
EP075B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791555)							
ES1500870-007	Anonymous	EP075: Acenaphthene	83-32-9	5 mg/kg	79.1	50	130
		EP075: Pyrene	129-00-0	5 mg/kg	118	50	130
EP075D: Nitrosamines (QCLot: 3791555)							
ES1500870-007	Anonymous	EP075: N-Nitrosodi-n-propylamine	621-64-7	5 mg/kg	70.5	50	130
EP075E: Nitroaromatics and Ketones (QCLot: 3791555)							
ES1500870-007	Anonymous	EP075: 2.4-Dinitrotoluene	121-14-2	5 mg/kg	57.6	40	130
EP075G: Chlorinated Hydrocarbons (QCLot: 3791555)							
ES1500870-007	Anonymous	EP075: 1.4-Dichlorobenzene	106-46-7	5 mg/kg	76.0	60	130
		EP075: 1.2.4-Trichlorobenzene	120-82-1	5 mg/kg	79.2	50	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791526)							
ES1501013-002	BH3 0.5-1.0M	EP080: C6 - C9 Fraction	----	32.5 mg/kg	98.1	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791554)							
ES1500870-007	Anonymous	EP071: C10 - C14 Fraction	----	560 mg/kg	80.3	73	137
		EP071: C15 - C28 Fraction	----	2370 mg/kg	62.5	53	131
		EP071: C29 - C36 Fraction	----	1695 mg/kg	64.6	52	132
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791560)							
ES1500960-001	Anonymous	EP071: C10 - C14 Fraction	----	640 mg/kg	86.5	73	137
		EP071: C15 - C28 Fraction	----	3140 mg/kg	86.5	53	131
		EP071: C29 - C36 Fraction	----	2860 mg/kg	80.0	52	132
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3792148)							
ES1501013-031	BH1 3.5-4.0M	EP080: C6 - C9 Fraction	----	32.5 mg/kg	96.0	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791526)							
ES1501013-002	BH3 0.5-1.0M	EP080: C6 - C10 Fraction	C6_C10	37.5 mg/kg	92.0	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791554)							
ES1500870-007	Anonymous	EP071: >C10 - C16 Fraction	>C10_C16	902 mg/kg	85.3	73	137
		EP071: >C16 - C34 Fraction	----	3190 mg/kg	55.7	53	131
		EP071: >C34 - C40 Fraction	----	1087 mg/kg	66.9	52	132
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791560)							
ES1500960-001	Anonymous	EP071: >C10 - C16 Fraction	>C10_C16	850 mg/kg	111	73	137
		EP071: >C16 - C34 Fraction	----	4800 mg/kg	84.2	53	131

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	 High
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791560) - continued							
ES1500960-001	Anonymous	EP071: >C34 - C40 Fraction	----	2400 mg/kg	60.2	52	132
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3792148)							
ES1501013-031	BH1 3.5-4.0M	EP080: C6 - C10 Fraction	C6_C10	37.5 mg/kg	96.1	70	130
EP080: BTEXN (QCLot: 3791526)							
ES1501013-002	BH3 0.5-1.0M	EP080: Benzene	71-43-2	2.5 mg/kg	89.5	70	130
		EP080: Toluene	108-88-3	2.5 mg/kg	88.5	70	130
		EP080: Ethylbenzene	100-41-4	2.5 mg/kg	93.4	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2.5 mg/kg	91.5	70	130
		EP080: ortho-Xylene	95-47-6	2.5 mg/kg	93.5	70	130
		EP080: Naphthalene	91-20-3	2.5 mg/kg	84.0	70	130
EP080: BTEXN (QCLot: 3792148)							
ES1501013-031	BH1 3.5-4.0M	EP080: Benzene	71-43-2	2.5 mg/kg	80.3	70	130
		EP080: Toluene	108-88-3	2.5 mg/kg	84.9	70	130
		EP080: Ethylbenzene	100-41-4	2.5 mg/kg	84.1	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2.5 mg/kg	81.9	70	130
		EP080: ortho-Xylene	95-47-6	2.5 mg/kg	88.0	70	130
		EP080: Naphthalene	91-20-3	2.5 mg/kg	86.2	70	130

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report Spike Concentration	Spike Recovery (%) MS	 MSD	Recovery Limits (%) Low	 High	RPDs (%) Value	 Control Limit
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791526)										
ES1501013-002	BH3 0.5-1.0M	EP080: C6 - C9 Fraction	----	32.5 mg/kg	98.1	----	70	130	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791526)										
ES1501013-002	BH3 0.5-1.0M	EP080: C6 - C10 Fraction	C6_C10	37.5 mg/kg	92.0	----	70	130	----	----
EP080: BTEXN (QCLot: 3791526)										
ES1501013-002	BH3 0.5-1.0M	EP080: Benzene	71-43-2	2.5 mg/kg	89.5	----	70	130	----	----
		EP080: Toluene	108-88-3	2.5 mg/kg	88.5	----	70	130	----	----
		EP080: Ethylbenzene	100-41-4	2.5 mg/kg	93.4	----	70	130	----	----

Sub-Matrix: **SOIL**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	*Spike Recovery (%)*		*Recovery Limits (%)*		*RPDs (%)*	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*MSD*	*Low*	*High*	*Value*	*Control Limit*
EP080: BTEXN (QCLot: 3791526) - continued										
ES1501013-002	BH3 0.5-1.0M	EP080: meta- & para-Xylene	108-38-3 106-42-3	2.5 mg/kg	91.5	----	70	130	----	----
		EP080: ortho-Xylene	95-47-6	2.5 mg/kg	93.5	----	70	130	----	----
		EP080: Naphthalene	91-20-3	2.5 mg/kg	84.0	----	70	130	----	----
EP074E: Halogenated Aliphatic Compounds (QCLot: 3791527)										
ES1501013-002	BH3 0.5-1.0M	EP074: 1.1-Dichloroethene	75-35-4	2.5 mg/kg	72.5	----	70	130	----	----
		EP074: Trichloroethene	79-01-6	2.5 mg/kg	88.1	----	70	130	----	----
EP074F: Halogenated Aromatic Compounds (QCLot: 3791527)										
ES1501013-002	BH3 0.5-1.0M	EP074: Chlorobenzene	108-90-7	2.5 mg/kg	94.3	----	70	130	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791554)										
ES1500870-007	Anonymous	EP071: C10 - C14 Fraction	----	560 mg/kg	80.3	----	73	137	----	----
		EP071: C15 - C28 Fraction	----	2370 mg/kg	62.5	----	53	131	----	----
		EP071: C29 - C36 Fraction	----	1695 mg/kg	64.6	----	52	132	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791554)										
ES1500870-007	Anonymous	EP071: >C10 - C16 Fraction	>C10_C16	902 mg/kg	85.3	----	73	137	----	----
		EP071: >C16 - C34 Fraction	----	3190 mg/kg	55.7	----	53	131	----	----
		EP071: >C34 - C40 Fraction	----	1087 mg/kg	66.9	----	52	132	----	----
EP075A: Phenolic Compounds (QCLot: 3791555)										
ES1500870-007	Anonymous	EP075: Phenol	108-95-2	5 mg/kg	73.8	----	60	130	----	----
		EP075: 2-Chlorophenol	95-57-8	5 mg/kg	74.6	----	60	130	----	----
		EP075: 2-Nitrophenol	88-75-5	5 mg/kg	63.9	----	50	130	----	----
		EP075: 4-Chloro-3-methylphenol	59-50-7	5 mg/kg	79.2	----	50	130	----	----
		EP075: Pentachlorophenol	87-86-5	10 mg/kg	39.9	----	10	130	----	----
EP075B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791555)										
ES1500870-007	Anonymous	EP075: Acenaphthene	83-32-9	5 mg/kg	79.1	----	50	130	----	----
		EP075: Pyrene	129-00-0	5 mg/kg	118	----	50	130	----	----
EP075D: Nitrosamines (QCLot: 3791555)										
ES1500870-007	Anonymous	EP075: N-Nitrosodi-n-propylamine	621-64-7	5 mg/kg	70.5	----	50	130	----	----
EP075E: Nitroaromatics and Ketones (QCLot: 3791555)										
ES1500870-007	Anonymous	EP075: 2.4-Dinitrotoluene	121-14-2	5 mg/kg	57.6	----	40	130	----	----
EP075G: Chlorinated Hydrocarbons (QCLot: 3791555)										
ES1500870-007	Anonymous	EP075: 1.4-Dichlorobenzene	106-46-7	5 mg/kg	76.0	----	60	130	----	----
		EP075: 1.2.4-Trichlorobenzene	120-82-1	5 mg/kg	79.2	----	50	130	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791560)										

Sub-Matrix: **SOIL**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*MSD*	*Low*	*High*	*Value*	*Control Limit*
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3791560) - continued										
ES1500960-001	Anonymous	EP071: C10 - C14 Fraction	----	640 mg/kg	86.5	----	73	137	----	----
		EP071: C15 - C28 Fraction	----	3140 mg/kg	86.5	----	53	131	----	----
		EP071: C29 - C36 Fraction	----	2860 mg/kg	80.0	----	52	132	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3791560)										
ES1500960-001	Anonymous	EP071: >C10 - C16 Fraction	>C10_C16	850 mg/kg	111	----	73	137	----	----
		EP071: >C16 - C34 Fraction	----	4800 mg/kg	84.2	----	53	131	----	----
		EP071: >C34 - C40 Fraction	----	2400 mg/kg	60.2	----	52	132	----	----
EP075(SIM)A: Phenolic Compounds (QCLot: 3791561)										
ES1500960-001	Anonymous	EP075(SIM): Phenol	108-95-2	10 mg/kg	80.2	----	70	130	----	----
		EP075(SIM): 2-Chlorophenol	95-57-8	10 mg/kg	77.8	----	70	130	----	----
		EP075(SIM): 2-Nitrophenol	88-75-5	10 mg/kg	94.9	----	60	130	----	----
		EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	10 mg/kg	87.3	----	70	130	----	----
		EP075(SIM): Pentachlorophenol	87-86-5	10 mg/kg	58.4	----	20	130	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 3791561)										
ES1500960-001	Anonymous	EP075(SIM): Acenaphthene	83-32-9	10 mg/kg	93.1	----	70	130	----	----
		EP075(SIM): Pyrene	129-00-0	10 mg/kg	94.1	----	70	130	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3792148)										
ES1501013-031	BH1 3.5-4.0M	EP080: C6 - C9 Fraction	----	32.5 mg/kg	96.0	----	70	130	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3792148)										
ES1501013-031	BH1 3.5-4.0M	EP080: C6 - C10 Fraction	C6_C10	37.5 mg/kg	96.1	----	70	130	----	----
EP080: BTEXN (QCLot: 3792148)										
ES1501013-031	BH1 3.5-4.0M	EP080: Benzene	71-43-2	2.5 mg/kg	80.3	----	70	130	----	----
		EP080: Toluene	108-88-3	2.5 mg/kg	84.9	----	70	130	----	----
		EP080: Ethylbenzene	100-41-4	2.5 mg/kg	84.1	----	70	130	----	----
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2.5 mg/kg	81.9	----	70	130	----	----
		EP080: ortho-Xylene	95-47-6	2.5 mg/kg	88.0	----	70	130	----	----
		EP080: Naphthalene	91-20-3	2.5 mg/kg	86.2	----	70	130	----	----
EG005T: Total Metals by ICP-AES (QCLot: 3795622)										
ES1500753-043	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	104	----	70	130	----	----
		EG005T: Cadmium	7440-43-9	50 mg/kg	101	----	70	130	----	----
		EG005T: Chromium	7440-47-3	50 mg/kg	102	----	70	130	----	----
		EG005T: Copper	7440-50-8	250 mg/kg	103	----	70	130	----	----
		EG005T: Lead	7439-92-1	250 mg/kg	95.8	----	70	130	----	----

Sub-Matrix: **SOIL**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	*Spike Recovery (%)*		*Recovery Limits (%)*		*RPDs (%)*	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*MSD*	*Low*	*High*	*Value*	*Control Limit*
EG005T: Total Metals by ICP-AES (QCLot: 3795622) - continued										
ES1500753-043	Anonymous	EG005T: Nickel	7440-02-0	50 mg/kg	101	----	70	130	----	----
		EG005T: Zinc	7440-66-6	250 mg/kg	99.0	----	70	130	----	----
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3795623)										
ES1500753-043	Anonymous	EG035T: Mercury	7439-97-6	5 mg/kg	108	----	70	130	----	----
EG005T: Total Metals by ICP-AES (QCLot: 3795625)										
ES1501013-009	BH5 1-1.3M	EG005T: Arsenic	7440-38-2	50 mg/kg	114	----	70	130	----	----
		EG005T: Cadmium	7440-43-9	50 mg/kg	97.8	----	70	130	----	----
		EG005T: Chromium	7440-47-3	50 mg/kg	100	----	70	130	----	----
		EG005T: Copper	7440-50-8	250 mg/kg	110	----	70	130	----	----
		EG005T: Lead	7439-92-1	250 mg/kg	91.8	----	70	130	----	----
		EG005T: Nickel	7440-02-0	50 mg/kg	95.8	----	70	130	----	----
		EG005T: Zinc	7440-66-6	250 mg/kg	92.4	----	70	130	----	----
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3795626)										
ES1501013-009	BH5 1-1.3M	EG035T: Mercury	7439-97-6	5 mg/kg	104	----	70	130	----	----

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **ES1501013**	Page	: 1 of 12
Client	: ZOIC ENVIRONMENTAL PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR GRAEME MALPASS	Contact	: Client Services
Address	: SUITE 4, LEVEL3 105 PITT STREET SYDNEY NSW AUSTRALIA 2000	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: GRAEME.MALPASS@ZOIC.COM.AU	E-mail	: sydney@alsglobal.com
Telephone	: 02 9231 1045	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: MARULAN SOUTH MINE	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 19-JAN-2015
Sampler	: GM	Issue Date	: 28-JAN-2015
Order number	: 14071		
		No. of samples received	: 50
Quote number	: SY/014/15	No. of samples analysed	: 35

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with recommended holding times (USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA055: Moisture Content							
Soil Glass Jar - Unpreserved (EA055-103) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M, BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**----**	----	----	**21-JAN-2015**	28-JAN-2015	✓
Soil Glass Jar - Unpreserved (EA055-103) BH1 0.3-0.5M, BH1 3.5-4.0M, BH2 2.1-2.5M, BH2 DUP2, BH2 4.0-4.5M	**15-JAN-2015**	**----**	----	----	**21-JAN-2015**	29-JAN-2015	✓
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples							
Snap Lock Bag - Separate asbestos bag received (EA200) ASB01 0-0.1M, ASB01 FRAGMENT, ASB03 0-0.1M, ASB04 0-0.1M, ASB05 0-0.1M, ASB05 FRAGMENT, ASB07 0-0.1M, ASB08 0-0.1M, ASB08 FRAGMENT, ASB09 FRAGMENT	**15-JAN-2015**	**---**	14-JUL-2015	----	**28-JAN-2015**	14-JUL-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container** / Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EG005T: Total Metals by ICP-AES							
Soil Glass Jar - Unpreserved (EG005T) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M, BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**22-JAN-2015**	13-JUL-2015	✓	**23-JAN-2015**	13-JUL-2015	✓
Soil Glass Jar - Unpreserved (EG005T) BH1 0.3-0.5M, BH1 3.5-4.0M, BH2 2.1-2.5M, BH2 DUP2, BH2 4.0-4.5M	**15-JAN-2015**	**22-JAN-2015**	14-JUL-2015	✓	**23-JAN-2015**	14-JUL-2015	✓
EG035T: Total Recoverable Mercury by FIMS							
Soil Glass Jar - Unpreserved (EG035T) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M, BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**22-JAN-2015**	11-FEB-2015	✓	**23-JAN-2015**	11-FEB-2015	✓
Soil Glass Jar - Unpreserved (EG035T) BH1 0.3-0.5M, BH1 3.5-4.0M, BH2 2.1-2.5M, BH2 DUP2, BH2 4.0-4.5M	**15-JAN-2015**	**22-JAN-2015**	12-FEB-2015	✓	**23-JAN-2015**	12-FEB-2015	✓
EP050: Anionic Surfactants as MBAS							
Soil Glass Jar - Unpreserved (EP050) BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	13-JUL-2015	✓	**22-JAN-2015**	23-JAN-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation* *Date extracted*	*Due for extraction*	*Evaluation*	*Analysis* *Date analysed*	*Due for analysis*	*Evaluation*
EP080/071: Total Petroleum Hydrocarbons							
Soil Glass Jar - Unpreserved (EP071) BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**21-JAN-2015**	02-MAR-2015	✓
Soil Glass Jar - Unpreserved (EP071) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
Soil Glass Jar - Unpreserved (EP071) BH1 0.3-0.5M, BH1 3.5-4.0M, BH2 2.1-2.5M, BH2 DUP2, BH2 4.0-4.5M	**15-JAN-2015**	**21-JAN-2015**	29-JAN-2015	✓	**21-JAN-2015**	02-MAR-2015	✓
EP074D: Fumigants							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓
EP074E: Halogenated Aliphatic Compounds							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓
EP074F: Halogenated Aromatic Compounds							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓
EP074A: Monocyclic Aromatic Hydrocarbons							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EP074B: Oxygenated Compounds							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓
EP074C: Sulfonated Compounds							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓
EP074G: Trihalomethanes							
Soil Glass Jar - Unpreserved (EP074) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	21-JAN-2015	✓	**21-JAN-2015**	21-JAN-2015	✓
EP075(SIM)A: Phenolic Compounds							
Soil Glass Jar - Unpreserved (EP075(SIM)) BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**21-JAN-2015**	02-MAR-2015	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Soil Glass Jar - Unpreserved (EP075(SIM)) BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**21-JAN-2015**	02-MAR-2015	✓
Soil Glass Jar - Unpreserved (EP075(SIM)) BH1 0.3-0.5M, BH1 3.5-4.0M, BH2 2.1-2.5M, BH2 DUP2, BH2 4.0-4.5M	**15-JAN-2015**	**21-JAN-2015**	29-JAN-2015	✓	**21-JAN-2015**	02-MAR-2015	✓
EP075H: Anilines and Benzidines							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EP075G: Chlorinated Hydrocarbons							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075F: Haloethers							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075E: Nitroaromatics and Ketones							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075D: Nitrosamines							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075I: Organochlorine Pesticides							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075J: Organophosphorus Pesticides							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075A: Phenolic Compounds							
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method		***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*			***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EP075C: Phthalate Esters								
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M,	NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP075B: Polynuclear Aromatic Hydrocarbons								
Soil Glass Jar - Unpreserved (EP075) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M,	NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**22-JAN-2015**	02-MAR-2015	✓
EP080: BTEXN								
Soil Glass Jar - Unpreserved (EP080) TRIP BLANK 10,	TRIP SPIKE 10	**13-JAN-2015**	**21-JAN-2015**	27-JAN-2015	✓	**21-JAN-2015**	27-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) TSC		**13-JAN-2015**	**21-JAN-2015**	27-JAN-2015	✓	**22-JAN-2015**	27-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) BH3 0.5-1.0M, BH4 0-0.45M, BH5 0-0.5M, BH6 0-0.5M, BH7 0-0.5M, BH8 0.5-0.9M, BH8 1.0-1.5M, BH9 1.5-2.0M, BH10 0.5-1.0M	NH3 1.5-2.0M, BH4 1.5-2.0M, BH5 1-1.3M, BH6 1.5-2.0M, BH7 1.0-1.5M, BH8 DUP1, BH9 0-0.5M, BH10 0.2-0.5M,	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**21-JAN-2015**	28-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) BH1 0.3-0.5M		**15-JAN-2015**	**21-JAN-2015**	29-JAN-2015	✓	**21-JAN-2015**	29-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) BH1 3.5-4.0M, BH2 DUP2,	BH2 2.1-2.5M, BH2 4.0-4.5M	**15-JAN-2015**	**21-JAN-2015**	29-JAN-2015	✓	**22-JAN-2015**	29-JAN-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	**Sample Date**	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		**Date extracted**	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Soil Glass Jar - Unpreserved (EP080) TRIP BLANK 10, TRIP SPIKE 10	**13-JAN-2015**	**21-JAN-2015**	27-JAN-2015	✓	**21-JAN-2015**	27-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) TSC	**13-JAN-2015**	**21-JAN-2015**	27-JAN-2015	✓	**22-JAN-2015**	27-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) BH3 0.5-1.0M, NH3 1.5-2.0M, BH4 0-0.45M, BH4 1.5-2.0M, BH5 0-0.5M, BH5 1-1.3M, BH6 0-0.5M, BH6 1.5-2.0M, BH7 0-0.5M, BH7 1.0-1.5M, BH8 0.5-0.9M, BH8 DUP1, BH8 1.0-1.5M, BH9 0-0.5M, BH9 1.5-2.0M, BH10 0.2-0.5M, BH10 0.5-1.0M	**14-JAN-2015**	**21-JAN-2015**	28-JAN-2015	✓	**21-JAN-2015**	28-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) BH1 0.3-0.5M	**15-JAN-2015**	**21-JAN-2015**	29-JAN-2015	✓	**21-JAN-2015**	29-JAN-2015	✓
Soil Glass Jar - Unpreserved (EP080) BH1 3.5-4.0M, BH2 2.1-2.5M, BH2 DUP2, BH2 4.0-4.5M	**15-JAN-2015**	**21-JAN-2015**	29-JAN-2015	✓	**22-JAN-2015**	29-JAN-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Anionic Surfactants as MBAS	EP050	1	4	**25.0**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Moisture Content	EA055-103	4	37	**10.8**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
PAH/Phenols (SIM)	EP075(SIM)	2	17	**11.8**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Organic Compounds	EP075	2	13	**15.4**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	26	**11.5**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	4	36	**11.1**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	4	30	**13.3**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	4	33	**12.1**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds	EP074	1	8	**12.5**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
PAH/Phenols (SIM)	EP075(SIM)	1	17	**5.9**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Organic Compounds	EP075	1	13	**7.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	26	**7.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	36	**5.6**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	2	30	**6.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	2	33	**6.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds	EP074	1	8	**12.5**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Anionic Surfactants as MBAS	EP050	1	4	**25.0**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
PAH/Phenols (SIM)	EP075(SIM)	1	17	**5.9**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Organic Compounds	EP075	1	13	**7.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	26	**7.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	36	**5.6**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	2	30	**6.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	2	33	**6.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds	EP074	1	8	**12.5**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
PAH/Phenols (SIM)	EP075(SIM)	1	17	**5.9**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Organic Compounds	EP075	1	13	**7.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	26	**7.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	36	**5.6**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	2	30	**6.7**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	2	33	**6.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds	EP074	1	8	**12.5**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Moisture Content	EA055-103	SOIL	In-house. A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Asbestos Identification in bulk solids	EA200	SOIL	AS 4964 - 2004 Method for the qualitative identification of asbestos in bulk samples Analysis by Polarised Light Microscopy including dispersion staining
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 21st ed., 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Anionic Surfactants as MBAS	EP050	SOIL	In house: Referenced to APHA 21st ed., 5540 B & C. MBAS results determined following 1:5 solid / water leach. This method comprises three successive extractions from acid aqueous medium containing excess methylene blue, into chloroform, followed by an aqueous backwash and measurement of the colour by spectrophotometry at 625nm. ALS is not NATA accredited for this analysis.
TRH - Semivolatile Fraction	EP071	SOIL	(USEPA SW 846 - 8015A) Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C40.
Volatile Organic Compounds	EP074	SOIL	(USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Method 501)
Semivolatile Organic Compounds	EP075	SOIL	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (2013) Schedule B(3) (Method 502)
PAH/Phenols (SIM)	EP075(SIM)	SOIL	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS in Selective Ion Mode (SIM) and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Method 502 and 507)
TRH Volatiles/BTEX	EP080	SOIL	(USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Methanolic Extraction of Soils for Purge and Trap	* ORG16	SOIL	(USEPA SW 846 - 5030A) 5g of solid is shaken with surrogate and 10mL methanol prior to analysis by Purge and Trap - GC/MS.
Tumbler Extraction of Solids	ORG17	SOIL	In-house, Mechanical agitation (tumbler). 10g of sample, Na2SO4 and surrogate are extracted with 30mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Duplicate (DUP) RPDs							
EP075C: Phthalate Esters	ES1500870-007	Anonymous	**bis(2-ethylhexyl) phthalate**	117-81-7	24.3 %	0-20%	**RPD exceeds LOR based limits**
Laboratory Control Spike (LCS) Recoveries							
EP075G: Chlorinated Hydrocarbons	4562908-007	----	**Hexachloropropylene**	1888-71-7	33.4 %	39.1-110%	**Recovery less than lower control limit**

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- **No Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order : **ES1501013**

Client : **ZOIC ENVIRONMENTAL PTY LTD**
Contact : MR GRAEME MALPASS
Address : SUITE 4, LEVEL3 105 PITT STREET
SYDNEY NSW AUSTRALIA 2000

E-mail : GRAEME.MALPASS@ZOIC.COM.AU
Telephone : 02 9231 1045
Facsimile : ----

Project : MARULAN SOUTH MINE
Order number : 14071
C-O-C number : ----
Site : ----
Sampler : GM

Laboratory : Environmental Division Sydney
Contact : Client Services
Address : 277-289 Woodpark Road Smithfield
NSW Australia 2164

E-mail : sydney@alsglobal.com
Telephone : +61-2-8784 8555
Facsimile : +61-2-8784 8500

Page : 1 of 4
Quote number : ES2015ZOIENV0001 (SY/014/15)
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received : 19-JAN-2015
Client Requested Due Date : 28-JAN-2015
Issue Date : 19-JAN-2015 15:59
Scheduled Reporting Date : **28-JAN-2015**

Delivery Details

Mode of Delivery : Carrier
No. of coolers/boxes : 2 ESKYS
Security Seal : Intact.
Temperature : 4.1'C - Ice present
No. of samples received : 50
No. of samples analysed : 35

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Asbestos analysis will be conducted by ALS Newcastle.**
- **MBAS analysis will be conducted by ALS Brisbane**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **Sample BH8 TRIP 1 and BH2 TRIP2 forward to Envirolab**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	(On Hold) SOIL No analysis requested	SOIL - EA200 Asbestos Identification in Soils	SOIL - EA200B Asbestos Identification in Bulk Solids	SOIL - EP050 Anionic Surfactants as MBAS	SOIL - S-02 8 Metals (incl. Digestion)	SOIL - S-04 TRH/BTEXN	SOIL - S-18 TRH(C6-C9)/BTEXN	SOIL - S-23 SVOC/VOC
ES1501013-001	14-JAN-2015 15:00	BH3 0-0.4M	✓							
ES1501013-002	14-JAN-2015 15:00	BH3 0.5-1.0M					✓	✓		✓
ES1501013-003	14-JAN-2015 15:00	BH3 1.2-1.5M	✓							
ES1501013-004	14-JAN-2015 15:00	NH3 1.5-2.0M					✓	✓		✓
ES1501013-005	14-JAN-2015 15:00	BH4 0-0.45M					✓	✓		✓
ES1501013-006	14-JAN-2015 15:00	BH4 0.5-1.0M	✓							
ES1501013-007	14-JAN-2015 15:00	BH4 1.5-2.0M					✓	✓		✓
ES1501013-008	14-JAN-2015 15:00	BH5 0-0.5M				✓	✓	✓		✓
ES1501013-009	14-JAN-2015 15:00	BH5 1-1.3M				✓	✓	✓		✓
ES1501013-010	14-JAN-2015 15:00	BH6 0-0.5M				✓	✓	✓		✓
ES1501013-011	14-JAN-2015 15:00	BH6 1.5-2.0M				✓	✓	✓		✓
ES1501013-014	14-JAN-2015 15:00	BH7 1.5-2.0M	✓							
ES1501013-015	14-JAN-2015 15:00	BH8 0-0.5M	✓							
ES1501013-020	14-JAN-2015 15:00	BH9 0.5-1.0M	✓							
ES1501013-024	13-JAN-2015 15:00	TRIP BLANK 10							✓	
ES1501013-025	13-JAN-2015 15:00	TRIP SPIKE 10							✓	
ES1501013-027	15-JAN-2015 15:00	BH1 0.5-1.0M	✓							
ES1501013-028	15-JAN-2015 15:00	BH1 1.5-2.0M	✓							
ES1501013-029	15-JAN-2015 15:00	BH1 2.5-3.0M	✓							
ES1501013-030	15-JAN-2015 15:00	BH1 3.0-3.5M	✓							
ES1501013-032	15-JAN-2015 15:00	BH2 0.3-0.5M	✓							
ES1501013-033	15-JAN-2015 15:00	BH2 0.5-1.0M	✓							
ES1501013-034	15-JAN-2015 15:00	BH2 1.0-1.5M	✓							
ES1501013-038	15-JAN-2015 15:00	ASB01 0-0.1M		✓						
ES1501013-039	15-JAN-2015 15:00	ASB01 FRAGMENT			✓					
ES1501013-040	15-JAN-2015 15:00	ASB02 0-0.1M	✓							
ES1501013-041	15-JAN-2015 15:00	ASB03 0-0.1M		✓						
ES1501013-042	15-JAN-2015 15:00	ASB04 0-0.1M		✓						
ES1501013-043	15-JAN-2015 15:00	ASB05 0-0.1M		✓						
ES1501013-044	15-JAN-2015 15:00	ASB05 FRAGMENT			✓					
ES1501013-045	15-JAN-2015 15:00	ASB06 0-0.1M	✓							
ES1501013-046	15-JAN-2015 15:00	ASB07 0-0.1M		✓						
ES1501013-047	15-JAN-2015 15:00	ASB08 0-0.1M		✓						
ES1501013-048	15-JAN-2015 15:00	ASB08 FRAGMENT			✓					
ES1501013-049	15-JAN-2015 15:00	ASB09 FRAGMENT			✓					

			(On Hold) SOIL No analysis requested	SOIL - EA200 Asbestos Identification in Soils	SOIL - EA200B Asbestos Identification in Bulk Solids	SOIL - EP050 Anionic Surfactants as MBAS	SOIL - S-02 8 Metals (incl. Digestion)	SOIL - S-04 TRH/BTEXN	SOIL - S-18 TRH(C6-C9)/BTEXN	SOIL - S-23 SVOC/VOC
ES1501013-050	13-JAN-2015 15:00	TSC							✓	

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - S-26 8 metals/TRH/BTEXN/PAH	SOIL - S-27 TRH/BTEXN/PAH/Phenols/8Metals
ES1501013-012	14-JAN-2015 15:00	BH7 0-0.5M		✓
ES1501013-013	14-JAN-2015 15:00	BH7 1.0-1.5M		✓
ES1501013-016	14-JAN-2015 15:00	BH8 0.5-0.9M		✓
ES1501013-017	14-JAN-2015 15:00	BH8 DUP1		✓
ES1501013-018	14-JAN-2015 15:00	BH8 1.0-1.5M		✓
ES1501013-019	14-JAN-2015 15:00	BH9 0-0.5M		✓
ES1501013-021	14-JAN-2015 15:00	BH9 1.5-2.0M		✓
ES1501013-022	14-JAN-2015 15:00	BH10 0.2-0.5M		✓
ES1501013-023	14-JAN-2015 15:00	BH10 0.5-1.0M		✓
ES1501013-026	15-JAN-2015 15:00	BH1 0.3-0.5M	✓	
ES1501013-031	15-JAN-2015 15:00	BH1 3.5-4.0M	✓	
ES1501013-035	15-JAN-2015 15:00	BH2 2.1-2.5M	✓	
ES1501013-036	15-JAN-2015 15:00	BH2 DUP2	✓	
ES1501013-037	15-JAN-2015 15:00	BH2 4.0-4.5M	✓	

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

MR GRAEME MALPASS

- *AU Certificate of Analysis - NATA (COA)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- A4 - AU Tax Invoice (INV)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- Chain of Custody (CoC) (COC)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- EDI Format - ENMRG (ENMRG)	Email	GRAEME.MALPASS@ZOIC.COM.AU
- EDI Format - ESDAT (ESDAT)	Email	GRAEME.MALPASS@ZOIC.COM.AU

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 122227

Client:

Zoic Environmental
Suite 4, Level 3, 105 Pitt St
Sydney
NSW 2000

Attention: Gareme Malpass

Sample log in details:

Your Reference:	**Marulan South Mine**
No. of samples:	2 soils
Date samples received / completed instructions received	20/012015 / 20/01/2015

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	28/01/15 / 23/01/15
Date of Preliminary Report:	Not Issued

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

ACCREDITED FOR TECHNICAL COMPETENCE

vTRH(C6-C10)/BTEXN in Soil			
Our Reference:	UNITS	122227-1	122227-2
Your Reference	-------------	BH8 TRIP1	BH2 TRIP2
Date Sampled	------------	14/01/2015	15/01/2015
Type of sample		SOIL	SOIL
Date extracted	-	21/01/2015	21/01/2015
Date analysed	-	21/01/2015	21/01/2015
TRH C_6 - C_9	mg/kg	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25
Benzene	mg/kg	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1
m+p-xylene	mg/kg	<2	<2
o-Xylene	mg/kg	<1	<1
naphthalene	mg/kg	<1	<1
Surrogate aaa-Trifluorotoluene	%	98	98

svTRH (C10-C40) in Soil			
Our Reference:	UNITS	122227-1	122227-2
Your Reference	-------------	BH8 TRIP1	BH2 TRIP2
Date Sampled	------------	14/01/2015	15/01/2015
Type of sample		SOIL	SOIL
Date extracted	-	21/01/2015	21/01/2015
Date analysed	-	22/01/2015	22/01/2015
TRHC$_{10}$ - C$_{14}$	mg/kg	410	<50
TRHC$_{15}$ - C$_{28}$	mg/kg	6,700	120
TRHC$_{29}$ - C$_{36}$	mg/kg	2,900	410
TRH>C$_{10}$-C$_{16}$	mg/kg	1,100	<50
TRH>C$_{10}$ - C$_{16}$ less Naphthalene (F2)	mg/kg	1,100	<50
TRH>C$_{16}$-C$_{34}$	mg/kg	8,200	350
TRH>C$_{34}$-C$_{40}$	mg/kg	1,700	310
Surrogate o-Terphenyl	%	#	99

PAHs in Soil Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	122227-1 BH8 TRIP1 14/01/2015 SOIL	122227-2 BH2 TRIP2 15/01/2015 SOIL
Date extracted	-	21/01/2015	21/01/2015
Date analysed	-	21/01/2015	21/01/2015
Naphthalene	mg/kg	0.7	<0.1
Acenaphthylene	mg/kg	0.3	<0.1
Acenaphthene	mg/kg	1.2	<0.1
Fluorene	mg/kg	1.7	<0.1
Phenanthrene	mg/kg	6.0	<0.1
Anthracene	mg/kg	0.7	<0.1
Fluoranthene	mg/kg	0.7	<0.1
Pyrene	mg/kg	3.3	<0.1
Benzo(a)anthracene	mg/kg	0.8	<0.1
Chrysene	mg/kg	0.9	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	0.6	<0.2
Benzo(a)pyrene	mg/kg	0.66	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	0.2	<0.1
Dibenzo(a,h)anthracene	mg/kg	0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	0.3	<0.1
Benzo(a)pyrene TEQ NEPM B1	mg/kg	0.9	<0.5
Total Positive PAHs	mg/kg	18	NIL (+)VE
Surrogate p-Terphenyl-d14	%	104	104

Total Phenolics in Soil		
Our Reference:	UNITS	122227-1
Your Reference	-------------	BH8TRIP1
Date Sampled	------------	14/01/2015
Type of sample		SOIL
Date extracted	-	21/01/2015
Date analysed	-	21/01/2015
Total Phenolics (as Phenol)	mg/kg	<5

Acid Extractable metals in soil Our Reference:	UNITS	122227-1	122227-2	122227-3
Your Reference	-------------	BH8 TRIP1	BH2 TRIP2	BH8 TRIP1 - TRIPLICATE
Date Sampled	------------	14/01/2015	15/01/2015	14/01/2015
Type of sample		SOIL	SOIL	SOIL
Date digested	-	21/01/2015	21/01/2015	21/01/2015
Date analysed	-	21/01/2015	21/01/2015	21/01/2015
Arsenic	mg/kg	6	6	6
Cadmium	mg/kg	<0.4	0.7	<0.4
Chromium	mg/kg	7	6	6
Copper	mg/kg	9	17	8
Lead	mg/kg	9	30	7
Mercury	mg/kg	<0.1	<0.1	<0.1
Nickel	mg/kg	7	7	7
Zinc	mg/kg	29	69	22

Moisture			
Our Reference:	UNITS	122227-1	122227-2
Your Reference	-------------	BH8 TRIP1	BH2 TRIP2
Date Sampled	------------	14/01/2015	15/01/2015
Type of sample		SOIL	SOIL
Date prepared	-	21/01/2015	21/01/2015
Date analysed	-	22/01/2015	22/01/2015
Moisture	%	6.7	11

Method ID	Methodology Summary
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012 subset	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Inorg-008	Moisture content determined by heating at 105+/-5 deg C for a minimum of 12 hours.

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/01/2015	[NT]	[NT]	LCS-2	21/01/2015
Date analysed	-			21/01/2015	[NT]	[NT]	LCS-2	21/01/2015
TRHC_6 - C_9	mg/kg	25	Org-016	<25	[NT]	[NT]	LCS-2	117%
TRHC_6 - C_{10}	mg/kg	25	Org-016	<25	[NT]	[NT]	LCS-2	117%
Benzene	mg/kg	0.2	Org-016	<0.2	[NT]	[NT]	LCS-2	98%
Toluene	mg/kg	0.5	Org-016	<0.5	[NT]	[NT]	LCS-2	118%
Ethylbenzene	mg/kg	1	Org-016	<1	[NT]	[NT]	LCS-2	120%
m+p-xylene	mg/kg	2	Org-016	<2	[NT]	[NT]	LCS-2	124%
o-Xylene	mg/kg	1	Org-016	<1	[NT]	[NT]	LCS-2	125%
naphthalene	mg/kg	1	Org-014	<1	[NT]	[NT]	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%		Org-016	101	[NT]	[NT]	LCS-2	100%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/01/2015	[NT]	[NT]	LCS-2	21/01/2015
Date analysed	-			22/01/2015	[NT]	[NT]	LCS-2	22/01/2015
TRHC_{10} - C_{14}	mg/kg	50	Org-003	<50	[NT]	[NT]	LCS-2	102%
TRHC_{15} - C_{28}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	110%
TRHC_{29} - C_{36}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	111%
TRH>C_{10}-C_{16}	mg/kg	50	Org-003	<50	[NT]	[NT]	LCS-2	102%
TRH>C_{16}-C_{34}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	110%
TRH>C_{34}-C_{40}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	111%
Surrogate o-Terphenyl	%		Org-003	93	[NT]	[NT]	LCS-2	108%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/01/2015	[NT]	[NT]	LCS-2	21/01/2015
Date analysed	-			21/01/2015	[NT]	[NT]	LCS-2	21/01/2015
Naphthalene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	LCS-2	95%
Acenaphthylene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Acenaphthene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Fluorene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	LCS-2	107%
Phenanthrene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	LCS-2	97%
Anthracene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Fluoranthene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	LCS-2	96%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Pyrene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	LCS-2	111%
Benzo(a)anthracene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Chrysene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Benzo(b,j+k) fluoranthene	mg/kg	0.2	Org-012 subset	<0.2	[NT]	[NT]	[NR]	[NR]
Benzo(a)pyrene	mg/kg	0.05	Org-012 subset	<0.05	[NT]	[NT]	LCS-2	100%
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012 subset	<0.1	[NT]	[NT]	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012 subset	100	[NT]	[NT]	LCS-2	105%

QUALITY CONTROL Total Phenolics in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/01/2015	[NT]	[NT]	LCS-1	21/01/2015
Date analysed	-			21/01/2015	[NT]	[NT]	LCS-1	21/01/2015
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	[NT]	[NT]	LCS-1	102%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date digested	-			21/01/2015	122227-1	21/01/2015 || 21/01/2015	LCS-7	21/01/2015
Date analysed	-			21/01/2015	122227-1	21/01/2015 || 21/01/2015	LCS-7	21/01/2015
Arsenic	mg/kg	4	Metals-020 ICP-AES	<4	122227-1	6 || 4 || RPD: 40	LCS-7	109%
Cadmium	mg/kg	0.4	Metals-020 ICP-AES	<0.4	122227-1	<0.4 || <0.4	LCS-7	108%
Chromium	mg/kg	1	Metals-020 ICP-AES	<1	122227-1	7 || 4 || RPD: 55	LCS-7	112%
Copper	mg/kg	1	Metals-020 ICP-AES	<1	122227-1	9 || 5 || RPD: 57	LCS-7	118%
Lead	mg/kg	1	Metals-020 ICP-AES	<1	122227-1	9 || 5 || RPD: 57	LCS-7	106%
Mercury	mg/kg	0.1	Metals-021 CV-AAS	<0.1	122227-1	<0.1 || <0.1	LCS-7	98%
Nickel	mg/kg	1	Metals-020 ICP-AES	<1	122227-1	7 || 4 || RPD: 55	LCS-7	111%
Zinc	mg/kg	1	Metals-020 ICP-AES	<1	122227-1	29 || 17 || RPD: 52	LCS-7	110%

Report Comments:

TRH_S_NEPM:
Percent recovery is not possible to report as the high concentration of analytes in the sample/s have caused interference.

Acid Extractable Metals in Soil: The laboratory RPD acceptance criteriae has been exceeded for 122227-1 for Ni, Zn. Therefore a triplicate result has been issued as laboratory sample number 122227-3.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test
NA: Test not required
<: Less than
PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than
NT: Not tested
NA: Test not required
LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

122227

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com
NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
✓ SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: Marulan South Mine
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994 646
SAMPLER: AS ABOVE SAMPLER MOBILE: AS ABOVE
COC emailed to ALS? ([redacted] YES
EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): (as above)
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: NIL

TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: [✓ 1] 2 3 4 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
SAM	Steven	Daniel	
DATE/TIME: 16/1/15 1:20pm	DATE/TIME: 19/1/15 1130	DATE/TIME: 20/1 1000	DATE/TIME:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	TPH BTEX S-26 M8 PAH	S-23 svoc/voc	TPH BTEX M8 S-27 PAH phenol	EP050 MBAS	EA 200 asbestos	S2 8 metals	HOLD	S4 TPH C6-C40 BTEX	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. HC = hydrocarbon.
1	BH3 0 - 0.4m	14.1.15	SOIL	150mm GLASS JAR	1							✓		—
2	BH3 0.5 - 1.0m	"	"	"	1		✓				✓		✓	—
3	BH3 1.2 - 1.5m	"	"	"	1							✓		Faint HC odour
4	BH3 1.5 - 2.0m	"	"	"	1		✓				✓		✓	—
5	BH4 0 - 0.45m	"	"	"	1		✓				✓		✓	—
6	BH4 0.5 - 1.0m	"	"	"	1							✓		—
7	BH4 1.5 - 2.0m	"	"	"	1		✓				✓		✓	Faint HC odour
8	BH5 0 - 0.5m	"	"	"	2		✓		✓		✓		✓	—
9	BH5 1 - 1.3m	"	"	"	2		✓		✓		✓		✓	—
10	BH6 0 - 0.5m	"	"	"	2		✓		✓		✓		✓	—
11	BH6 1.5 - 2.0m	"	"	"	2		✓		✓		✓		✓	—
				TOTAL	—	—	8	—	4	—	8	3	8	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass.
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 122227
Date Received: 20/1/15
Time Received: 10:00
Received by: TDHF
Temp: [✓ Cool]/Ambient
Cooling: Ice/[✓ Icepack]
Security: [✓ Intact]/Broken/None

Environmental Division
Sydney
Work Order
ES1501013

Telephone : +61-2-8784 8555

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994646
SAMPLER: as above SAMPLER MOBILE: as above
COC emailed to ALS? ([redacted] YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above

TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SYO/14/15

COC SEQUENCE NUMBER (Circle)
COC: 1 [✓ 2] 3 4 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY: GAM
DATE/TIME: 16/1/15 1:20pm

RECEIVED BY: Steven
DATE/TIME: 19/1/15 1130

RELINQUISHED BY:
DATE/TIME: 20/1 1000

RECEIVED BY:
DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ~~[illegible]~~ PLEASE SEND TRIPLICATE SAMPLES TO ENVIROLAB SYDNEY

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	EP050	EA200		HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. hc = hydrocarbon
12	BH7 ~~[illegible]~~ 0-0.5m	14.1.15	SOIL	150mm JAR GLASS	1			✓						–
13	BH7 1-1.5m	"	"	"	1			✓						–
14	BH7 1.5-2.0m	"	"	"	1							✓		–
15	BH8 0-0.5m	"	"	"	1							✓		–
16	BH8 0.5-0.9m	"	"	"	1			✓						strong hc odour
17	BH8 DUP1	"	"	"	1			✓						–
~~18~~	BH8 TRIP1	"	"	"	1			✓					*	PLEASE SEND TO ENVIROLAB SYDNEY *
18	BH8 1.0-1.5m	"	"	"	1			✓						–
19	BH9 0-0.5m	"	"	"	1			✓						HC odour
20	BH9 0.5-1.0m	"	"	"	1							✓		faint hc odour
21	BH9 1.5-2.0m	"	"	"	1			✓						faint hc odour
				TOTAL	–	–	–	8	–	–	–	3	–	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

[illegible]

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINS
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994646
SAMPLER: as above SAMPLER MOBILE: as above
COC emailed to ALS? ([illegible]) YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: NIL

TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: 1 2 [✓ 3] 4 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY: GAM
DATE/TIME: 16/1/15 1:20pm

RECEIVED BY: Steven
DATE/TIME: 19/1/15 1130

RELINQUISHED BY: Dc
DATE/TIME: 20/1 1000

RECEIVED BY:
DATE/TIME:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	BPO50	EA200	TPH C6-C10 and BTEX	HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. HC - hydrocarbon
22	BH10 0.2-0.5m	14.1.15	SOIL	150mm GLASS JAR	1			✓						—
23	BH10 0.5-1.0m	~~B~~ "	"	"	1			✓						—
24	TRIP BLANK (10)	13.1.15	"	"	1						✓			prepared by ALS
25	TRIP SPIKE (10)	13.1.15	"	"	1						✓			"
26	BH1 0.3-0.5m	15.1.15	"	"	1	✓								faint HC odour
27	BH1 0.5-1.0m	"	"	"	1							✓		—
28	BH1 1.5-2.0m	"	"	"	1							✓		faint HC odour
29	BH1 2.5-3.0m	"	"	"	1							✓		—
30	BH1 3.0-3.5m	"	"	"	1							✓		faint HC odour
31	BH1 3.5-4.0m	"	"	"	1	✓								—
				TOTAL	–	2	–	18	–	–	2	4	–	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488 994646
SAMPLER: as above SAMPLER MOBILE: as above
COC emailed to ALS? ([illegible]) YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: Please forward TRIP 2 to Envirolab Sydney

TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: 1 2 3 [✓ 4] 5 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY: GAM	RECEIVED BY: Steven	RELINQUISHED BY: D	RECEIVED BY:
DATE/TIME: 16/1/15 1:20pm	DATE/TIME: 19/1/15 1130	DATE/TIME: 20/1 1000	DATE/TIME:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	EP050	EA200		HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. HC = hydrocarbon
32	BH2 0.3-0.5m	15.1.15	SOIL	150mm jar glass	1							✓		—
33	BH2 0.5-1.0m	"	"	"	1							✓		—
34	BH2 1.0-1.5m	"	"	"	1							✓		faint HC odour
35	BH2 2.1-2.5m	"	"	"	1	✓								HC odour
36	BH2 DUP 2	"	"	"	1	✓								—
*	BH2 TRIP 2	"	"	"	1	✓								FWD to ENVIROLAB SYDNEY
37	BH2 4.0-4.5	"	"	"	1	✓								—
				TOTAL	—	4	—	—	—	—	—	3	—	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT: ZOIC ENVIRONMENTAL
OFFICE: SYDNEY
PROJECT: MARULAN SOUTH MINE
ORDER NUMBER: 14071
PROJECT MANAGER: GRAEME MALPASS CONTACT PH: 0488994646
SAMPLER: AS ABOVE SAMPLER MOBILE: as above
COC emailed to ALS? ([redacted] YES EDD FORMAT (or default): ESDAT
Email Reports to (will default to PM if no other addresses are listed): graeme.malpass@zoic.com.au
Email Invoice to (will default to PM if no other addresses are listed): as above

TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY/014/15

COC SEQUENCE NUMBER (Circle)
COC: 1 2 3 4 [✓ 5] 6 7
OF: 1 2 3 4 [✓ 5] 6 7

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
GAM	Steven	D	
DATE/TIME: 16/1/15 1:20pm	DATE/TIME: 19/1/15 1130	DATE/TIME: 20/1 1000	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: NIL

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S-26	S-23	S-27	EP050	EA200		HOLD		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
38	ASB01 0-0.1m	15.01.15	SOIL	plastic bag	1					✓				—
39	ASB01 fragment	"	—	"	1					✓				potential asbestos
40	ASB02 0-0.1m	"	SOIL	"	1							✓		—
41	ASB03 0-0.1m	"	"	"	1					✓				—
42	ASB04 0-0.1m	"	"	"	1					✓				—
43	ASB05 0-0.1m	"	"	"	1					✓				—
44	ASB05 fragment	"	—	"	1					✓				potential asbestos
45	ASB06 0-0.1m	"	SOIL	"	1							✓		"
46	ASB07 0-0.1m	"	"	"	1					✓				—
47	ASB08 0-0.1m	"	SOIL	"	1					✓				—
48	ASB 08 fragment	"	—	"	1					✓				potential asbestos
49	ASB09 fragment	"		"	1					✓				"
				TOTAL	–	–	–	–	–	10	–	1	–	.

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

SAMPLE RECEIPT ADVICE

Client:

Zoic Environmental	ph: 0402 265 537
Suite 4, Level 3, 105 Pitt St	Fax:
Sydney NSW 2000	

Attention: Gareme Malpass

Sample log in details:

Your reference:	**Marulan South Mine**
Envirolab Reference:	**122227**
Date received:	20/012015
Date results expected to be reported:	**28/01/15**

Samples received in appropriate condition for analysis:	YES
No. of samples provided	2 soils
Turnaround time requested:	Standard
Temperature on receipt (°C)	9.5
Cooling Method:	Ice Pack
Sampling Date Provided:	YES

Comments:

If there is sufficient sample after testing, samples will be held for the following time frames from date of receipt of samples:
Water samples - 1 month
Soil and other solid samples - 2 months
Samples collected in canisters - 1 week. Canisters will then be cleaned.
All other samples are not retained after analysis
If you require samples to be retained for longer periods then retention fees will apply as per our pricelist.

Contact details:

Please direct any queries to Aileen Hie or Jacinta Hurst
ph: 02 9910 6200 fax: 02 9910 6201
email: ahie@envirolabservices.com.au or jhurst@envirolabservices.com.au

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1426315**	Page	: 1 of 13
Client	: **INTERNATIONAL ENVIRONMENTAL CONSULTANTS**	Laboratory	: Environmental Division Sydney
Contact	: MS KIRSTY NIELSEN	Contact	: Client Services
Address	: LONGMEAD, LOT 12 WOMBEYAN CAVES ROAD MITTAGONG NSW, AUSTRALIA 2575	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kirsty.nielsen@iec.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 4878 5502	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: MARULAN QUARRY RIVER MONITORING	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 27-NOV-2014
Sampler	: RB	Issue Date	: 08-DEC-2014
Site	: ----		
		No. of samples received	: 10
Quote number	: SY/028/14	No. of samples analysed	: 10

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.**
- **EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.**
- **EG020: It is recognised that total concentration is less than dissolved for some metal analytes, however the difference is within experimental variation of the methods.**

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**SR1**	**SR2**	**SR3**	**BUNGONIA CK UP**	**BUNGONIA CK DN**
			Client sampling date / time	27-NOV-2014 11:50	27-NOV-2014 12:30	27-NOV-2014 13:15	27-NOV-2014 10:00	27-NOV-2014 11:15
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-001**	**ES1426315-002**	**ES1426315-003**	**ES1426315-004**	**ES1426315-005**
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.44**	**7.49**	**7.56**	**7.69**	**8.11**
EA006: Sodium Adsorption Ratio (SAR)								
Sodium Adsorption Ratio	----	0.01	-	**0.78**	**0.78**	**0.85**	**0.97**	**0.89**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**116**	**119**	**119**	**743**	**632**
EA016: Non Marine - Estimated TDS Salinity								
Total Dissolved Solids (Calc.)	----	1	mg/L	**75**	**77**	**77**	**483**	**411**
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**31**	**31**	**31**	**292**	**245**
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**0.027**	**0.030**	**0.026**	**0.230**	**0.155**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**34**	**35**	**36**	**214**	**148**
Total Alkalinity as CaCO3	----	1	mg/L	**34**	**35**	**36**	**214**	**148**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	**2**	**2**	**36**	**61**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**14**	**14**	**14**	**87**	**67**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**6**	**6**	**6**	**84**	**65**
Magnesium	7439-95-4	1	mg/L	**4**	**4**	**4**	**20**	**20**
Sodium	7440-23-5	1	mg/L	**10**	**10**	**11**	**38**	**32**
Potassium	7440-09-7	1	mg/L	**1**	**1**	**1**	**2**	**2**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	**0.02**	**0.02**	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.002**	**0.002**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.013**	**0.013**	**0.014**	**0.060**	**0.052**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**SR1**	**SR2**	**SR3**	**BUNGONIA CK UP**	**BUNGONIA CK DN**
			Client sampling date / time	27-NOV-2014 11:50	27-NOV-2014 12:30	27-NOV-2014 13:15	27-NOV-2014 10:00	27-NOV-2014 11:15
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-001**	**ES1426315-002**	**ES1426315-003**	**ES1426315-004**	**ES1426315-005**
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.006**	**0.006**	**0.007**	**0.003**	**0.002**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L	**0.033**	**0.035**	**0.035**	**0.230**	**0.205**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	**0.08**	**0.08**	**0.08**	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	**0.06**	**0.05**	**0.03**	<0.01
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.002**	**0.002**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.013**	**0.015**	**0.014**	**0.061**	**0.053**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.016**	**0.016**	**0.019**	**0.003**	**0.008**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L	**0.035**	**0.036**	**0.035**	**0.230**	**0.205**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	**0.23**	**0.15**	**0.16**	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**SR1**	**SR2**	**SR3**	**BUNGONIA CK UP**	**BUNGONIA CK DN**
			Client sampling date / time	27-NOV-2014 11:50	27-NOV-2014 12:30	27-NOV-2014 13:15	27-NOV-2014 10:00	27-NOV-2014 11:15
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-001**	**ES1426315-002**	**ES1426315-003**	**ES1426315-004**	**ES1426315-005**
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052F: Dissolved Silica by ICPAES								
Silicon as SiO2	14464-46-1	0.1	mg/L	**6.0**	**6.2**	**6.1**	**10.5**	**9.2**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	**0.1**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	**0.10**	**0.01**	**3.12**	**5.63**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**0.3**	**0.3**	**0.6**	**1.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.3**	**0.4**	**0.3**	**3.7**	**6.7**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.01**	**0.01**	<0.01	<0.01
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**1.12**	**1.14**	**1.16**	**7.48**	**6.12**
Total Cations	----	0.01	meq/L	**1.09**	**1.09**	**1.13**	**7.54**	**6.33**
Ionic Balance	----	0.01	%	----	----	----	**0.43**	**1.75**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**5**	**4**	**4**	<1	**3**
EP025: Oxygen - Dissolved (DO)								
Dissolved Oxygen	----	0.1	mg/L	**8.4**	**8.2**	**8.2**	**8.1**	**8.9**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	<2	<2	<2
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1.0	µg/L	----	----	----	<1.0	----
2-Chlorophenol	95-57-8	1.0	µg/L	----	----	----	<1.0	----
2-Methylphenol	95-48-7	1.0	µg/L	----	----	----	<1.0	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L	----	----	----	<2.0	----
2-Nitrophenol	88-75-5	1.0	µg/L	----	----	----	<1.0	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L	----	----	----	<1.0	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L	----	----	----	<1.0	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L	----	----	----	<1.0	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L	----	----	----	<1.0	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**SR1**	**SR2**	**SR3**	**BUNGONIA CK UP**	**BUNGONIA CK DN**
			Client sampling date / time	27-NOV-2014 11:50	27-NOV-2014 12:30	27-NOV-2014 13:15	27-NOV-2014 10:00	27-NOV-2014 11:15
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-001**	**ES1426315-002**	**ES1426315-003**	**ES1426315-004**	**ES1426315-005**
EP075(SIM)A: Phenolic Compounds - Continued								
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L	----	----	----	<1.0	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L	----	----	----	<1.0	----
Pentachlorophenol	87-86-5	2.0	µg/L	----	----	----	<2.0	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	----	----	----	<1.0	----
Acenaphthylene	208-96-8	1.0	µg/L	----	----	----	<1.0	----
Acenaphthene	83-32-9	1.0	µg/L	----	----	----	<1.0	----
Fluorene	86-73-7	1.0	µg/L	----	----	----	<1.0	----
Phenanthrene	85-01-8	1.0	µg/L	----	----	----	<1.0	----
Anthracene	120-12-7	1.0	µg/L	----	----	----	<1.0	----
Fluoranthene	206-44-0	1.0	µg/L	----	----	----	<1.0	----
Pyrene	129-00-0	1.0	µg/L	----	----	----	<1.0	----
Benz(a)anthracene	56-55-3	1.0	µg/L	----	----	----	<1.0	----
Chrysene	218-01-9	1.0	µg/L	----	----	----	<1.0	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	----	----	----	<1.0	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	----	----	----	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	----	----	----	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	----	----	----	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	----	----	----	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	----	----	----	<1.0	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	----	----	----	<0.5	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L	----	----	----	<0.5	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	----	----	----	<20	----
C10 - C14 Fraction	----	50	µg/L	----	----	----	<50	----
C15 - C28 Fraction	----	100	µg/L	----	----	----	<100	----
C29 - C36 Fraction	----	50	µg/L	----	----	----	<50	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	----	----	----	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	----	----	----	<20	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	----	----	----	<20	----
>C10 - C16 Fraction	>C10_C16	100	µg/L	----	----	----	<100	----
>C16 - C34 Fraction	----	100	µg/L	----	----	----	<100	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**SR1**	**SR2**	**SR3**	**BUNGONIA CK UP**	**BUNGONIA CK DN**
			Client sampling date / time	27-NOV-2014 11:50	27-NOV-2014 12:30	27-NOV-2014 13:15	27-NOV-2014 10:00	27-NOV-2014 11:15
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-001**	**ES1426315-002**	**ES1426315-003**	**ES1426315-004**	**ES1426315-005**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	100	µg/L	----	----	----	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	----	----	----	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	----	----	----	<100	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	----	----	----	<1	----
Toluene	108-88-3	2	µg/L	----	----	----	<2	----
Ethylbenzene	100-41-4	2	µg/L	----	----	----	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	----	----	----	<2	----
ortho-Xylene	95-47-6	2	µg/L	----	----	----	<2	----
^ **Total Xylenes**	1330-20-7	2	µg/L	----	----	----	<2	----
^ **Sum of BTEX**	----	1	µg/L	----	----	----	<1	----
Naphthalene	91-20-3	5	µg/L	----	----	----	<5	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	----	----	----	**25.9**	----
2-Chlorophenol-D4	93951-73-6	0.1	%	----	----	----	**57.2**	----
2.4.6-Tribromophenol	118-79-6	0.1	%	----	----	----	**55.0**	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	----	----	----	**70.7**	----
Anthracene-d10	1719-06-8	0.1	%	----	----	----	**83.0**	----
4-Terphenyl-d14	1718-51-0	0.1	%	----	----	----	**73.9**	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	----	----	**108**	----
Toluene-D8	2037-26-5	0.1	%	----	----	----	**110**	----
4-Bromofluorobenzene	460-00-4	0.1	%	----	----	----	**77.2**	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

			Client sample ID	**BARBERS CK UP**	**BARBERS CK DN**	**MARULAN CK UP**	**MARULAN CK DN**	**BLOWHOLE**
			Client sampling date / time	27-NOV-2014 15:45	27-NOV-2014 14:30	27-NOV-2014 14:00	27-NOV-2014 14:45	27-NOV-2014 09:40
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-006**	**ES1426315-007**	**ES1426315-008**	**ES1426315-009**	**ES1426315-010**
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.44**	**7.54**	**7.74**	**8.11**	**8.12**
EA006: Sodium Adsorption Ratio (SAR)								
Sodium Adsorption Ratio	----	0.01	-	**1.34**	**1.09**	**3.35**	**1.99**	**0.50**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**867**	**1010**	**1800**	**1290**	**690**
EA016: Non Marine - Estimated TDS Salinity								
Total Dissolved Solids (Calc.)	----	1	mg/L	**564**	**656**	**1170**	**838**	**448**
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**305**	**384**	**471**	**422**	**299**
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**0.402**	**0.385**	**0.926**	**0.526**	**0.107**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**201**	**295**	**183**	**326**	**198**
Total Alkalinity as CaCO3	----	1	mg/L	**201**	**295**	**183**	**326**	**198**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**20**	**60**	**33**	**8**	**72**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**152**	**133**	**455**	**243**	**38**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**58**	**88**	**83**	**70**	**95**
Magnesium	7439-95-4	1	mg/L	**39**	**40**	**64**	**60**	**15**
Sodium	7440-23-5	1	mg/L	**54**	**49**	**167**	**94**	**20**
Potassium	7440-09-7	1	mg/L	**4**	**3**	**8**	**1**	**2**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	<0.01	**0.02**	<0.01	**0.02**
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.004**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.092**	**0.112**	**0.187**	**0.104**	**0.039**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**BARBERS CK UP**	**BARBERS CK DN**	**MARULAN CK UP**	**MARULAN CK DN**	**BLOWHOLE**
			Client sampling date / time	27-NOV-2014 15:45	27-NOV-2014 14:30	27-NOV-2014 14:00	27-NOV-2014 14:45	27-NOV-2014 09:40
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-006**	**ES1426315-007**	**ES1426315-008**	**ES1426315-009**	**ES1426315-010**
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.014**	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.100**	**0.041**	**0.205**	**0.020**	<0.001
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.001**	**0.002**	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L	**0.252**	**0.282**	**0.494**	**0.352**	**0.192**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.012**	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	**0.06**	<0.05	**0.18**	**0.05**	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.01**	**0.03**	**0.13**	<0.01	**0.02**
Arsenic	7440-38-2	0.001	mg/L	**0.002**	<0.001	**0.005**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.091**	**0.116**	**0.187**	**0.104**	**0.039**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.010**	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.100**	**0.044**	**0.256**	**0.028**	<0.001
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L	**0.255**	**0.288**	**0.490**	**0.348**	**0.193**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.013**	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	**0.07**	**0.08**	**0.46**	**0.08**	<0.05
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**BARBERS CK UP**	**BARBERS CK DN**	**MARULAN CK UP**	**MARULAN CK DN**	**BLOWHOLE**
			Client sampling date / time	27-NOV-2014 15:45	27-NOV-2014 14:30	27-NOV-2014 14:00	27-NOV-2014 14:45	27-NOV-2014 09:40
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-006**	**ES1426315-007**	**ES1426315-008**	**ES1426315-009**	**ES1426315-010**
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052F: Dissolved Silica by ICPAES								
Silicon as SiO2	14464-46-1	0.1	mg/L	**11.1**	**12.8**	**1.1**	**16.2**	**11.4**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.2**	**0.3**	**0.6**	**0.2**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.15**	**0.13**	**0.01**	**0.03**	**14.0**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.9**	**0.4**	**1.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.4**	**0.3**	**0.9**	**0.4**	**15.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.01**	**0.04**	**0.02**	**0.03**
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**8.72**	**10.9**	**17.2**	**13.5**	----
Total Anions	----	0.01	meq/L	----	----	----	----	**6.83**
Total Cations	----	0.01	meq/L	**8.56**	**9.89**	**16.9**	**12.6**	**6.90**
Ionic Balance	----	0.01	%	**0.95**	**4.82**	**0.88**	**3.80**	----
Ionic Balance	----	0.01	%	----	----	----	----	**0.51**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**3**	**1**	**14**	**5**	<1
EP025: Oxygen - Dissolved (DO)								
Dissolved Oxygen	----	0.1	mg/L	**4.4**	**6.3**	**7.2**	**7.7**	**8.6**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	**3**	<2	<2
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1.0	µg/L	----	<1.0	----	----	<1.0
2-Chlorophenol	95-57-8	1.0	µg/L	----	<1.0	----	----	<1.0
2-Methylphenol	95-48-7	1.0	µg/L	----	<1.0	----	----	<1.0
3- & 4-Methylphenol	1319-77-3	2.0	µg/L	----	<2.0	----	----	<2.0
2-Nitrophenol	88-75-5	1.0	µg/L	----	<1.0	----	----	<1.0
2.4-Dimethylphenol	105-67-9	1.0	µg/L	----	<1.0	----	----	<1.0
2.4-Dichlorophenol	120-83-2	1.0	µg/L	----	<1.0	----	----	<1.0

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

			Client sample ID	BARBERS CK UP	BARBERS CK DN	MARULAN CK UP	MARULAN CK DN	BLOWHOLE
			Client sampling date / time	27-NOV-2014 15:45	27-NOV-2014 14:30	27-NOV-2014 14:00	27-NOV-2014 14:45	27-NOV-2014 09:40
Compound	CAS Number	LOR	Unit	ES1426315-006	ES1426315-007	ES1426315-008	ES1426315-009	ES1426315-010
EP075(SIM)A: Phenolic Compounds - Continued								
2.6-Dichlorophenol	87-65-0	1.0	µg/L	----	<1.0	----	----	<1.0
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L	----	<1.0	----	----	<1.0
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L	----	<1.0	----	----	<1.0
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L	----	<1.0	----	----	<1.0
Pentachlorophenol	87-86-5	2.0	µg/L	----	<2.0	----	----	<2.0
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	----	<1.0	----	----	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	----	<1.0	----	----	<1.0
Acenaphthene	83-32-9	1.0	µg/L	----	<1.0	----	----	<1.0
Fluorene	86-73-7	1.0	µg/L	----	<1.0	----	----	<1.0
Phenanthrene	85-01-8	1.0	µg/L	----	<1.0	----	----	<1.0
Anthracene	120-12-7	1.0	µg/L	----	<1.0	----	----	<1.0
Fluoranthene	206-44-0	1.0	µg/L	----	<1.0	----	----	<1.0
Pyrene	129-00-0	1.0	µg/L	----	<1.0	----	----	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	----	<1.0	----	----	<1.0
Chrysene	218-01-9	1.0	µg/L	----	<1.0	----	----	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	----	<1.0	----	----	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	----	<1.0	----	----	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	----	<0.5	----	----	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	----	<1.0	----	----	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	----	<1.0	----	----	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	----	<1.0	----	----	<1.0
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	----	<0.5	----	----	<0.5
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L	----	<0.5	----	----	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	----	<20	----	----	<20
C10 - C14 Fraction	----	50	µg/L	----	<50	----	----	<50
C15 - C28 Fraction	----	100	µg/L	----	<100	----	----	<100
C29 - C36 Fraction	----	50	µg/L	----	<50	----	----	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	----	<50	----	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	----	<20	----	----	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	----	<20	----	----	<20

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**BARBERS CK UP**	**BARBERS CK DN**	**MARULAN CK UP**	**MARULAN CK DN**	**BLOWHOLE**
			Client sampling date / time	27-NOV-2014 15:45	27-NOV-2014 14:30	27-NOV-2014 14:00	27-NOV-2014 14:45	27-NOV-2014 09:40
Compound	*CAS Number*	*LOR*	*Unit*	**ES1426315-006**	**ES1426315-007**	**ES1426315-008**	**ES1426315-009**	**ES1426315-010**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C10 - C16 Fraction	>C10_C16	100	µg/L	----	<100	----	----	<100
>C16 - C34 Fraction	----	100	µg/L	----	<100	----	----	<100
>C34 - C40 Fraction	----	100	µg/L	----	<100	----	----	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	----	<100	----	----	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	----	<100	----	----	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	----	<1	----	----	<1
Toluene	108-88-3	2	µg/L	----	<2	----	----	<2
Ethylbenzene	100-41-4	2	µg/L	----	<2	----	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	----	<2	----	----	<2
ortho-Xylene	95-47-6	2	µg/L	----	<2	----	----	<2
^ **Total Xylenes**	1330-20-7	2	µg/L	----	<2	----	----	<2
^ **Sum of BTEX**	----	1	µg/L	----	<1	----	----	<1
Naphthalene	91-20-3	5	µg/L	----	<5	----	----	<5
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	----	**28.6**	----	----	**30.7**
2-Chlorophenol-D4	93951-73-6	0.1	%	----	**61.8**	----	----	**65.4**
2.4.6-Tribromophenol	118-79-6	0.1	%	----	**54.2**	----	----	**58.4**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	----	**76.2**	----	----	**75.6**
Anthracene-d10	1719-06-8	0.1	%	----	**86.0**	----	----	**88.9**
4-Terphenyl-d14	1718-51-0	0.1	%	----	**75.8**	----	----	**74.6**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	**84.4**	----	----	**103**
Toluene-D8	2037-26-5	0.1	%	----	**98.7**	----	----	**107**
4-Bromofluorobenzene	460-00-4	0.1	%	----	**91.4**	----	----	**79.8**

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27.4	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

QUALITY CONTROL REPORT

Work Order : **ES1426315**

Client : **INTERNATIONAL ENVIRONMENTAL CONSULTANTS**
Contact : MS KIRSTY NIELSEN
Address : LONGMEAD, LOT 12 WOMBEYAN CAVES ROAD
MITTAGONG NSW, AUSTRALIA 2575

E-mail : kirsty.nielsen@iec.com.au
Telephone : +61 02 4878 5502
Facsimile : ----

Project : MARULAN QUARRY RIVER MONITORING
Site : ----
C-O-C number : ----
Sampler : RB
Order number : ----

Quote number : SY/028/14

Page : 1 of 15

Laboratory : Environmental Division Sydney
Contact : Client Services
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164

E-mail : sydney@alsglobal.com
Telephone : +61-2-8784 8555
Facsimile : +61-2-8784 8500

QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Date Samples Received : 27-NOV-2014
Issue Date : 08-DEC-2014

No. of samples received : 10
No. of samples analysed : 10

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

NATA Accredited
Laboratory 825

Accredited for
compliance with
ISO/IEC 17025.

WORLD RECOGNISED
ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 3734099)									
ES1426313-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.49	7.51	0.3	0% - 20%
ES1426315-002	SR2	EA005-P: pH Value	----	0.01	pH Unit	7.49	7.52	0.4	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 3734098)									
ES1426313-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	902	902	0.0	0% - 20%
ES1426315-002	SR2	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	119	119	0.0	0% - 20%
ED009: Anions (QC Lot: 3735933)									
EM1412629-001	Anonymous	ED009-X: Bromide	24959-67-9	0.010	mg/L	0.022	0.022	0.0	No Limit
ES1426315-002	SR2	ED009-X: Bromide	24959-67-9	0.010	mg/L	0.030	0.028	6.9	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 3734097)									
ES1426313-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	327	331	1.1	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	327	331	1.1	0% - 20%
ES1426315-002	SR2	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	35	35	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	35	35	0.0	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 3734091)									
ES1426313-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	96	95	0.0	0% - 20%
ES1426315-002	SR2	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	2	0.0	No Limit
ED045G: Chloride Discrete analyser (QC Lot: 3734090)									
ES1426313-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	26	26	0.0	0% - 20%
ES1426315-002	SR2	ED045G: Chloride	16887-00-6	1	mg/L	14	14	0.0	0% - 50%
ED093F: Dissolved Major Cations (QC Lot: 3737755)									
ES1426091-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	30	28	8.6	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	16	16	0.0	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	27	27	0.0	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	4	3	0.0	No Limit
ES1426315-003	SR3	ED093F: Calcium	7440-70-2	1	mg/L	6	6	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	4	4	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	11	10	0.0	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 3737756)									
ES1426313-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	***Client sample ID***	***Method: Compound***	***CAS Number***	***LOR***	***Unit***	***Original Result***	***Duplicate Result***	***RPD (%)***	***Recovery Limits (%)***
EG020F: Dissolved Metals by ICP-MS (QC Lot: 3737756) - continued									
ES1426313-001	Anonymous	EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.044	0.044	0.0	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.042	0.042	0.0	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.019	0.019	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
ES1426315-004	BUNGONIA CK UP	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.060	0.062	1.8	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.003	0.003	0.0	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 3737758)									
ES1426315-004	BUNGONIA CK UP	EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.230	0.231	0.0	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 3737743)									
ES1426313-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.053	0.052	0.0	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.003	0.003	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 3737743) - continued									
ES1426313-001	Anonymous	EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	0.003	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.014	0.014	0.0	0% - 50%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.077	0.081	5.0	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.052	0.056	7.6	0% - 50%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.46	0.45	3.5	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	3.12	3.18	1.9	0% - 20%
ES1426315-003	SR3	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.014	0.014	0.0	0% - 50%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.019	0.019	0.0	0% - 50%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.05	0.06	0.0	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.16	0.15	9.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 3737744)									
ES1426313-001	Anonymous	EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.235	0.242	3.2	0% - 20%
ES1426315-003	SR3	EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.035	0.036	3.6	0% - 20%
EG035F: Dissolved Mercury by FIMS (QC Lot: 3737757)									
ES1426313-004	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
ES1426315-002	SR2	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3737881)									
ES1426091-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
ES1426313-008	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3737882)									
ES1426315-010	BLOWHOLE	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3737882) - continued									
ES1426368-010	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 3734100)									
ES1426313-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.2	0.0	No Limit
ES1426315-002	SR2	EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 3734921)									
ES1426233-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	102	104	1.2	0% - 20%
ES1426315-004	BUNGONIA CK UP	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	3.12	3.21	3.0	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 3734916)									
ES1426233-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	14.5	13.0	10.9	0% - 20%
ES1426315-005	BUNGONIA CK DN	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.1	1.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 3734917)									
ES1426233-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.09	0.07	23.9	No Limit
ES1426315-005	BUNGONIA CK DN	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 3738141)									
ES1426231-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	18	17	0.0	0% - 50%
ES1426315-003	SR3	EP005: Total Organic Carbon	----	1	mg/L	4	4	0.0	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 3734491)									
EP1409867-001	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	9	15	50.0	No Limit
ES1426315-003	SR3	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3738114)									
ES1426409-022	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
ES1426409-028	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3738114)									
ES1426409-022	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
ES1426409-028	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
EP080: BTEXN (QC Lot: 3738114)									
ES1426409-022	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit
ES1426409-028	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP080: BTEXN (QC Lot: 3738114) - continued									
ES1426409-028	Anonymous	EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EA010P: Conductivity by PC Titrator (QCLot: 3734098)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	105	95	113
ED009: Anions (QCLot: 3735933)								
ED009-X: Bromide	24959-67-9	0.01	mg/L	<0.010	2 mg/L	104	93	109
ED037P: Alkalinity by PC Titrator (QCLot: 3734097)								
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	102	81	111
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3734091)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	108	86	122
ED045G: Chloride Discrete analyser (QCLot: 3734090)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	108	75	123
				----	1000 mg/L	99.4	77	119
ED093F: Dissolved Major Cations (QCLot: 3737755)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	96.9	90	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	108	90	110
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	101	82	118
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	110	87	117
EG020F: Dissolved Metals by ICP-MS (QCLot: 3737756)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	99.9	78	118
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.1	80	118
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	105	78	116
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	94.6	80	112
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.4	82	112
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	95.7	81	113
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	95.4	80	114
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	92.9	79	113
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	98.9	81	113
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	95.9	81	113
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	100	79	117
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	95.6	81	115
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	99.6	73	125
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	93.5	81	113
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	99.2	80	116
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	105	73	123
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	95.1	78	116
EG020F: Dissolved Metals by ICP-MS (QCLot: 3737758)								

Sub-Matrix: **WATER**

Method: Compound	*CAS Number*	*LOR*	*Unit*	*Method Blank (MB) Report*	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
				Result	*Concentration*	*LCS*	*Low*	*High*
EG020F: Dissolved Metals by ICP-MS (QCLot: 3737758) - continued								
EG020B-F: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	95.4	80	112
EG020T: Total Metals by ICP-MS (QCLot: 3737743)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	92.1	81	121
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	79	121
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	96.4	79	119
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	95.8	84	116
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.2	83	113
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	98.3	84	116
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	95.2	84	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	100	83	117
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	101	84	116
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	97.1	85	115
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	102	84	124
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	99.3	84	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	87.4	68	128
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	95.7	84	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	101	77	117
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	106	75	129
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	120
EG020T: Total Metals by ICP-MS (QCLot: 3737744)								
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	97.8	83	117
EG035F: Dissolved Mercury by FIMS (QCLot: 3737757)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	87.7	78	114
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3737881)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	95.7	77	115
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3737882)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	96.1	77	115
EK040P: Fluoride by PC Titrator (QCLot: 3734100)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5.0 mg/L	94.4	75	119
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3734921)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	102	87	119
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3734916)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	----	5 mg/L	100	66	119
				----	1.0 mg/L	95.1	66	126
				<0.1	10 mg/L	89.4	66	114
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3734917)								

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3734917) - continued								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	92.5	67	117
				----	0.442 mg/L	94.6	63	123
				----	1.0 mg/L	102	66	124
EP005: Total Organic Carbon (TOC) (QCLot: 3738141)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	79.7	76	120
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 3734491)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	200 mg/L	105	74	110
EP075(SIM)A: Phenolic Compounds (QCLot: 3734065)								
EP075(SIM): Phenol	108-95-2	0.2	µg/L	<1.0	5 µg/L	34.6	24.5	61.9
EP075(SIM): 2-Chlorophenol	95-57-8	0.2	µg/L	<1.0	5 µg/L	71.1	63.8	110
EP075(SIM): 2-Methylphenol	95-48-7	0.2	µg/L	<1.0	5 µg/L	69.7	55.9	112
EP075(SIM): 3- & 4-Methylphenol	1319-77-3	0.4	µg/L	<2.0	10 µg/L	60.8	42.5	114
EP075(SIM): 2-Nitrophenol	88-75-5	0.2	µg/L	<1.0	5 µg/L	75.6	62.7	117
EP075(SIM): 2.4-Dimethylphenol	105-67-9	0.2	µg/L	<1.0	5 µg/L	70.6	59.9	112
EP075(SIM): 2.4-Dichlorophenol	120-83-2	0.2	µg/L	<1.0	5 µg/L	77.7	59.3	122
EP075(SIM): 2.6-Dichlorophenol	87-65-0	0.2	µg/L	<1.0	5 µg/L	81.4	64.3	118
EP075(SIM): 4-Chloro-3-Methylphenol	59-50-7	0.2	µg/L	<1.0	5 µg/L	73.2	63	119
EP075(SIM): 2.4.6-Trichlorophenol	88-06-2	0.2	µg/L	<1.0	5 µg/L	80.0	58.7	118
EP075(SIM): 2.4.5-Trichlorophenol	95-95-4	0.2	µg/L	<1.0	5 µg/L	74.9	50	108
EP075(SIM): Pentachlorophenol	87-86-5	0.4	µg/L	<2.0	10 µg/L	44.2	10	95
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 3734065)								
EP075(SIM): Naphthalene	91-20-3	0.2	µg/L	<1.0	5 µg/L	82.4	58.6	119
EP075(SIM): Acenaphthylene	208-96-8	0.2	µg/L	<1.0	5 µg/L	87.6	63.6	114
EP075(SIM): Acenaphthene	83-32-9	0.2	µg/L	<1.0	5 µg/L	78.1	62.2	113
EP075(SIM): Fluorene	86-73-7	0.2	µg/L	<1.0	5 µg/L	87.5	63.9	115
EP075(SIM): Phenanthrene	85-01-8	0.2	µg/L	<1.0	5 µg/L	72.1	62.6	116
EP075(SIM): Anthracene	120-12-7	0.2	µg/L	<1.0	5 µg/L	83.1	64.3	116
EP075(SIM): Fluoranthene	206-44-0	0.2	µg/L	<1.0	5 µg/L	92.1	63.6	118
EP075(SIM): Pyrene	129-00-0	0.2	µg/L	<1.0	5 µg/L	92.4	63.1	118
EP075(SIM): Benz(a)anthracene	56-55-3	0.2	µg/L	<1.0	5 µg/L	88.8	64.1	117
EP075(SIM): Chrysene	218-01-9	0.2	µg/L	<1.0	5 µg/L	86.9	62.5	116
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.2	µg/L	<1.0	5 µg/L	83.6	61.7	119
EP075(SIM): Benzo(k)fluoranthene	207-08-9	0.2	µg/L	<1.0	5 µg/L	96.3	61.7	117
EP075(SIM): Benzo(a)pyrene	50-32-8	0.2	µg/L	<0.5	5 µg/L	90.7	63.3	117
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	0.2	µg/L	<1.0	5 µg/L	89.4	59.9	118
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	0.2	µg/L	<1.0	5 µg/L	91.7	61.2	117
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	0.2	µg/L	<1.0	5 µg/L	85.8	59.1	118

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3734064)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	2000 µg/L	88.0	59	129
EP071: C15 - C28 Fraction	----	100	µg/L	<100	3000 µg/L	98.3	71	131
EP071: C29 - C36 Fraction	----	50	µg/L	<50	2000 µg/L	102	62	120
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3738114)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	104	75	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3734064)								
EP071: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	2500 µg/L	99.6	58.9	131
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	3500 µg/L	106	73.9	138
EP071: >C34 - C40 Fraction	----	50	µg/L	<100	1500 µg/L	104	67	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3738114)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	106	75	127
EP080: BTEXN (QCLot: 3738114)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	98.6	70	124
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	94.9	65	129
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	90.8	70	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	87.7	69	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	91.2	72	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	104	70	124

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED009: Anions (QCLot: 3735933)							
EM1412629-001	Anonymous	ED009-X: Bromide	24959-67-9	0.2 mg/L	87.0	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3734091)							
ES1426313-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70	130
ED045G: Chloride Discrete analyser (QCLot: 3734090)							
ES1426313-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	100	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 3737756)							
ES1426313-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	103	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	110	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	*SpikeRecovery(%)*	*Recovery Limits (%)*	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG020F: Dissolved Metals by ICP-MS (QCLot: 3737756) - continued							
ES1426313-002	Anonymous	EG020A-F: Barium	7440-39-3	0.2 mg/L	102	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	102	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	100	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	98.7	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	99.4	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	99.4	70	130
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	105	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	98.5	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	100	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	101	70	130
EG020T: Total Metals by ICP-MS (QCLot: 3737743)							
ES1426313-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	106	70	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	102	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	106	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	103	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	102	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	102	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	107	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	102	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	105	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	100	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	102	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	102	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 3737757)							
ES1426313-003	Anonymous	EG035F: Mercury	7439-97-6	0.0100 mg/L	82.2	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3737881)							
ES1426091-001	Anonymous	EG035T: Mercury	7439-97-6	0.010 mg/L	89.3	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3737882)							
ES1426315-010	BLOWHOLE	EG035T: Mercury	7439-97-6	0.010 mg/L	88.7	70	130
EK040P: Fluoride by PC Titrator (QCLot: 3734100)							
ES1426313-001	Anonymous	EK040P: Fluoride	16984-48-8	5.0 mg/L	117	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3734921)							
ES1426233-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	# Not Determined	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3734916)							
ES1426233-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	250 mg/L	88.2	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3734917)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3734917) - continued							
ES1426233-002	Anonymous	EK067G: Total Phosphorus as P	----	2 mg/L	91.8	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 3738141)							
ES1426231-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	80.8	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3738114)							
ES1426409-022	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	122	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3738114)							
ES1426409-022	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	120	70	130
EP080: BTEXN (QCLot: 3738114)							
ES1426409-022	Anonymous	EP080: Benzene	71-43-2	25 µg/L	103	70	130
		EP080: Toluene	108-88-3	25 µg/L	104	70	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	99.9	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	100	70	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	99.8	70	130
		EP080: Naphthalene	91-20-3	25 µg/L	108	70	130

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

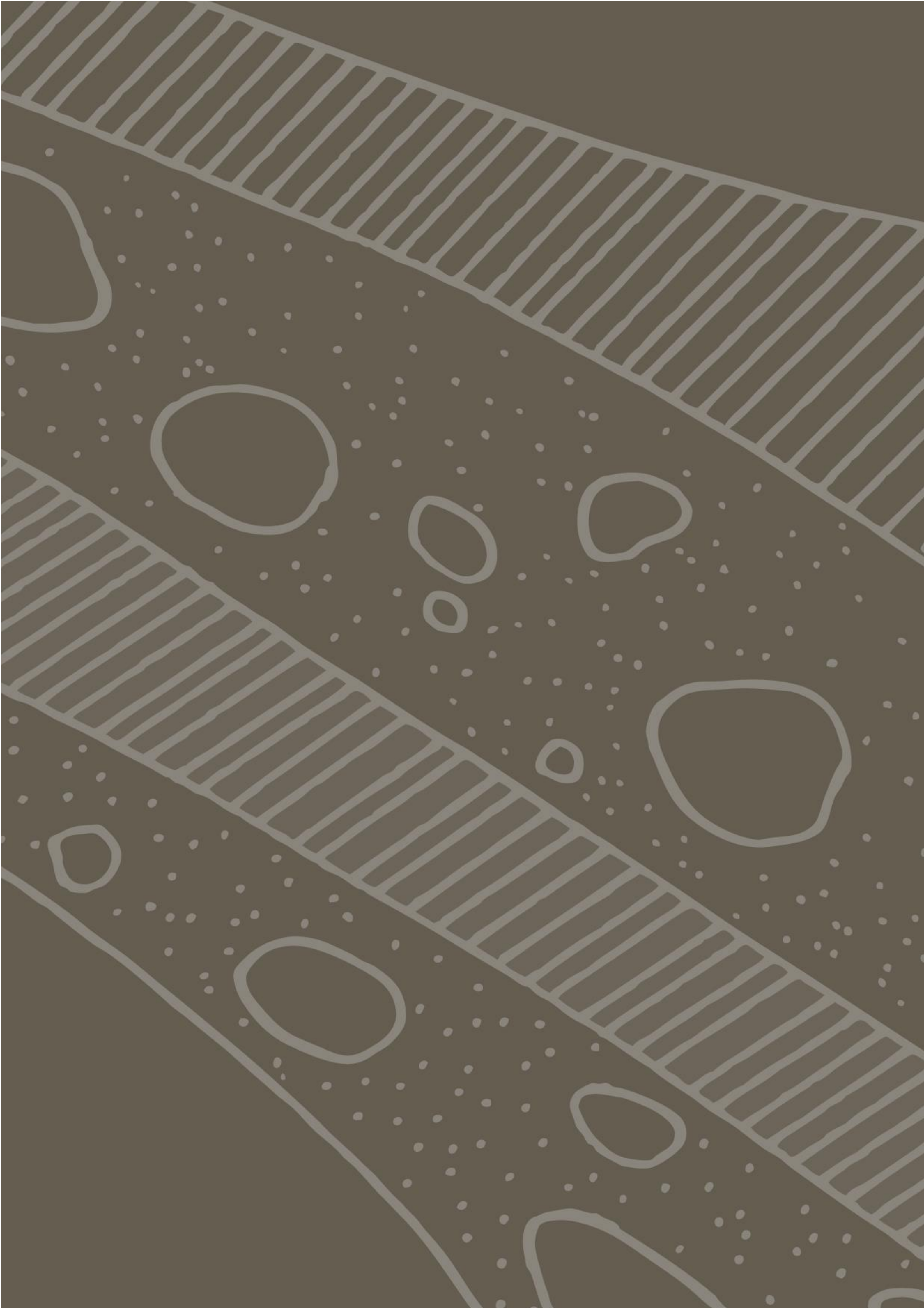
				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*MSD*	*Low*	*High*	*Value*	*Control Limit*
ED045G: Chloride Discrete analyser (QCLot: 3734090)										
ES1426313-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	100	----	70	130	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3734091)										
ES1426313-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	----	70	130	----	----
EK040P: Fluoride by PC Titrator (QCLot: 3734100)										
ES1426313-001	Anonymous	EK040P: Fluoride	16984-48-8	5.0 mg/L	117	----	70	130	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3734916)										
ES1426233-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	250 mg/L	88.2	----	70	130	----	----
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3734917)										
ES1426233-002	Anonymous	EK067G: Total Phosphorus as P	----	2 mg/L	91.8	----	70	130	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3734921)										
ES1426233-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	# Not Determined	----	70	130	----	----

Sub-Matrix: **WATER**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	MSD	Low	High	Value	Control Limit
ED009: Anions (QCLot: 3735933)										
EM1412629-001	Anonymous	ED009-X: Bromide	24959-67-9	0.2 mg/L	87.0	----	70	130	----	----
EG020T: Total Metals by ICP-MS (QCLot: 3737743)										
ES1426313-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	106	----	70	130	----	----
		EG020A-T: Beryllium	7440-41-7	1 mg/L	102	----	70	130	----	----
		EG020A-T: Barium	7440-39-3	1 mg/L	106	----	70	130	----	----
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	103	----	70	130	----	----
		EG020A-T: Chromium	7440-47-3	1 mg/L	102	----	70	130	----	----
		EG020A-T: Cobalt	7440-48-4	1 mg/L	102	----	70	130	----	----
		EG020A-T: Copper	7440-50-8	1 mg/L	107	----	70	130	----	----
		EG020A-T: Lead	7439-92-1	1 mg/L	102	----	70	130	----	----
		EG020A-T: Manganese	7439-96-5	1 mg/L	105	----	70	130	----	----
		EG020A-T: Nickel	7440-02-0	1 mg/L	100	----	70	130	----	----
		EG020A-T: Vanadium	7440-62-2	1 mg/L	102	----	70	130	----	----
		EG020A-T: Zinc	7440-66-6	1 mg/L	102	----	70	130	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 3737756)										
ES1426313-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	103	----	70	130	----	----
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	110	----	70	130	----	----
		EG020A-F: Barium	7440-39-3	0.2 mg/L	102	----	70	130	----	----
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	102	----	70	130	----	----
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	100	----	70	130	----	----
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	98.7	----	70	130	----	----
		EG020A-F: Copper	7440-50-8	0.2 mg/L	99.4	----	70	130	----	----
		EG020A-F: Lead	7439-92-1	0.2 mg/L	99.4	----	70	130	----	----
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	105	----	70	130	----	----
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	98.5	----	70	130	----	----
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	100	----	70	130	----	----
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	101	----	70	130	----	----
EG035F: Dissolved Mercury by FIMS (QCLot: 3737757)										
ES1426313-003	Anonymous	EG035F: Mercury	7439-97-6	0.0100 mg/L	82.2	----	70	130	----	----
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3737881)										
ES1426091-001	Anonymous	EG035T: Mercury	7439-97-6	0.010 mg/L	89.3	----	70	130	----	----
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3737882)										
ES1426315-010	BLOWHOLE	EG035T: Mercury	7439-97-6	0.010 mg/L	88.7	----	70	130	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3738114)										
ES1426409-022	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	122	----	70	130	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3738114)										
ES1426409-022	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	120	----	70	130	----	----
EP080: BTEXN (QCLot: 3738114)										

Sub-Matrix: **WATER**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	MSD	Low	High	Value	Control Limit
EP080: BTEXN (QCLot: 3738114) - continued										
ES1426409-022	Anonymous	EP080: Benzene	71-43-2	25 µg/L	103	----	70	130	----	----
		EP080: Toluene	108-88-3	25 µg/L	104	----	70	130	----	----
		EP080: Ethylbenzene	100-41-4	25 µg/L	99.9	----	70	130	----	----
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	100	----	70	130	----	----
		EP080: ortho-Xylene	95-47-6	25 µg/L	99.8	----	70	130	----	----
		EP080: Naphthalene	91-20-3	25 µg/L	108	----	70	130	----	----
EP005: Total Organic Carbon (TOC) (QCLot: 3738141)										
ES1426231-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	80.8	----	70	130	----	----



Appendix K

Biodiversity development assessment report

VOLUME 4

Appendix J	Phase 1 and 2 environmental site assessment
Appendix K	Biodiversity development assessment report
Appendix L	Aquatic ecology assessment

Marulan South Limestone Mine Continued Operations

Biodiversity Development Assessment Report

Prepared for Boral Cement Limited

March 2019

Document control

Project no.:	2155
Project client:	Boral Cement Limited
Project office:	Sydney
Document description:	Biodiversity Development Assessment Report (BDAR) for the proposed Marulan South Limestone Mine Continued Operations Project.
Project Director:	Matthew Richardson
Project Manager:	Luke Baker
Authors:	Luke Baker
Internal review:	Sian Griffiths
Document status:	Rev1
Document address:	P:\Projects\2000s\2100s\2155 Marulan South Biodiversity\Report\Drafts
Local Government Area:	Goulburn Mulwaree LGA

Document revision status

Author	Revision number	Internal review	Date issued
L. Baker	Draft 1	Sian Griffiths, Rod Wallace/Les Longhurst (Boral Resources) and Neville Hattingh (Element Environment)	05.11.18
L. Baker	Draft 2	Neville Hattingh (Element Environment)	07.11.18
L. Baker	Rev1	Mark Roberts (Element Environment)	07.03.19

Cover photograph: General location photo for the Marulan South Limestone Mine Continued Operations Project

Niche Environment and Heritage

A specialist environmental and heritage consultancy.

Head Office

Level 1, 19 Sorrell Street
Parramatta NSW 2150
All mail correspondence to:
PO Box 2443
North Parramatta NSW 1750
Email: info@niche-eh.com

Sydney
0488 224 888
Central Coast
0488 224 999
Illawarra
0488 224 777
Armidale
0488 224 094
Newcastle
0488 224 160
Mudgee
0488 224 025
Port Macquarie
0488 224 999
Brisbane
0488 224 036
Cairns
0488 284 743

Executive summary

Context

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 Pty Ltd (Niche) was commissioned by Boral to assess the ecological values and impacts associated with the Project, and provide a Biodiversity Development Assessment Report (BDAR). This BDAR has applied the OEH (2017) Biodiversity Assessment Methodology (BAM) to describe and assess the ecological values within the Study Area and surrounds, and determine how the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). This report also has assessed the potential impacts of the Project on Matters of National Environmental Significance (MNES) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In addition to requirements under the BAM and Commonwealth environmental approvals process, this biodiversity assessment addresses specific requirements provided in the Secretaries Environmental Assessment Requirements (SEARs) for the SSD application relating to biodiversity, issued in June 2015.

Study area

The Project site includes the Study Area as shown in Figure 5, current mining lease area CML 16 and the proposed 30 year disturbance footprint, whist the Study Area includes the area of direct and indirect impacts from the following key Project elements:

- Western Overburden Emplacement
- Northern Overburden Emplacement
- Southern Overburden Emplacement
- Road Sales Stockpile Area
- Marulan Creek Dam
- Marulan South Road Realignment

- Access roads
- Sediment basins and water storage dams
- Surface water drainage lines
- Marulan Creek Dam and proposed Marulan Creek Dam Inundation Area.

The Study Area is approximately 252.4 ha, consisting of a mix of areas of native bushland, cleared pasture land, dams and existing infrastructure. In total, approximately 182.4 ha is regarded as native vegetation as per the OEH (2017) Biodiversity Assessment Methodology (BAM) noting that most of it is of a relatively low vegetation integrity score (<25).

Survey overview

Numerous surveys have been completed by Niche since 2013 within the Study Area. Flora and fauna field survey work was conducted and performed broadly in four phases:

1. Preliminary site assessment was conducted in November 2013. These surveys were conducted within a footprint that exceeded the current Study Area to identify constraints, and assist with clarification of impact assessment requirements for the proposed Mine layout.
2. Survey of proposed disturbance areas and the Study Area in 2014 – 2015
   a. Flora survey (November 2014)
   b. Fauna survey (February 2015)
   c. Additional surveys for the Marulan South aquatic ecology assessment during which, opportunistic or targeted terrestrial fauna survey was conducted within the Bungonia and Shoalhaven gorges and their tributaries (March 2015).
3. Additional field survey activities to clarify potential impacts for certain matters such as vegetation alignment and fauna habitat (May 2015).
4. Additional field survey within the Northern Overburden Emplacement in February 2018.
5. Re-assessment of the existing flora plots which used the OEH (2014) Framework for Biodiversity Assessment (FBA) methodology. These plots were updated using the BAM in August 2018.

Fauna survey undertaken was consistent with various State and Federal Government guidelines including OEH’s (2004) Working Draft Threatened Biodiversity Survey and assessment. The survey involved targeted fauna trapping, including camera traps, Anabats, harp traps, and bird, reptile and amphibian survey. The survey was conducted to target both ecosystem credit and species credit species as identified by the BAM.

Native vegetation Assessment

Vegetation within the Study Area has been mapped previously as part of the Native Vegetation of South Eastern NSW (Tozer et al. 2006). Vegetation validation of this mapping was undertaken. The validation confirmed that the Study Area contained the following Plant Community Types (PCT):

- PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)
- PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)
- PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)
- PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524).

One Threatened Ecological Community (TEC) listed under the BC Act and EPBC Act was recorded in the Study Area: White Box Yellow Box Blakely's Red Gum Woodland. The TEC coincides with the occurrence of PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670). Three different condition classes of the TEC were recorded within the Study Area. In total approximately 88.6 ha of the TEC listed under the BC Act and EPBC Act would be impacted by the Project.

Vegetation alignment was confirmed and discussed on-site during consultation with OEH on the 16th June 2015.

Threatened flora

During the field survey, one threatened flora - *Solanum celatum*, listed as threatened under the BC Act was recorded within the Study Area. A large population of *Solanum celatum* is known to occur throughout the Bungonia region. No other threatened flora were detected.

Threatened fauna

Sixty-four threatened fauna have been recorded or have predicted habitat within 10 km of the Study Area. Of those species listed under the BC Act, 14 are regarded as 'species credit species' which, unlike 'ecosystem credit species,' cannot be assumed to be present based on the presence of habitat surrogates.

Seven threatened fauna were recorded from the Study Area (Diamond Firetail, Eastern Bent-wing-bat, Greater Broad-nosed Bat, Large-eared Pied Bat, Scarlet Robin, Eastern Free-tail Bat and Yellow-bellied Sheathtail-bat). A further 12 species were recorded outside the Study Area during the survey (Eastern False Pipistrelle, Golden-tipped Bat, Southern Myotis, Grey-headed Flying-fox, Koala, Powerful Owl, Sooty Owl, Turquoise Parrot, Varied Sittella, Glossy Black-Cockatoo, Rufous Fantail, and Yellow-bellied Glider). Most of these species were recorded away from the Study Area in the extensive and intact habitat features of the Shoalhaven River.

A number of additional threatened fauna have the potential to occur within the Study Area but were not recorded, most likely due to their potential use of the Study Area or wider locality being limited to sporadic occurrences (e.g. nomadic birds).

Of the species credit fauna, the Koala and Large-eared Pied Bat were found to occupy the Study Area. The Koala has an area of 132.4 hectares of occupiable habitat within the Study Area, whilst the Large-eared Pied Bat has been attributed an area of 140.3 hectares, based on foraging habitat within the Study Area. These areas of habitat have been regarded in this assessment as the species polygon, which has been used to generate the species credits required for the development.

No further Species Credit Species are likely to be impacted by the Project.

SEPP 44. Koala habitat

The Study Area contains *potential Koala habitat* as defined under SEPP44, given Schedule 2 tree species meet at least 15% of the total number of trees within portions of the Study Area.

The site does not constitute Core Koala habitat given the absence of a resident population of koalas utilising the Study Area. A discussion on SEPP 44 Koala habitat is provided in section 4.8.

Impacts – Native vegetation

The main impact on biodiversity associated with the Project is clearing of native vegetation and removal of habitat within the Study Area. The extent of clearing of native vegetation communities is estimated at 182.4

ha. An offset for the impact to native vegetation has been proposed in this assessment as per the requirements of the BAM.

One TEC will be impacted by the Project – White Box Yellow Box Blakely's Red Gum Grassy Woodland. Approximately 88.6 ha of the TEC would be impacted, with the majority of the vegetation comprised of highly degraded condition classes and assisted regeneration areas comprising of planted tubestock among native pasture. An offset for the impact on this TEC has been proposed as per the requirements of the BAM.

An Assessment of Significance under the EPBC Act has also been conducted for the impact on the TEC. The Assessment concluded the Project is likely to significantly impact the TEC. An offset would be provided for the impact to this TEC to satisfy the Commonwealth offset requirement.

Impacts – Threatened flora

One individual of *Solanum celatum* would be impacted by the Project. No other threatened flora would be impacted by the Project given the lack of suitable habitat and results of the targeted field survey. It is therefore unlikely that the Project will result in a significant impact to any threatened flora.

Impacts – Threatened fauna

Twenty-six threatened and migratory fauna are considered to be affected by the Project. Most of these species are likely to utilise the foraging habitat of the Study Area on an intermittent basis.

In accordance with the BAM, the Koala and Large-eared Pied Bat are the only species credit fauna affected by the Project. Approximately 132.4 ha of Koala habitat, and 140.3 ha of Large-eared Pied Bat habitat would be impacted by the Project.

The remainder of threatened fauna considered to be affected by the Project are regarded as ecosystem credit fauna.

Those threatened fauna which are listed under the EPBC Act that may be impacted include: Fork-tailed Swift, Great Egret, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Large-eared Pied Bat, Koala and Grey-headed Flying-fox. An EPBC Act Assessment of Significance for each of these species has been completed. Based on the results of the Assessments, a significant impact to the Koala is considered likely. A significant impact to other threatened fauna listed on the EPBC Act are considered unlikely. The Regent Honeyeater was also identified in correspondence by the Department of Environment and Energy (DoEE) as likely to utilise the Study Area. However, it should be noted that the species was not detected during the field survey and no historic records within or immediately surrounding the Study Area.

Impacts – Bungonia National Park, Bungonia Conservation Area, Morton National Park

No impacts to biodiversity within Bungonia National Park, Bungonia Conservation Area or Morton National Park are likely as a result of the Project. At the closest point, proposed vegetation clearing occurs approximately 350 m from Bungonia National park and State Conservation Reserve, and over 750 m from Morton National Park. The Study Area is further separated from the conservation areas by gorges, Bungonia Creek, Barbers Creek and bushland. It is unlikely that the existing indirect impacts (noise, dust) currently operating at the Mine would increase as a result of the Project to such a level that would result in significant impacts to fauna or threatened biodiversity within the conservation areas.

Avoidance and minimisation

Based on the results of the risk assessment and preliminary studies, alternative designs were considered, however were dismissed by Boral largely dictated by the availability of the resource location, Boral owned land, within the development consent boundary, that is not required for other mining operations, and is located as far as possible from constraints such as neighbouring residences. Each of the alternatives are detailed in section 6 of the report, along with the reason for dismissal, and justification for the current Project design. Biodiversity values of each alternative are discussed where relevant. Where significant features could not be avoided, identification of mitigation measures to minimise impacts have been proposed.

Mitigation and management

The Project will reduce impacts to biodiversity through the following mitigation measures which are described in detail in Section 6.3:

- Biodiversity Management Plan which will include the following protocols and guidelines:
  - pest management
  - weed management
  - procedures for pre-clearing assessments in accordance with the Vegetation Clearance Protocol
  - fencing and signposting erected around construction zones and areas of native vegetation to be retained.
- Rehabilitation Management Plan
- Air Quality Management Plan including dust suppression measures
- Update of the existing Boral (2015) Bushfire Management Plan
- Spill management procedures
- Management and removal of all rubbish from the Study Area
- Directing artificial lighting into the Study Area to minimise light spill

Quantifying offset of impacts

The BAM identifies the Biodiversity Credit Calculator as the appropriate tool for quantifying the precise nature of the offsets required in both ecosystem and species credit terms.

The ecosystem credits required to offset the Project equate to the following:

- Total of 1,466 credits for PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)
- Total of 1,042 credits for PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)
- Total of 260 credits for PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)
- Total of 325 credits for PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524).

The species credits required for the Project include:

- A total of 2,941 credits for the removal of 132.4 hectares of Koala habitat
- A total of 4,567 credits for the removal of 140.3 hectares of Large-eared Pied Bat habitat.
- A total of 2 credits for the removal of 0.1 hectares of *Solanum celatum* (based on a buffer of 30 metres around the one individual recorded as per the requirements of the BAM).

Offset strategy

An offset strategy has been discussed in section 7. Boral propose to offset the Project using a range of offsetting mechanisms including:

- Property 1 – Boral owned Stewardship Site (BCT Case No. 0001191) - Establishing a Stewardship Site at a property Boral have purchased in the Bungonia Subregion. This property would be used to offset the following biodiversity offset liability:

    - PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin (SR534)
    - PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)
    - Koala EPBC Act offset requirement
    - Large-eared Pied Bat EPBC Act offset requirement
    - Partial NSW offset for Koala and Large-eared Pied Bat (residual State offset liability to be paid into Biodiversity Conservation Payment Fund)
- Property 2 – Private owned (BCT Case No. 00011444, 00011437, 00011449, 00011453) - currently submitted to the Biodiversity Conservation Trust to formaly establish as a Stewardship Site. These Stewarship Site would offset the PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) credits liability and satisify for the Commonwealth offset liability for the Box Gum Woodland TEC.
- Payment into the BCT Payment Fund for any residential credits to satisfy State offset liability.

Glossary

Term	Definition
Clearing area	The area directly impacted by the Project either by clearing of vegetation or trimming of vegetation.
Development envelope	The location of the proposed development. Direct impacts occur wholly within this area.
Direct impacts:	Those that directly affect habitat and individuals of a species, population or ecological community. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat.
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.
Locality	The site and surrounds, nominally a 10 km radius from the Site.
Project	30 year Mine plan, including associated overburden emplacement areas, Mine water supply dam, and various associated infrastructure
Project site	The Study Area and 30 year Mine lease (CML 16)
Subject site (Site)	Means the area directly affected by the Project.
Study area	The area of direct and indirect impact

Abbreviations

Acronym	Term/Definition
BAM	Biodiversity Assessment Methodology
BDAR	Biodiversity Development Assessment Report
BAM Calculator	Biodiversity Credit Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BMP	Biodiversity Management Plan
BOS	*NSW Biodiversity Offsets Scheme*
CEEC	Critically Endangered Ecological Community
DP&E	NSW Department of Planning and Environment
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ha	Hectare/s
IBRA	Interim Biogeographic Regionalisation for Australia
MNES	Matters of National Environmental Significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*).
OEH	Office of Environment and Heritage (formerly DECCW, DECC, DEC)
PEA	Preliminary Environmental Assessment
PCT	Plant Community Type
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements

Acronym	Term/Definition
SSD	State Significant Development
TEC	Threatened Ecological Community

Table of Contents

List of Figures

List of Tables

1. Introduction to Biodiversity Development Assessment

1.1 Introduction

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 Biodiversity 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 associated with the Project, and provide a Biodiversity Development Assessment Report (BDAR). This BDAR has applied the OEH (2017) Biodiversity Assessment Methodology (BAM) to describe and assess the ecological values within the Study Area and surrounds, and determine how the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). This report also has assessed the potential impacts of the Project on Matters of National Environmental Significance (MNES) under the Commonwealth Environment *Protection and Biodiversity Conservation Act 1999* (EPBC Act), addresses the Secretary's Environmental Assessment Requirements (SEARs), and identifies avoidance, mitigation and offsets for the Project.

1.2 The Project

1.2.1 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.

Consolidated Mining Lease No. 16 (CML 16) under which the Mine operates, covers an area of 616.5 ha, which includes land owned by Boral (approximately 475 ha), Crown Land (adjoining to the south and east) and private land (Figure 2).

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 Mine is separated from the Bungonia State Conservation Area to the south by Bungonia Creek which forms Bungonia Gorge and is separated from the Shoalhaven River and Morton National Park to the east by Barbers Creek (Figure 2).

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. 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 properties (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.

1.2.2 Description

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.

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.

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.

1.2.3 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. 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.

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.

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.

1.3 Study area

The Study Area includes the area of direct and indirect impacts from the infrastructure described in section 1.2.3 (Figure 3, Figure 4, Figure 5) including:

- Western Overburden Emplacement
- Southern Overburden Emplacement
- Northern Overburden Emplacement
- Stockpile Areas
- Marulan Creek Dam
- Marulan South Road Realignment
- Access roads
- Sediment basins and water storage dams
- Surface water drainage lines
- Marulan Creek Dam/proposed Marulan Creek Dam Inundation Area.

The Study Area is approximately 252.4 hectares in area. This BDAR has assessed all impacts to biodiversity that occur within the Study Area.

1.4 Interaction with Peppertree Modification 5 Project

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

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

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

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

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

1.5 Approval Process

1.5.1 Application of the BAM

This BDAR has applied the BAM to describe and assess the ecological values within the Study Area and surrounds, and determine how the Project is likely to have an impact on threatened biodiversity listed under the BC Act and the EPBC Act.

This assessment has used the BAM Calculator (version 1.2.1.00).

1.5.2 Commonwealth requirements

An approval under the Commonwealth EPBC Act is required for the Project due to identified impacts on listed Matters of National Environmental Significance (MNES). A Referral has been submitted to the Commonwealth Department of the Environment and Energy (DoEE) in accordance with the requirements of Part 8 of the EPBC Act. This report provides Assessments of Significance for those MNES that may be impacted by the Project, and details of the proposed offsets for those MNES likely to be significantly impacted.

1.5.3 Secretary's environmental assessment requirements (SEARs)

In addition to requirements under the BAM and Commonwealth environmental approvals process, this biodiversity assessment addresses specific requirements provided in the SEARs for the SSD application relating to biodiversity, issued in June 2015 and re-issued in June 2018 by the Department of Planning and Environment (DP&E). Table 1 below cross-references this report with the relevant SEARs.

Table 1. SEARs addressed in Assessment

Requirement	Section addressed in report
NSW Department of Planning and Environment (DPE) (25th June 2018)	
The Department has reviewed the SEARs issued on the 10th June 2015 and is satisfied that they can be relied upon for the completion of the EIS, provided the EIS is finalised and submitted by 20th December 2018. However, the SEARs will be subject to the following adjustments: Under the transitional provisions of the Biodiversity Conservation (Savings and Transitional Regulation 2017, any EIS submitted on or after 25 February 2019 must be prepared in accordance with Par 7 of the Biodiversity Conservation Act 2016.	We have utilised the Biodiversity Assessment Methodology for this assessment to streamline the offsetting requirement for the Project.
NSW Department of Planning and Environment (DPE) (10th June 2015)	
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; and ▪ 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;	Description of the environment – sections 1 and 2. Impact Assessment – section 5 and Appendix 1 and Appendix 6. Cumulative impacts- section 6.4. Mitigation measures – section 6.3 Offsets – section 7. Monitoring and reporting – section 6.4
Consideration of the development against all relevant environmental planning instruments (including Part 3 of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007)	
The EIS must address the following specific issues: Biodiversity – including: • an assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the NSW Biodiversity Offsets Policy for Major Projects and the requirements of OEH; • measures taken to avoid, reduce or mitigate impacts on biodiversity; • accurate estimates of proposed vegetation clearing; and • a comprehensive offset strategy to ensure the development maintains or improves biodiversity values of the region in the medium to long term.	This assessment follows the structure of the BAM. Description of the environment – sections 1 and 2. Impact Assessment – section 5 and Appendix 1 and Appendix 6. Mitigation measures – section 6.3 Offsets – section 7.

Requirement	**Section addressed in report**
Relevant documents: • NSW Biodiversity Offset Policy for Major Projects (OEH) • Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECCW 2009) • Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DECC 2004) • Threatened Species Assessment Guidelines: the Assessment of Significance (DECC 2007) • Guidelines for Threatened Species Assessment (DoP 2005) • BioBanking Assessment Methodology (OEH) • Environmental Offsets Policy (Commonwealth DoE) • State Environmental Planning Policy No. 44 – Koala Habitat Protection	Referred to throughout this report.
NSW Department of Planning and Environment (DPE) – Revised SEARs (27th October 2015)	
The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in Item 1. A list of protected matters that the Department of the Environment considered likely to be significantly impacted is provided at Attachment A to these Guidelines. Note that this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under this controlling provision, likely to be significantly impacted, are assessed for the Commonwealth decision-maker's consideration.	MNES have been considered in the Impact Assessment. Assessments of Significance provided in Appendix 8.
The EIS must address the following issues: • the precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on matters of national environmental significance (MNES). • an assessment of the likely impacts of the development on each EPBC Act-listed species and/or ecological community where there is likely to be a significant impact from the proposed development.	MNES have been considered in the Impact Assessment. Assessments of Significance provided in Appendix 8.
The EIS must address the following issues in relation to Biodiversity including: • identification of all EPBC Act listed threatened species and community likely to be located in the Project area or in the vicinity; and • identification of all EPBC Act listed threatened species and community likely to be significantly impacted by the development in accordance with the Matters of National Environmental Significance – Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999 (Significant Impact Guidelines).	MNES have been considered in the Impact Assessment. Likelihood of occurrence provided in Appendix 1. Assessments of Significance provided in Appendix 8.

Requirement	Section addressed in report
For each of the relevant EPBC Act listed threatened species and community likely to be significantly impacted by the development the EIS must provide: • a description of the environment (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans; • details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements; and • specifically: i. identification and details of habitat critical for survival of the koala in accordance with the EPBC Act referral guidelines for the vulnerable Koala (Department of the Environment 2014) for both the impact site and any proposed offset site; ii. Detailed mapping identifying the extent and quality of the EPBC Act listed critically endangered White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands in accordance with the EPBC Act listing criteria and policy statement for that community for both the impact site and proposed offset site.	MNES Assessments of Significance completed for those species likely to be impacted by the Project (Appendix 8). Critical habitat for Koala detailed in Appendix 8. Mapping of CEEC provided in Figure 12.
For each of the relevant EPBC Act listed threatened species and community likely to be significantly impacted by the development the EIS must provide a description of the impacts of the action having regard to the full national extent of the species or community's range including; • a detailed assessment of the extent, nature and consequence of the likely direct, indirect and consequential impacts – refer to the Significant Impact Guidelines for guidance on the various types of impact that need to be considered; • a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; and • a description of any likely cumulative impacts, where potential Project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity).	MNES Assessments of Significance provided in Appendix 8.
For each of the relevant EPBC Act listed threatened species and community likely to be significantly impacted by the development the EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: • a description of proposed avoidance and mitigation measures to deal with relevant impacts of the action; • assessment of the expected or predicted effectiveness of the mitigation measures, and • a description of the outcomes that the avoidance and mitigation measures will achieve.	Impact Assessment – section 5 and Appendix 1 and Appendix 6. Cumulative impacts- section 6.4. Mitigation measures – section 6.3 Offsets – section 7.
For each of the relevant EPBC Act listed threatened species and community likely to be significantly impacted by the development the EIS must provide reference to, and consideration of relevant Commonwealth guidelines and policy statements including conservation advice, recovery plans, threat abatement plans and wildlife conservation plans.	MNES Assessments of Significance provided in Appendix 8.

Requirement	**Section addressed in report**
For each of the relevant EPBC Act listed threatened species and community likely to be significantly impacted by the development the EIS must provide: • identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account. • details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; • details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the development in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites. [Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. In applying the FBA, residual impacts on EPBC Act listed threatened ecological communities must be offset with Plant Community Type(s) (PCT) that are ascribed to the specific EPBC listed ecological community. PCTs from a different vegetation class will not generally be acceptable as offsets for EPBC listed communities.]	Impact Assessment – section 5 and Appendix 1 and Appendix 6. Cumulative impacts - section 6.4. Mitigation measures – section 6.3 Offsets – section 7.
Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy. http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy. [Note if the EPBC Act Environmental Offset Policy is used to calculate proposed offsets for a threatened species or community you may wish to seek further advice from the Department of Planning and Environment.]	Offsets – section 7.
Office of Environment and Heritage (OEH) (12 May 2015)	
Biodiversity impacts related to the proposed Project are to be assessed and documented in accordance with the Framework for Biodiversity Assessment unless otherwise agreed by OEH, by a personal accredited in accordance with s142B(1)c of the TSC Act.	BAM used in this assessment.
Impacts on the following species, populations and ecological communities will require further consideration and provision of the information specified in s9.2 of the FBA: • White Box Yellow Box Blakely's Red Gum Woodland – EEC • Eastern Bent-wing bat, *Miniopterus schreibersii oceanensis* • Koala, *Phascolarctos cinereus*	BAM used in this assessment. SAII has been completed for these species.
The assessment for the Eastern Bent-wing bat must assess the impacts of the proposed development on foraging habitat for this species, as the Project is within an important ecological area for this species. Impacts to the karst system that the Eastern Bent-wing bats utilise in the area will be assessed outside of the FBA as described below.	Species impacts have been addressed in section 5 and SAII has been completed as a precautionary approach.
Audrey Kutzner (Ranger) Bungonia SRA has been monitoring Koala records within the adjoining SCA lands and should be consulted on assessing the Bungonia local Koala population numbers.	Consultation in section 1.6. Koala impacts – section 5 and SAII completed.

Requirement	**Section addressed in report**
The EA must identify: - The natural features (both surface and sub-surface) that could be affected by mining activities or subsidence that the Eastern Bent-wing bat utilises for roosting, and breeding habitat. - An assessment of the potential direct and indirect ecological impacts of the predicted mining activities in the short, medium and long term on the breeding habitat. - Measures proposed to avoid, minimise, manage and offset the direct and indirect impacts, including an evaluation of the effectiveness and reliability of the proposed measures.	Eastern Bent-wing bat in section 5 and SAII completed. Mitigation measures – section 5.1 Offsets – section 7.
The EIS must identify: - Matters to be considered outlined in the Guidelines for developments adjoining land and water managed by DECCW (DECCW 2010) and include: ○ The nature of the impacts, including direct and indirect impacts. ○ The extent of the direct and indirect impacts, ○ The duration of the direct and indirect impacts. ○ The objectives of the reservation of the land. ○ Measures proposed to prevent, control, abate, minimise and manage the direct and indirect impacts including an evaluation of the effectiveness and reliability of the proposed measures. ○ Residual impacts.	Impacts – in section5. Cumulative impacts - section 6.4. Mitigation measures – section 5.1 Offsets – section 7.
DRE input into SEARs	
The flora, fauna and ecological attributes of the disturbed area should be recorded and placed in a regional context.	Landscape assessment – section 2. Result of field survey – section 3 and 4.
DPE (2019) Adequacy comments	
The Department notes that consultation with the Office of Environment and Heritage (OEH) regarding the preparation of the biodiversity assessment appears to have concluded in 2016, prior to the implementation of the Biodiversity Assessment Methodology (BAM). The Department also notes that OEH has recently provided detailed comments regarding the Biodiversity Development Assessment Report (BDAR) for Peppertree Quarry Modification 5. The Department requests that you carefully consider those comments, as they relate to SSD 7009, and consult with OEH (as required) prior to finalising the EIS.	Comments in relation to Peppertree Modofication 5 have been incorporated throughout this assessment.
Section 7.2 of the BDAR distinguishes between offsetting requirements under the Environment Protection and Biodiversity Conservation Act 1999 and credit liabilities under the BAM for matters of national environmental significance (MNES). Further discussion/explanation is required in this regard.	Section 7 details the biodiversity offsetting strategy inrelation to both Commonwealth and State requirements

Requirement	Section addressed in report
Section 7.2 indicates that Biodiversity Stewardship Sites have been identified which will partially satisfy offsetting requirements. The Department will require further details regarding the number of credits available at these sites. However, this information may be provided at the Response to Submissions stage if details are not currently available. The Department also notes that the Commonwealth has not endorsed the Biodiversity Conservation Fund as an offsetting mechanism. Consequently, payment into the fund should not be relied on to satisfy offsetting requirements for MNES.	The exact number of credits generated at the Stewardsip Sites has not been provided in this assessment due to confidentiality reasons. Niche and Boral would be happy to provide the details in confidence, or alternatively, OEH and DPE would be able to discuss with the Biodiversity Conservation Trust regarding their review of the Stewardship Sites (Stewardship case numbers provided in section 7).

1.6 Consultation

A core requirement of the SEARs was to undertake consultation with relevant agencies and provide evidence that the proposed development and environmental assessment addresses the considerations of various agencies.

Table 2 below summarises the key issues covered during correspondence with various agencies including the OEH, DoEE, National Parks and Wildlife Service (NPWS) and Goulburn Mulwaree Council. Several meetings took place with key stakeholders from these organisations specifically to present information on the Project in regard to ecology and to seek advice regarding survey, impact assessment and offsetting requirements.

Table 2. Consultation

Dates of consultation	Agency	Relevant key issues/discussion points	How are the issues addressed in this report?
01/04/2015	DoEE	Canberra meeting with Caitlin Ellis and Paula Banks (DoEE), Rod Wallace (Boral), Simon Tweed (Niche) and Neville Hattingh (Element Environment). Boral and consultants presented the Project along with environmental studies conducted to date. Feedback was sought and received regarding assessment of MNES, particularly an approach to major identified issues such as White Box Yellow Box Blakely's Red Gum Woodland and the Koala subject to Commonwealth Referral. Discussion of the bilateral agreement, offsetting requirements and the relationships between OEH and DoEE during the approvals process took place. The meeting was followed by a series of emails regarding Koala and White Box Yellow Box Blakely's Red Gum Woodland issues as well as liaison with several DoEE staff. The meeting discussed requirements for future survey.	Quantification, mapping and assessments of significance for MNES. Input and approach to offsetting strategy.
April-July 2015	OEH	Emails and conversations to BioBanking team (OEH). Clarification on application of the FBA process and technical requirements.	Correct assessment of corridors, linkages, offsetting calculations.
04/06/2015	OEH NPWS	Phone call with Miles Boak (OEH) regarding White Box Yellow Box Blakely's Red Gum Woodland and other threatened species matters. Phone call with Doug Mills (OEH) regarding bat records, roost sites and previous research done. Phone call with Audrey Kutzner (NSW NPWS) regarding Koala records and surveys within Bungonia and surrounds as well as other threatened species issues including bats. Discussion of mapping of White Box Yellow Box Blakely's Red Gum Woodland.	Information incorporated into assessments of significance for relevant threatened species matters.
09/06/2015 11/06/2015	GM Council	Phone call with Stewart Lloyd (GM Council). Enquired as to any Council mapping of vegetation with emphasis on EEC/CEECs. Council's mapping is limited – there is some collaboration between Council and the recent mapping Project by OEH led by John Briggs with a focus on identification of White Box Yellow Box Blakely's Red Gum Woodland. Discussion of other Marulan site issues. Emailed to request identification of any known important local or regional biodiversity corridors.	Consultation with OEH on latest mapping Project. Ensures vegetation mapping used for wider locality is the best available and that corridors are identified. Enabled Council's input regarding any

Dates of consultation	Agency	Relevant key issues/discussion points	How are the issues addressed in this report?
			concerns or issues for addressing.
11/06/2015	OEH NPWS	Email to Miles Boak (OEH), Audrey Kutzner (NPWS) and Doug Mills (OEH) – Request to obtain further information on bat roost locations and any important wildlife corridors.	Incorporated into assessments of significance.
16/06/2015	OEH	Site meeting at Maulan South Mine: Rod Wallace (Boral); Miles Boak, Allison Treweek and Susan Lamb (OEH); Simon Tweed (Niche). General overview of Project and field assessment conducted. Site inspection focusing on Box Gum Woodland areas. Discussion of assistance OEH and NPWS could provide regarding further information for key assessment items and identification of future offset lands.	Information has been incorporated throughout reporting particularly in impact assessment and offsets strategy.
June/July 2015	OEH NPWS	Ongoing email consultation and data exchange between Niche and relevant OEH/NPWS staff regarding survey effort, Box Gum Woodland and offsetting investigations.	Information incorporated as required, particularly in impact assessment and offset strategy.
9/6/2016	OEH	Meeting on-site with Miles Boak, and John Briggs (OEH) regarding the difficulty with aligning the vegetation units recorded on-site with an appropriate Plant Community Type (PCT). Key conclusions from the meeting and site inspection include the following: Agreed that vegetation on-site was likely to align to the following best fit BVTs and their associated Tozer (2006) mapping unit: • SR624 Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (this is equivalent to P10. Eastern Tablelands Dry Forest). • SR534 Coast Grey Box - stringybark dry woodland on slopes of the Shoalhaven Gorges, southern Sydney Basin Bioregion (this is equivalent to P27. Bungonia Slates Woodland). • SR670 Yellow Box grassy woodland of the northern Monaro and Upper Shoalhaven area, South Eastern Highlands Bioregion (this is equivalent to P24. Tableland Grassy White Box Yellow Box Blakely’s Red Gum Woodland).	The conclusions from this meeting have assisted in aligning the vegetation to appropriate PCTs. The site inspection with OEH was vital in providing confidence in the PCT alignment.

Dates of consultation	Agency	Relevant key issues/discussion points	How are the issues addressed in this report?
		SR534 Coast Grey Box - stringybark dry woodland has an estimated cleared percentage of 15% within the CMA. Most of this vegetation community is within Bungonia State Conservation Area and Morton National Parks or Crown Land. Very restricted. It will therefore be difficult to find an offset for this BVT. Variation rule is likely to be accepted for this BVT. Likely have *Eucalyptus bosistoana* predominantly within the gullies/slopes with some *E. melliodora* amongst them. Very difficult to distinguish between the two species as both are occurring together. Likely that some of the Red Gums within the gullies/slopes area are *E. tereticornis*. SR624 Silvertop Ash - Blue-leaved Stringybark shrubby open forest is Dry Sclerophyll Forest Formation with 40% cleared within the CMA. All efforts to directly offset this BVT would be made. If unlikely to offset directly, a BVT of Dry Sclerophyll Forest Formation that has an equal or greater than 40% cleared would be proposed.	
11/02/2019	OEH	Phone meeting with Allison Treeweek (OEH), Tania Ashworth (OEH), Neville Haddingh (Element), Luke Baker (Niche) and Rachael Snape (Boral) to discuss the Marulan South Project in the context of Peppertree Modification 5 Assessment. The purpose of the meeting was to discuss the Marulan South Project development application, and how it relates to Peppertree Modificaiton 5. The meeting also discussed that the BAM was used for the assessments, and that biodiversity Stewardship Sites would be established as part of the biodiversity offset strategy.	-

1.7 Assessment objectives and format

The primary objective of this assessment is to use the guidelines and methodology provided in the BAM to determine the impact the Project would have on biodiversity, avoid and mitigate these impacts and then calculate the Project's biodiversity offset requirement. In addition, the SEARs for the Project have been addressed, and impacts on Commonwealth MNES are addressed through the process of the BAM and by assessments of significance for potentially impacted species.

This BDAR has two broad stages consistent with the BAM methodology:

Stage 1 – Biodiversity Assessment

- assessment of landscape features
- assessment of native vegetation
- assessment of threatened species and populations.

Stage 2 – Impact Assessment

- avoid and minimise impacts on biodiversity values
- consider impact and offset thresholds
- determine and calculate offset requirements.

Whilst not a requirement of the BAM, a biodiversity offset strategy has also been prepared to satisfy the requirements of the SEARs.

1.8 Assessment resources and assessor qualifications

This BDAR has been prepared by the following accredited assessors or experts:

- Luke Baker – Senior Ecologist/Ecology Team Leader/Accredited Biodiversity Assessor: flora and fauna field survey, data management, data entry, credit calculations, review of credit calculations, report preparation
- Simon Tweed – Senior Ecologist/Ecology Team Leader/Accredited Biodiversity Assessor: Field survey
- Amanda Griffiths – Senior Ecologist/Accredited Biodiversity Assessor: Field survey
- Alex Christie –Ecologist/Accredited Biodiversity Assessor: Field survey and data management.

Other specialist staff involved in preparing the assessment include:

- Lucy Porter – Ecologist: field survey
- Dr Ross Jenkins and Greg Tobin – GIS Officer: mapping.

2. Landscape assessment

2.1 Landscape assessment - methods

As detailed in section 4 of the BAM (OEH 2017), a landscape assessment for the Project is required, and is completed within the BAM Calculator. Landscape value is an assessment of a number of factors including:

- native vegetation cover
- rivers, streams and estuaries
- areas of geological significance
- habitat connectivity.

For each factor the current state of the landscape is assessed, and compared with the state of the landscape if the Project were to proceed.

2.1.1 Landscape features and scoring

Table 3 below provides details of the landscape settings and scored landscape features for the Project.

Table 3: Landscape features and scoring under the NSW BAM

Landscape features	Description	Figure reference
IBRA bioregion/subregion	South Eastern Highlands Interim Biogeographic Regionalisation for Australia (IBRA) region, and Bungonia IBRA subregion	Figure 7
Mitchell Landscapes	Two Mitchell landscapes occur across the Study Area: Bungonia Tableland and Shoalhaven Gorge. The Project predominantly occurs within the Bungonia Tableland Mitchell landscape and as such this Mitchell landscape has been used for the landscape assessment calculations.	Figure 7
Rivers, streams and estuaries and Strahler stream order	Marulan Creek, which is a 4th order stream, occurs to the north of the Study Area at the location of the Marulan Creek Dam proposed Marulan Creek Dam Inundation Area and Marulan Creek dam spillway. A number of ephemeral drainage channels occur through the middle of the Study Area, which would only provide very limited flow during high rainfall events. There are a number of small farm dams which occur throughout the Study Area. These dams were empty during the warmer months of field survey.	Figure 7
Wetlands within and adjacent to development	None	n/a
Cleared areas	The majority of native vegetation present within the Study Area has been subject to historic clearing and grazing. Regeneration of these areas has occurred over the past 40 years when logging ceased. As a result, much of the native vegetation contains a relatively open woodland/forest structure with eucalypts of a similar age. Areas that have extensively cleared are a combination of native pasture/introduced pasture with scattered eucalypts. These more open	Figure 8

Landscape features	Description	Figure reference
	areas were typically used for foraging by goats, rabbits and kangaroos, which has resulted in portions of bare earth cover. Cleared areas are more prominent to the east where existing Mine Pit, and rail loop occurs.	
Connectivity features	From a regional perspective, the habitats within the Study Area are connected to extensive expanses of vegetation associated with the Shoalhaven Gorge and Bungonia State Conservation Area. To the east, the Study Area is predominately limited in connectivity due to the existing Mine Pit. The land to the west and north-west, is predominantly cleared for agriculture. However, scattered patches of native vegetation occur across the tableland areas, some of which is connected to the Study Area. The Project site has some capacity to act as a linkage between the vegetated reserve areas and the patchy vegetation of the tablelands. The most consolidated linkages are illustrated within Figure 8, with the most affected linkage being from the north-western corner of the Project site and extending for approximately 5 kilometres in the same direction. The Study Area does not form part of any national landscape corridors (SEWPaC, 2012a) and no identified OEH wildlife corridors occur within the vicinity of the Project site (OEH, 2011a). Land clearance for the Project would contribute to some fragmentation of fauna habitat, in particular through the combination of the Northern Overburden Emplacement and Western Overburden Emplacement reducing the connectivity width to patches of vegetation to the north-west. The amount of contiguous bushland remaining, however, means that most of the surrounding native vegetation cover would remain physically connected. Connectivity losses would occur for the life of the Mine with connectivity being progressively reinstated during Mine rehabilitation. However, the landforms reinstated during rehabilitation are likely to be a less favourable linkage for some fauna species due to their topography, heterogeneity and reduced quality in some areas. More mobile species such as birds and bats without highly specific habitat requirements (at least for certain lifecycle aspects) are likely to be most effective at using reinstated linkages. Vegetation to be disturbed for the proposed Marulan Creek Dam proposed Marulan Creek Dam Inundation Area is unlikely to result in an increase in loss of connectivity, given the relatively narrow linear disturbance, and that the impact area is predominantly cleared paddocks. No other riparian linkages would be impacted by the proposal	Figure 8
Buffer area (percent native vegetation cover)	A 1,500m buffer was applied to the site resulting in an overall buffer area of 3,489.5 ha. Aerial interpretation coupled with the results of the current field survey, was used to map the area of native vegetation, and introduced vegetation. In total, 1,356.9 ha is non-native vegetation (consisting of Mine pit, existing emplacement and infrastructure, residential and roads/rail links etc.) and 2,132.6 ha is native vegetation. ***Woody vegetation cover*** The native vegetation extent and cover of woody vegetation was determined via aerial photography interpretation based on canopy cover.	Figure 8

Landscape features	Description	Figure reference
	For woody vegetation 52.2% of the buffer area was determined to support native woody vegetation with benchmark cover (1,823.9 ha). ***Non-woody vegetation cover*** For non-woody vegetation, experience of the Study Area was drawn upon in addition to aerial photography interpretation to estimate cover of native grassland vegetation. Areas that were naturally grassland correspond with high fertility depressions situated away from core infrastructure. It was conservatively estimated that 8.8 % of the buffer area contains native grassland (308.7 ha). ***Total native vegetation cover*** Combining the estimated woody and non-woody vegetation cover resulted in 61% of the buffer area supporting native vegetation. This falls into the 30-70% category within the BAM Calculator.	
Site context	Site based assessment as per BAM.	-
Geological significance and soils	One cave is known to occur within 900 m of the Study Area, known as Main Gully Spring (Bauer and Bauer 1998). Main Gully Spring is located beneath the Mine and it is known during periods of high discharge that this cave acts as an overflow. A number of chambers and tunnels are described by Bauer and Bauer (1998) as occurring in the cave including a chamber 1 m x 2.7 m wide, and a pool approximately 7 m from the entrance. The cave is inundated with water during periods of rainfall. Given the distance from the Study Area and safety restrictions, this cave was not inspected by Niche during the field survey, however Boral and Element Environment representitives inspected the cave with an experienced caver in August 2017. Photographs and videos of the cave were provided to Niche in order to gauge its usage as fauna habitat which is discussed later in section 6.2. Due to the distance from the Study Area, it is highly unlikely that the cave would be impacted by the Project. Mining and blasting, which is to occur approximately 900 m north of the cave, is unlikely to result in any impact to the cave system. This is supported by the fact that there are no known impacts to the cave system even though there has been an on-going history of mining and blasting within the existing Mine pit, especially the southern end of the South Pit which is considerably closer to the cave than what future proposed balsting would be. Therefore, the Project is not forecast to increase noise or vibration to the Main Gully Spring Cave or any other known caves in the locality. The cave would therefore not be impacted by the Project. Further discussion in relation to fauna habitat potential within the cave is provided in section 6.2. There are no other areas of geological significance within the buffer area. There are no high hazard soil areas.	Figure 7

3. Native vegetation and flora assessment

3.1 Bionet Atlas & EPBC Act Protected Matters Search

A review of spatial records of threatened flora within a 10 km radius of the Study Area was undertaken using data obtained from the Bionet Atlas, and predicted threatened biodiversity were generated from an EPBC Act Protected Matters Search.

Thirty-one threatened flora have been previously recorded or have modelled habitat within a 10 km radius of the Study Area (Appendix 1) according to the database searches.

The potential for these species to occur within the Study Area is discussed in section 3.3 and Appendix 1. The results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey.

3.2 Plant community delineation and mapping

Vegetation within the Study Area has been mapped previously as part of the Native vegetation of South Eastern NSW (Tozer et al. 2006) (Figure 9). The mapping units of the Tozer et al. (2006) mapping have been aligned by OEH to an associated PCT in the OEH Vegetation Information System (VIS) database. This mapping Project aided the initial preliminary vegetation mapping of the Study Area and surrounds, and was used initially to inform a constraints assessment for the Project in 2014.

Validation of the Tozer et al. (2006) mapping Project, and revision of the mapping was undertaken from the 3rd to the 6th of February 2015, with further refinements completed on the 12th February 2018 (Figure 10). The validated mapping utilised the methodology specified in the OEH (2014) Framework for Biodiversity Assessment, which entail assigning the vegetation on-site to an associated PCT and condition class.

The FBA required the collection of the following attributes which assisted in determining a relevant condition class to each vegetation polygon:

- native species richness (20 x 20 m)
- native over-storey cover (projective foliage cover at 5 m intervals along 50 m transect)
- native mid-storey cover (projective foliage Cover at 5 m intervals along 50 m transect)
- native ground cover (grasses) (frequency tally at 1 m intervals along 50 m transect)
- native ground cover (shrubs) (frequency tally at 1 m intervals along 50 m transect)
- native ground cover (other) (frequency tally at 1 m intervals along 50 m transect)
- exotic cover (as for native over-storey, mid-storey and groundcover)
- over-storey regeneration (proportion of overstorey dominants present as immature recruitment)
- number of trees with hollows (within 50 x 20 m plot)
- total length of fallen logs (within 50 x 20 m plot).

In addition to the prescribed FBA transect data collection above, within each 20 x 20 m plot all vascular plant species were identified (to species level where sufficient plant material was available) and assigned a cover abundance score.

In total, the vegetation validation completed to February 2018 resulted in over 30 FBA plots completed within the Study Area and within the immediate region.

Between the FBA plots, walking and driving transects were completed in order to determine the extent of each vegetation polygon. Given the prior clearing events and grazing pressures in portions of the Study Area, the transition between polygons was not clear in some instances, and thus topography and the PCT habitat descriptions, coupled with the Tozer et al. (2006) descriptions were used to map the extent.

The field survey presented a number of difficulties with eucalypt identification, due to the historic clearing of the site, and the overlap of *Eucalyptus bosistoana* and *E. melliodora* - which are quite similar in appearance. Similarly, the presence of *Eucalyptus tereticornis*, *E. Blakelyi* and *E. amplifolia* were in combination, thus also presenting identification difficulties. To assist in identification of the eucalypts and alignment to relevant PCTs and Tozer et al. (2006) mapping units, a site visit with John Briggs (OEH) and Miles Boak (OEH) was undertaken on 6th of June 2016 with Niche. The site visit and subsequent consultation (Table 2) assisted in aligning the PCTs within the Study Area.

Due to the changes in biodiversity legislation (commencement of the BC Act – enacted in August 2017), an update of the flora survey was completed from July 31st to the 1st of August 2018 which followed the BAM. The update of the flora survey to the BAM, streamlined the biodiversity development/offset credit ratios, which were not possible given no credit conversion tools were publically available.

The most recent flora survey effort consisted of 38 BAM plots/transects within the Study Area (Figure 10). The BAM plots collected the data detailed in Table 4.

Table 4. BAM attribute data requirement

Attribute	Survey requirement
Stratum and layer	Stratum & layer in which each species occurs
Growth form	Growth form for each recorded species
Species name	Scientific name and common name
Cover	Estimate the % foliage cover across the plot of each species rooted in or overhanging the plot.
Abundance rating	For species with cover less than or equal to 5%, count or estimate the number of individuals or shoots of each species within the plot, using the following intervals: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000,1500,2000, etc.
Composition	Assessment of composition is based on the number of native plant species (richness) observed and recorded by the assessor within a plot for each growth form group.
Structure	Structure is the assessment of foliage cover for each growth form group within the 20m x 20m plot boundary. The assessor must record an estimate of the foliage cover for each native and exotic species present within the 20m x 20m plot. Foliage cover estimates for each species must draw from the following number series: 0.1, 0.2, 0.3,……1, 2, 3,……10, 15, 20, 25,……100%. The assessor must assign high threat weeds.
Function	The number of large trees, tree stem size class, tree regeneration and length of fallen logs is recorded within a 1000m^2 plot Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots evenly located along the central transect The number of trees with hollows is determined by counting the number of trees with hollows that are visible from the ground in the 20m x 50m plot.

Walking meanders were undertaken between plot locations. At a minimum, the combined foot traverses complied with the recommended number and length of traverses per area of stratification unit (vegetation community) according to DEC (2004) and OEH (2016) survey guidelines. The walking meanders were also used to survey for threatened flora species across the Study Area, in particular the presence of *Solanum celatum* which occurs widely across the locality.

The number of plots undertaken, along with the required survey effort as specified in the BAM is provided in Table 4 and shown in Figure 10.

The species list and transect data obtained during the field assessment is provided in Appendix 3 and Appendix 4.

3.2.1 Plant community delineation and mapping

As detailed above, the vegetation of the Study Area was validated using methods consistent with the BAM.

Within the Study Area five native vegetation types and one non-native vegetation type were identified. These vegetation communities were aligned to the relevant Tozer et al. (2006) vegetation unit, and Plant Community Types (PCTs) required for use with the BAM.

Different condition classes were assigned to vegetation where obvious differences in structure and quality occurred, resulting in two PCTs and four vegetation categories as shown in in Table 5.

Descriptions for those communities which occur within the Study Area are provided in Appendix 2, and the updated vegetation community mapping is shown in Figure 11.

Table 5. Vegetation mapping and alignment for vegetation types within the Study Area

Vegetation zone no.	Plant Community Type (PCT)	Equivalent Tozer et al. (2006) mapping unit	Vegetation formation	Vegetation class	Threatened Ecological Community (TEC)*	PCT % cleared	Condition identifier input used in calculator	Total (ha)	Plots required	Plots completed
1	PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	P24. Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland (best fit)	Grassy Woodlands	Southern Tableland Grassy Woodlands	EEC under BC Act. CEEC under EPBC Act.	92	Medium	48.8	4	10
2							Poor	31.9	4	5
3							Acacia	7.9	3	6
4	PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	P27. Bungonia Slates Woodland	Dry Sclerophyll Forests (Shrub/grass subformation)	Central Gorge Dry Sclerophyll Forests	Not listed	15	Medium	57.9	5	5
5							Poor	7.5	3	3
6	PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)	P10. Eastern Tablelands Dry Forest	Dry Sclerophyll Forests (Shrubby sub-formation)	South East Dry Sclerophyll Forests	Not listed	40	Medium	13.7	3	3
7							Poor	2.6	2	2
8	731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524)	P23. Tableland Hills Grassy Woodland	Grassy Woodlands	Southern Tableland Grassy Woodlands	Not listed	80	Medium	12.0	3	3
9	PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) – Best fit equivalent based on surrounding land use and previous Tozer et al. (2006) mapping	No equivalent	Grassy Woodlands	Southern Tableland Grassy Woodlands	Not listed	92 – however no real equivalent for this vegetation community	Non EEC_water dependent	0.1	1	1
10	Non-native	-	-	-	-	-		70.0	-	
	Total							252.4		
	Total native vegetation							182.4		

3.2.2 Plant community descriptions

Refer to Appendix 2 for plant community descriptions and diagnostic species for each PCT.

3.2.3 Site values

Flora

Floristic data recorded from floristic plots performed throughout the identified vegetation zones (Figure 11) is included within Appendix 3.

Plot and transect values

The results of the plot data and species list obtained during the field assessment is provided in Appendix 3 and Appendix 4.

Vegetation integrity scores

The Vegetation integrity assessment was carried out by entering plot data into the BAM Calculator. The data provides quantitative measures of composition, structure and function for each vegetation zone (Appendix 4). The BAM Calculator compares the values recorded with the benchmark for the vegetation class to provide the Vegetation integrity score. This score represents the overall condition of the vegetation compared against the benchmark (out of 100).

The score from these inputs, coupled with data in the following section of this report, is used to determine the number of ecosystem credits that are required to offset development.

All vegetation zones within the development envelope scored within the threshold for offsetting (15 out of 100 for threatened ecological communities and 17 out of 100 for non-threatened ecological communities). Ecosystem credit offsets are required for impacts to all native vegetation within the development envelope.

3.2.4 High threat and priority weeds

During the field surveys five high threat weeds as listed under the NSW *Biosecurity Act 2015* were recorded within the BAM plots.

High threat weed species recorded include: *Nassella trichotoma* (Serrated Tussock), *Lycium ferocissimum* (Africian Box Thorn), *Chloris gayana* (Rhodes Grass), *Hypericum perforatu*m (St Johns Wart) and *Paspalum dilatatum* (Dallas Grass).

As indicated in the Flora plot results (Appendix 4), the abundance and cover of *Nassella trichotoma* (Serrated Tussock) was quite high across most of the flora plots, in particular those completed within the open areas which have been historically grazed. These areas typically coincide with the occurrence of PCT1334 Yellow Box - Blakely's Red Gum grassy woodland.

3.2.5 Threatened ecological communities

A list of Threatened Ecological Communities (TECs) occurring or potentially occurring within the locality as generated from the database searches detailed in section 3.1, is provided in Appendix 1. The database searches identified seven TECs that have been identified as potentially occurring within the locality.

Based on the results of the detailed vegetation validation, an analysis of existing vegetation mapping by Tozer et al. (2006), and review of the Conservation Advice of the TECs, one TEC was identified as being present within the Study Area:

- Yellow Box Blakely’s Red Gum Woodland and Derived Native Grassland (Endangered Ecological Community (EEC) under the BC Act and Critically Endangered Ecological Community (CEEC) EPBC Act).

The Yellow Box Blakely’s Red Gum Woodland community was identified as aligning to PCT1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670).

Based on the plot surveys within and surrounding the development envelope, three vegetation condition classes were attributed to the TEC:

1. Moderate condition: Consisting of clumps of scattered trees with a mix of native and introduced ground cover (vegetation integrity 40.4)
2. Poor condition: consisting of few scattered *Eucalyptus melliodora, E. bosistoana,* and *E. blakelyi* (vegetation integrity 23.7)
3. Acacia: consisting of planted and regenerating Acacias and occasional eucalypts (not a CEEC under the EPBC Act) (vegetation integrity 26.1)

In total, 88.6 ha of the TEC is listed under the BC Act, and 80.6 ha under the EPBC Act. Further justification regarding the alignment under each Act has been provided in Appendix 2. The location of the TEC has been provided in Figure 12.

3.3 Threatened flora

Threatened flora with the potential to occur, as generated by the BAM Calculator, are presented in Table 7 and Appendix 1. This list was refined post field survey for the development envelope within the BAM Calculator on the basis of the vegetation types, condition and habitat features as well as the results of field survey. The list of predicted and candidate species generated via the BAM Calculator is in Table 6. A status for each species is provided which represents the basis for deciding whether a species was present or absent from the development envelope.

Walking meanders were used to survey for threatened flora species across the Study Area, in particular the presence of *Solanum celatum*, given the species has been previously recorded throughout the locality. In total, approximately 14 hours of threatened flora random meanders per two ecologists were conducted between 3rd and 6th February 2015, and 5th February 2018. And a further 5 hours completed between 31st July and 1st August 2018.

During the field survey, one individual of *Solanum celatum* was recorded within the Study Area at the Southern Overburden Emplacement Area (Figure 13). The individual was recorded midslope along a shallow gully, within vegetation mapped as PCT778 Coast Grey Box – stringybark dry woodland. The species is also known to be present within the locality with extensive records within the Bungonia State Conservation Area. Under section 6.1.4.29 of the BAM, a species polygon is to be established by the location of the individual plant or group of plants, and a 30m buffer area around the outside of the individual plant or group of plants. In the case of the *Solanum celatum* recorded, an area of 0.1 ha has therefore been attributed.

Threatened flora that have potential to occur in the habitat types of the Study Area are relatively conspicuous and are unlikely to remain undetected during the survey. Given the field survey was completed during the recommended survey times for those species identified in the BAM Calculator (Table 6), the flora habitat requirements, and the conspicuous nature of the species, it is highly unlikely that threatened flora occur within the Study Area.

Table 6. Candidate threatened flora as generated by the Biodiversity Credit Calculator

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[1]
Flockton Wattle	*Acacia flocktoniae*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – conspicuous species not detected during targeted field survey. Field survey completed during recommended survey time (November, February).
Thick Lip Spider Orchid	*Caladenia tessellata*													No – no records within 10km of subject site. There is some marginal habitat within the Study Area within the areas containing Box Gum Woodland with an open understorey, however given the species was not detected during survey which was completed during the known flowering time (October), the species is unlikely to be present.
Buttercup Doubletail	*Diuris aequalis*										Yes	Yes	Yes	No – no records within the locality. Only known from 20 fragmented populations, none of which occur near the Study Area. The species can occur within Box Gum Woodland habitat, however was not detected during the field survey which was completed during the known flowering time for the species.
Pink Donkey Orchid	*Diuris tricolor*									Yes	Yes			No – no records within the locality. No habitat within the Study Area. The species was not detected during the field survey which was completed during the known flowering time for the species.
Paddys River Box, Camden Woollybutt	*Eucalyptus macarthurii*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No - conspicuous species that is unlikely to remain undetected during field survey.
Superb Midge Orchid	*Genoplesium superbum*	Yes	Yes	Yes										No – no habitat present at site. No records within the locality. The species is restricted to the Central and Southern Tablelands of NSW where it has been recorded from 2 locations near Nerriga, c. 20 km apart, and north of Wallerawang. Surveys completed during the recommended survey period (February). Not recorded during field survey.
Cambage Kunzea	*Kunzea cambagei*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – relatively conspicuous species unlikely to remain undetected during field survey. Field survey completed during recommended survey time (all year).
Dwarf Phyllota	*Phyllota humifusa*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during the field survey that was completed during the recommended survey time for the species (all year). Relatively conspicuous, and unlikely to remain undetected during the field survey.
Bungonia Rice-flower	*Pimelea axiflora* subsp. *pubescens*									Yes	Yes	Yes	Yes	No – not detected during targeted flora survey which was completed during the recommended survey time (November). Unlikely to remain undetected during the survey.
Cotoneaster Pomaderris	*Pomaderris cotoneaster*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during targeted flora survey which was completed during the recommended survey period (all year). Unlikely to remain undetected during the survey.

---

[1] As determined by BAM calculator

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[1]
Delicate Pomaderris	*Pomaderris delicata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during targeted flora survey which was completed during the recommended survey time (November). Unlikely to remain undetected during the survey.
Matted Bush-pea	*Pultenaea pedunculata*									Yes	Yes	Yes		No – not detected during targeted flora survey which was completed during the recommended survey period (November). Unlikely to remain undetected during the survey.
Solanum celatum	*Solanum celatum*									Yes	Yes	Yes		Yes – one individual detected during the field survey.
Silky Swainson-pea	*Swainsona sericea*	Yes	Yes							Yes	Yes	Yes	Yes	No – not detected during targeted flora survey which was completed during the recommended flowering period (November). Unlikely to remain undetected during the survey.

4. Assessment of fauna and fauna habitat

4.1 Bionet Atlas & EPBC Act Protected Matters Search

Similar to that in section 3.1, a review of spatial records of threatened fauna within a 10 km radius of the Study Area was undertaken using data obtained from the Bionet Atlas, and predicted threatened biodiversity were generated from an EPBC Act Protected Matters Search.

Thirty-five threatened fauna have been previously recorded or have modelled habitat within a 10 km radius of the Study Area (Appendix 1) according to the database searches. The potential for these species to occur within the Study Area is discussed in section 4.3 and Appendix 1. The results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey.

4.2 Methods – field survey

The fauna field surveys incorporated both targeted survey using established survey techniques (as described in Table 7) and habitat-based assessment.

The fauna survey design had an emphasis on the detection of species credit fauna where habitat was present. Since ecosystem credit species (see Appendix 1) have a high likelihood of being present on the site (based on the presence of habitat surrogates), specific targeted survey was not always performed for these species. However, the survey design attempted to detect the range of fauna using the Study Area in order to assist with evaluating its importance to fauna more generally.

The fauna survey effort was conducted over four main fauna survey periods corresponding to the different Project components:

- Study area and surrounds surveyed over four days between 26th November and 1st December 2014. This included spotlighting, call playback, and habitat based assessment.
- Targeted fauna survey across Study Area from the 2nd to 6th February 2014. This included camera trapping, spotlighting, and habitat assessment.
- Amphibian and habitat survey along Barbers Creek, Bungonia Creek and areas of Shoalhaven River between the confluences with the above creeks. This was undertaken on the 2nd to 4th March 2015.
- Flora and fauna survey undertaken on 19th to 21st May 2015 and included Koala SAT surveys, spotlighting, call-play back, habitat assessment, bird surveys and Anabat analysis.
- Koala SAT surveys completed within the Northern Overburden Emplacement Area on 5th February 2018.

Habitat assessment considered the type and condition of habitats for fauna species. Habitat features recorded within the survey area included:

- Topographic features (such as slope, aspect and landscape position)
- Geology/soil type
- Dominant vegetation community composition, structure and condition of strata levels
- Form, quality and location of water sources
- The presence, number, size and condition of unique habitat features (such as tree hollows and crevices, loose tree bark, fallen timber mistletoe and any rock outcropping or scattered surface rock)
- The level of disturbance.

Details regarding the survey effort and techniques employed are provided in Table 7, and the location of each survey are shown on Figure 14.

Table 7. Fauna survey details and effort

Method	Effort and Timing	Total effort	Details	Target species (NSW)	Target species (Commonwealth)	EPBC species survey guidelines met in relation to Study Area?
Ultrasonic call recording for bats	3 x 1 night = 3 nights; 29/10/2014 to 31/10/2014	90 hours	One Anabat II bat detector and Anabat CF recorder unit was deployed at three sites over one night along potential flyways or watercourses.	Large-eared Pied Bat, Eastern False Pipistrelle, Golden-tipped Bat, Eastern Bent-wing-bat, Eastern Freetail-bat, Southern Myotis, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat.	Large-eared Pied Bat	Yes guidelines met for Large-eared Pied Bat.
Ultrasonic call recording for bats	2 x nights 02/02/2015 1 x night 04/02/2015 1 x night 05/02/2015 3 x nights 03/02/2015 3 x nights 02/02/2015	100 hours	Wildlife Acoustics SM2BAT ultrasonic recorders were deployed at five sites and set to record from dawn to dusk. The detectors were placed on the ground or elevated up to a metre where possible and, pointed upwards at approximately a 45 degree angle.			
Harp Trapping	2 x nights; 02/02/2015 1 x night; 04/02/2015 1 x night; 05/02/2015 2 x nights 04/02/2015	72 hours	Harp traps were deployed overnight along identified flyways along tracks or close to waterways. There were limited narrow flyways throughout the Study Area.			
Diurnal bird surveys (2 hectare)	0.75 hours; 02/02/2015 1 hour; 02/02/2015 1 hours; 03/02/2015 1 hour; 04/02/2015 0.75 hours; 05/02/2015 0.75 hours; 05/02/2015 0.75 hours; 02/03/2015 1.75 hours; 03/03/2015 1 hour; 20/05/2015 2 hours; 21/05/2015 1 hours; 01/08/2018 2 hours; 03/08/2018	27.5 hours	20 minute, 2 hectare bird surveys were extended in time due to relatively low bird activity in most areas and additional species being recorded after or at the end of the typical standard 20 min period. Incidental bird sightings were made throughout surveys activities with species of note being recorded spatially. Birds were identified with the use of 10 X 42 binoculars or from their calls.	All birds	All birds, including Regent Honeyeater	Yes survey guidelines met- Regent Honeyeater – 20 hours over 10 days using area searches.
Reptile survey	20 mins 05/02/2015 45 mins 06/02/2015 25 mins 05/02/2018	90 mins	Random meander turning over surface rocks. Note that such habitat was very restricted and sparse.	Pink-tailed Legless Lizard Striped Legless Lizard Broad-headed Snake Little Whip Snake Rosenberg's Goanna	Pink-tailed Legless Lizard Striped Legless Lizard Broad-headed Snake	Habitat in Study Area limited to non-existent. Survey effort therefore suitable given the lack of habitat present.

Method	Effort and Timing	Total effort	Details	Target species (NSW)	Target species (Commonwealth)	EPBC species survey guidelines met in relation to Study Area?
Remote Cameras	27 nights x 2 cameras (37,38) 06/02/2015 31 nights x 4 cameras (40,45,39,43) 02/03/2015 27 nights x 3 cameras (41,78,74) 06/02/2015 30 nights x 2 cameras (46,48) 03/02/2015 30 nights x 2 cameras (75,77) 03/02/2015	3,408 hours	Moultrie 990i infrared cameras were deployed. Half of the cameras were baited with a mix of peanut-butter/oats/honey while the other half were baited with sardines. Cameras were placed along animal tracks near water points or other features.	Spotted-tail Quoll, Long-nosed Potoroo, Brush-tail Rock Wallaby, New Holland Mouse.	Spotted-tail Quoll, Brush-tail Rock Wallaby, Long-nosed Potoroo, New Holland Mouse.	Yes – 3.408 hours of trapping is extensive for a range of threatened mammals.
Spotlighting	30 mins; 03/02/2015 30 mins; 03/02/2015 45 mins; 05/02/2015 30 mins; 03/02/2015 45 mins; 04/02/2015 45 mins; 05/02/2015 2 hours; 02/03/2015 2 hours; 03/03/2015 2 hours; 03/03/2015 60 mins 05/02/2018 30 mins 31/08/2018	19.5 hours	Spotlighting surveys targeting arboreal mammals and nocturnal birds were performed, primarily on foot but also from a slow moving vehicle throughout parts of the Study Area.	Koala, Yellow-bellied Glider, Squirrel Glider, Sooty Owl, Powerful Owl, Masked Owl, Barking Owl, Spotted-tailed Quoll.	Greater Glider, Grey-headed Flying Fox, Koala	Yes – Koala assumed present. No Grey-headed Flying Fox camp site as evident by field inspection. Greater Glider lacks habitat.
Call playback and Owl Listening	3 x 45 minute surveys: 03/02/2015, 05/02/2015 1 x 45 minute survey: 04/2/2015	3 hours	Target species – Powerful Owl, Masked Owl, Sooty Owl, Koala, Yellow-bellied Glider and Sugar Glider. Call-playback sites were established at three locations within the Study Area over the three nights. After an initial listening period of five minutes, calls of the target species were broadcast through a 10 watt megaphone for five minutes followed by a five minute listening period and a period of spotlighting.	Koala, Yellow-bellied Glider, Squirrel Glider, Sooty Owl, Powerful Owl, Masked Owl, Barking Owl.	Koala	Yes – Koala assumed to be present.
Frog chorus survey and aquatic habitat surveys.	15 mins; 03/02/2015 20 mins; 03/02/2015 30 mins; 05/02/2015 60 mins; 04/02/2015 30 mins; 04/02/2015 3 hours; 02/03/2015 3 hours; 03/03/2015 3 hours; 03/03/2015	11 hours	Frogs were listened for at dams and permanent and ephemeral drainage lines throughout the Study Area. Active searching for frogs using spotlights was also conducted around watercourses. Frog surveys were done outside of the Study area along the Shoalhaven River and its tributaries recognising the potential for indirect impacts through water discharge.	Littlejohn's Tree Frog, Green and Golden Bell Frog, Giant Burrowing Frog.	Littlejohn's Tree Frog, Green and Golden Bell Frog, Giant Burrowing Frog.	Yes – lack of habitat in Study Area.

Method	Effort and Timing	Total effort	Details	Target species (NSW)	Target species (Commonwealth)	EPBC species survey guidelines met in relation to Study Area?
Stag watching	2 x 30 mins; 03/02/2015 2 x 30 mins; 05/02/2015	2 hours	Trees with hollows or cracks were watched immediately prior to sunset.	Yellow-bellied Glider, Squirrel Glider, Sooty Owl, Powerful Owl, Masked Owl, Barking Owl.		
Koala SAT	3 x surveys; 03/02/2015 1 x survey; 05/02/2015 1 x survey 05/02/2018 1 x survey 02/08/2018	4 hours	SAT (Koala scat) surveys were conducted across the Study Area. In addition to SAT surveys random tree inspections were carried out during traverses of the Study Area at selected feed trees searching for scats and characteristic bark scratches.	Koala	Koala	Yes – Koala assumed to be present.
Opportunistic survey	During all activities	48 hours	Opportunistic observations were made of fauna aided with binoculars and photography as appropriate. Opportunistic survey included searches of habitat such as under logs, rocks or waste piles (where limited areas of such habitat existed) or within heaped leaf litter, casual bird or mammal observations or observations of their calls, including during overnight activities within the Shoalhaven River area, and observations of indirect evidence for certain species such as scats tracks and other traces.	All species	All species	

4.3 Assessment of threatened fauna species and populations

Threatened fauna species predicted or potentially occurring within the IBRA subregion were reviewed. This list was refined post field survey for the development envelope within the BAM Calculator on the basis of the vegetation types, condition and habitat features as well as the results of field survey. The list of predicted and candidate species generated via the BAM Calculator is in Table 8. A status for each species is provided which represents the basis for deciding whether a species was present or absent from the development envelope. No ecosystem credit species were omitted from the BAM Calculator, despite there being very limited or no habitat present within the Site for many of the predicted species.

Table 8: List of predicted and candidate threatened species for the proposed Project

Common Name	Scientific Name	Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[2]
Candidate fauna species (species credit species)														
Regent Honeyeater (Breeding)	*Anthochaera phrygia*									Yes	Yes	Yes	Yes	No – no breeding habitat identified within the Study Area. The species was also not recorded foraging during the survey. Surveys completed during recommended survey period in October. The total survey hours exceed the survey guidelines specified in DEWHA (2017).
Pink-tailed Legless Lizard	*Aprasia parapulchella*									Yes	Yes	Yes		No – lack of rocky habitat. Targeted reptile surveys did not record the species.
Gang-gang Cockatoo (Breeding)	*Callocephalon fimbriatum*	Yes									Yes	Yes	Yes	No – no breeding habitat identified within the Study Area. The species was also not recorded foraging during the survey.
Glossy Black-Cockatoo (Breeding)	*Calyptorhynchus lathami*			Yes	Yes	Yes	Yes	Yes	Yes					No – no breeding habitat identified within the Study Area. The species was also not recorded foraging during the survey which was completed during the recommended survey time (November).
Eastern Pygmy-possum	*Cercartetus nanus*	Yes	Yes	Yes						Yes	Yes	Yes	Yes	No – species not recorded during targeted survey. Unlikely to be present. No previous records within the Study Area. Survey completed during recommended survey time (November).
Large-eared Pied Bat	*Chalinolobus dwyeri*	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes – recorded during the field survey.

---

[2] As determined by Bam calculator

Common Name	Scientific Name	Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[2]
Giant Burrowing Frog	*Heleioporus australiacus*	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Yes	No – no habitat present within the Study Area (lack of fringing vegetation along the Marulan Creek. No tadpoles recorded in the proposed Marulan Creek Dam Inundation Area to the north of the site. No tadpoles recorded during the targeted amphibian survey.
Little Eagle (Breeding)	*Hieraaetus morphnoides*								Yes	Yes	Yes			No – no breeding habitat identified within the Study Area. The species was also not recorded foraging during the survey.
Broad-headed Snake (breeding)	*Hoplocephalus bungaroides*									Yes	Yes			No – lack of preferred habitat present for the species. Reptile surveys completed during recommended survey period (November)
Southern Brown Bandicoot (eastern)	*Isoodon obesulus obesulus*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during the field survey which was completed during the recommended survey period (all year). No previous records at the site.
Swift Parrot (Breeding)	*Lathamus discolor*					Yes	Yes	Yes	Yes					No – no breeding habitat identified within the Study Area. The species was also not recorded foraging during the survey. Surveys completed during the recommended survey time (August).
Booroolong Frog	*Litoria booroolongensis*											Yes	Yes	No –habitat present within the Study Area is marginal at best for the species. Marulan Creek does not contain fringing native vegetation, lacks flow unless after heavy rain, and lacks rocky outcrops. Tadpoles not recorded during the targeted amphibian survey.
Little Bentwing-bat	*Miniopterus australis*	Yes	Yes										Yes	No – no breeding habitat identified within the Study Area. The species

Common Name	Scientific Name	Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[2]
(Breeding)														was also not recorded foraging during the survey.
Eastern Bentwing-bat (Breeding)	*Miniopterus schreibersii oceanensis*	Yes	Yes									Yes	Yes	No – no breeding habitat identified within the Study Area. The species was also not recorded foraging during the survey.
Stuttering Frog	*Mixophyes balbus*	Yes	Yes	Yes						Yes	Yes	Yes	Yes	No – No habitat present. No rainforest wet forest or tall open forest present at Marulan Creek.
Barking Owl (Breeding)	*Ninox connivens*					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – species not detected during targeted surveys completed during recommended survey period. No evidence at the base of trees of the presence of the Barking Owl. No large hollows recorded in the Study Area.
Powerful Owl (Breeding)	*Ninox strenua*					Yes	Yes	Yes	Yes					No – no breeding hollows (Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old)) were recorded within the Study Area. Species not recorded during targeted surveys.
Squirrel Glider	*Petaurus norfolcensis*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during survey.
Brush-tailed Rock-wallaby	*Petrogale penicillata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during survey. No records within locality. Unlikely to be present.
Pink Robin	*Petroica rodinogaster*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during survey. No records within locality. Unlikely to be present.
Koala	*Phascolarctos cinereus*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not recorded during the field survey, however is known to occur within the locality. It may use the habitat features of the Study Area. The Koala

Common Name	Scientific Name	Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[2]
														is therefore considered further in the impact assessment.
Grey-headed Flying-fox (Breeding)	*Pteropus poliocephalus*										Yes	Yes	Yes	No – no camp sites present.
Masked Owl (Breeding)	*Tyto novaehollandiae*					Yes	Yes	Yes	Yes					No – no breeding habitat (Living or dead trees with hollows greater than 20cm diameter) identified within the Study Area. The species was also not recorded foraging during the targeted survey.
Predicted threatened species (ecosystem credit species)														
Regent Honeyeater	*Anthochaera phrygia*	Species predicted to occur, and therefore do not require targeted survey												Assumed present
Gang-gang Cockatoo	*Callocephalon fimbriatum*													Assumed present
Glossy Black-Cockatoo	*Calyptorhynchus lathami*													Assumed present
Speckled Warbler	*Chthonicola sagittata*													Assumed present
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*													Assumed present
Varied Sittella	*Daphoenositta chrysoptera*													Assumed present
Spotted-tailed Quoll	*Dasyurus maculatus*													Assumed present
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*													Assumed present

Common Name	Scientific Name	Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[2]
Little Lorikeet	*Glossopsitta pusilla*													Assumed present
Painted Honeyeater	*Grantiella picta*													Assumed present
Little Eagle	*Hieraaetus morphnoides*													Assumed present
Broad-headed Snake	*Hoplocephalus bungaroides*													Assumed present
Swift Parrot	*Lathamus discolor*													Assumed present
Hooded Robin (south-eastern form)	*Melanodryas cucullata*													Assumed present
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*													Assumed present
Little Bentwing-bat	*Miniopterus australis*													Assumed present
Eastern Freetail-bat	*Mormopterus norfolkensis*													Assumed present
Turquoise Parrot	*Neophema pulchella*													Assumed present
Barking Owl	*Ninox connivens*													Assumed present
Powerful Owl	*Ninox strenua*													Assumed present
Yellow-bellied Glider	*Petaurus australis*													Assumed present
Scarlet Robin	*Petroica boodang*													Assumed present
Flame Robin	*Petroica phoenicea*													Assumed present

Common Name	Scientific Name	Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Status[2]
Koala	*Phascolarctos cinereus*													Assumed present
Long-nosed Potoroo	*Potorous tridactylus*													Assumed present
Grey-headed Flying Fox	*Pteropus poliocephalus*													Assumed present
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*													Assumed present
Greater Broad-nosed Bat	*Scoteanax rueppellii*													Assumed present
Diamond Firetail	*Stagonopleura guttata*													Assumed present
Little Whip Snake	*Suta flagellum*													Assumed present
Masked Owl	*Tyto novaehollandiae*													Assumed present
Rosenberg's Goannna	*Varanus rosenbergi*													Assumed present

4.4 Fauna habitat

Numerous sources of disturbance operate throughout most of the Study Area, which have impacted upon the condition of fauna habitat. Disturbances include:

- Selective clearing - which has occurred throughout all accessible areas of the Study Area, with timber being used historically to fuel furnaces in the Marulan area (pers. comm. Rod Wallace – Boral). As a result, all trees were of similar ages, and the understorey had been extensively cleared. Large hollow-bearing logs were very sparse due to the prior clearing events.
- Weed invasion - weeds range in their density across the Study Area from moderately sparse in the dry sclerophyll shrubby vegetation types to common throughout the Study Area within grassland habitat. The weed spread is in response to levels of grazing or other disturbance factors. Infestations of Serrated Tussock (*Nassella trichotoma*) were common throughout the entire Study Area, with higher concentrations in the open grass areas. This has greatly contributed to the relatively low site values scores associated with the PCTs.
- Historic cattle grazing - as such, the ground cover is a mix of native and introduced pasture species.
- Macropod grazing - a high level of macropod grazing was observed in open grass areas. As such, much of the native ground cover within these areas were sparse in composition and species richness.
- Feral animals - feral animals were common throughout the entire Study Area. Rabbits and Brown Hares are moderately common throughout most of the Study Area. Feral goats have also been sighted in the Study Area by Niche and known to occupy the Study Area on a regular basis.

The following broad fauna habitat types occur across the Study Area:

- Grassy Woodlands
- Dry Sclerophyll Forests (with a shrubby/grass understorey)
- Aquatic Habitat (creeks and dams).

Grassy Woodlands

Grassy Woodland areas within the proposed emplacement areas are dominated by PCT1334 Yellow Box - Blakely's Red Gum grassy woodland (SR670) (Photo 1). Habitat within these areas is variable in response to previous disturbance. Where there is consistent canopy cover, trees are predominantly young mature trees or advanced regeneration, however large trees occur sporadically.

Acacia thickets are common in areas where there has been recent soil disturbance. The shrub layer is typically limited in density and diversity throughout.

There are occasional tree hollows and logs associated with larger trees however such features are uncommon and hollows are generally limited to small size classes (< 20 cm in diameter, frequently 5 to 10 cm).

Dry Sclerophyll Forests

The Dry Sclerophyll Forests of the Study Area vary in character from the lower elevation slopes and gullies to higher elevation areas (Photo 2). Lower areas primarily support a naturally higher cover of woody shrubs within the understorey and groundcover, and there has been limited to no disturbance from grazing cattle. Such areas have been previously logged however, which has limited the development of large hollow bearing trees and presence of large logs.

Higher areas of Dry Sclerophyll Forests within the Study Area are naturally more open and grassy and have also typically experienced greater levels of disturbance through grazing, diminishing the availability of fauna habitats, particularly shelter for ground-dwelling mammals.

Aquatic Habitat

A number of dams occur within the Study Area, which are typically less than 0.15 hectares in size. The dams differ in their shape and depth and accordingly the quantity and diversity of aquatic macrophyte and shallow benthic habitat. Such habitat is important in determining the diversity and abundance of vertebrate fauna. In general terms the dams are typical of farm dams in the area and include small areas of fringing low diversity aquatic macrophyte assemblages within their shallows. The dams would play a role in water supply for vertebrate fauna and may act as foraging habitat for bats, birds and frogs.

The ephemeral creeks throughout the Study Area do not support permanent pools. Water from the minor ephemeral watercourses within the Study Area is either diverted to small dams or percolates through the underlying bedrock.

Marulan Creek, which occurs within the proposed Marulan Creek Dam Inundation Area, provides an area of semi-permanent pooling (Photo 3). These areas are generally occupied by native water logged species including: *Typha orientalis, Phragmites australis, Cynodon dactylon,* Juncus species, and *Cyperus polystachyos.* These areas provide habitat for common amphibians identified during the field survey including: Beeping Froglet, Common Eastern Toadlet, Clicking Froglet, Spotted Marsh Frog and Striped Marsh Frog.

Targeted amphibians surveys were conducted within Bungonia Creek, Shoalhaven River and Barber's Creek. These areas provided a range of habitat conditions, including larger permanent water bodies along Shoalhaven River, and intermittent flows along Barber's Creek. The survey recorded common amphibians including: Beeping Froglet, Clicking Froglet, Spotted Marsh Frog, and Striped Marsh Frog. The results of the targeted survey further grounded the conclusion that habitat for threatened amphibians – Giant Burrowing Frog, Green and Golden Bell Frog and Littlejohn's Tree Frog, which have the potential to occur within 10 km of the Study Area (based on database searches), were unlikely to be present in the survey area.

Photo 1. Grassy woodland habitat with a mix of *Eucalyptus bosistoana, E. melliodora, E. blakelyi* and *E. eugenioides*.

Photo 2. Gully forest habitat dominated by a mix of *Eucalyptus bosistoana* and Red Gums (*E.tereticornis/E.blakelyi X)*

Photo 3. Marulan Creek and the surrounding paddock grassland which is currently grazed

4.4.1 Condition of habitat

Numerous sources of disturbance operate throughout most of the Study Area, which have impacted upon the condition of fauna habitat. Disturbances include:

- Selective clearing - which has occurred throughout all accessible areas of the Study Area, with timber being used historically to fuel furnaces in the Marulan area (pers. comm. Rod Wallace – Boral). As a result, all trees were of similar ages, and the understorey had been extensively cleared. Large hollow-bearing logs were very sparse due to the prior clearing events.
- Weed invasion - weeds range in their density across the Study Area from moderately sparse in the dry sclerophyll shrubby vegetation types to common throughout the Study Area within grassland habitat. The weed spread is in response to levels of grazing or other disturbance factors. Infestations of Serrated Tussock (*Nassella trichotoma*) were common throughout the entire Study Area, with higher concentrations in the open grassy paddocks.
- Cattle grazing - the proposed site of the Western Overburden Emplacement is currently, and historically been used for cattle grazing. As such, the ground cover is a mix of native and introduced pasture species.
- Macropod grazing - a high level of macropod grazing was observed in open grassy areas, such as the proposed Northern Overburden Emplacement and Western Overburden Emplacement. As such, much of the native ground cover within these areas were sparse in composition and richness.
- Feral animals - feral animals were common throughout the entire Study Area. Rabbits and Brown Hares are moderately common throughout most of the Study Area. Foxes were identified at nine of 12 camera sites where fauna was recorded, indicating their widespread presence throughout the Study Area; whereas a single cat was recorded. Feral goats have also been sighted in the Study Area (pers. comm. Grant Thompson – Boral). These introduced predators, coupled with the low abundance of available sheltering habitat (such as hollow logs) may have led to a decreased abundance and diversity of small and medium sized ground dwelling mammals (section 4.5).

4.4.2 Connectivity of fauna habitat

From a regional perspective, the habitats within the Study Area are connected to extensive expanses of vegetation associated with the Shoalhaven gorge to the south and east in Bungonia State Conservation Area and Morton National Park. The land to the west, is predominantly cleared for agriculture. However, scattered patches of native vegetation occur across the tableland areas, some of which is connected to the

Study Area. The Study Area has some capacity to act as a linkage between the vegetated reserve areas and the patchy vegetation of the tablelands.

The Study Area does not form part of any national landscape corridors (SEWPaC, 2012a) and no identified OEH wildlife corridors occur within the vicinity of the Project site.

Vegetation clearing for the Project would contribute to some fragmentation of fauna habitat, in particular though the combination of the Northern Overburden Emplacement and Western Overburden Emplacement reducing the connectivity width to patches of vegetation to the north-west. The amount of contiguous bushland remaining, however, means that most of the surrounding native vegetation cover would remain physically connected.

Connectivity losses would occur for the life of the Mine with connectivity being progressively reinstated during Mine rehabilitation. However, the landforms reinstated during rehabilitation are likely to be a less favourable linkage for some fauna species due to their topography, heterogeneity and reduced quality in some areas. More mobile species, such as birds and bats, without highly specific habitat requirements (at least for certain lifecycle aspects) are likely to be most effective at using reinstated linkages.

Vegetation to be disturbed for the proposed Marulan Creek Dam proposed Marulan Creek Dam Inundation Area is unlikely to result in an increase in loss of connectivity given the relatively narrow linear disturbance, and that the proposed area is predominantly cleared paddocks. No other riparian linkages would be impacted by the Project.

4.5 Fauna recorded during field surveys

Fauna field surveys using the methods described in section 4.1 were undertaken in each of the identified habitats, with the suite of methods employed in each habitat type dependant on the potential presence of subject threatened fauna within that habitat type. Notable opportunistic sightings whilst travelling within the Study Area were also recorded. A complete species list is provided in Appendix 5.

A total of 132 species were recorded during field surveys from the Study Area and surrounds, comprising seven reptile, 34 mammal, two fish, 79 bird and 10 frog species.

A suite of these species were present only outside of the Study Area (for example within Bungonia Gorge) where condition of vegetation there presented a greater availability of fauna microhabitats in comparison to the Study Area. For example, greater log and tree hollow abundance, lack of weeds, older vegetation growth and better connectivity. It is believed that many of these species recorded within the Bungonia Gorge would be unlikely to be found in the Study Area with any regularity due to disturbance factors or lack of habitat availability.

There was a low abundance of native small ground-dwelling and arboreal mammals recorded during infrared camera and spotlighting surveys. It is difficult to make comparisons regarding species richness observed between proposed disturbance areas and nearby areas with better condition vegetation, since survey effort was biased towards disturbance areas in order to detect potentially occurring threatened species that could be impacted by the Project.

Some mobile species recorded would primarily be dependent on the adjacent woodland areas but would take advantage of parts of the Study Area to forage (e.g. common Wallaroo, Large-eared Pied Bat).

A high number of feral species were observed in the Study Area, including goats, rabbits, hares and feral cats. A flock of goats (approximately 35 goats) were recorded at the Northern Overburden Emplacement during the during the July 2018 field survey. According to Grant Thompson (Boral – Environmental officer), the goats have been in the Study Area most days since the start of 2018. It is noted that goats have been present within the current Mine and Study Area for many years. Goat culling within the adjacent national parks to the east and to the suth is a regular activity carried out by the NSW Department of Primary Industries (DPI). Hares and foxes were also frequently recorded in the Study Area during the field surveys.

4.5.1 Threatened fauna

A total of 19 threatened fauna species were recorded during all field surveys in and around the Study Area (Table 9, Figure 15). Seven of these species, including the Large-eared Pied Bat, Greater Broad-nosed Bat (possible recording), Eastern Bent-wing Bat, Yellow-bellied Sheath tail Bat, Eastern Free-tail Bat, Scarlet Robin and Diamond Firetail, were recorded in or immediately adjacent to the proposed disturbance area. The remaining 12 threatened species (Glossy Black Cockatoo, Koala, Southern Myotis, Eastern False Pipestrelle, Rufous Fantail, Grey-headed Flying Fox, Golden-tipped Bat, Powerful Owl, Sooty Owl, Turquoise Parrot, Yellow-bellied Glider and Varied Sittella) were recorded outside of the Study Area, mainly within the habitat features of Bungonia Gorge and the Shoalhaven River.

All threatened species recorded are listed as vulnerable threatened species under the BC Act, and three species (Large-eared Pied Bat, Grey-headed Flying Fox and Koala) are also listed as vulnerable under the EPBC Act. The Rufous Fantail is listed as Migratory under the EPBC Act.

As provided in Table 9, only the Koala, Large-eared Pied Bat and Southern Myotis are regarded in the BAM as 'species credit' fauna which would require biodiversity offsetting if the habitat features of these species are present and/or habitat features would be impacted by the Project. The Eastern Cave Bat, Glossy Black-cockatoo, Powerful Owl and Sooty Owl and Grey-headed Flying Fox are regarded as 'dual credit' species' with the species credit component only triggered if breeding habitat is present. The remainder of the species are regarded as 'ecosystem credit' species, which are assumed to have habitat within the vegetation types of the Study Area.

Only the Large-eared Pied Bat was recorded within the Study Area at three locations where anabat and harp traps were established. The Koala and Southern Myotis were recorded outside of the Study Area, within areas containing habitat that was well intact.

The Koala, despite not being recorded in the Study Area, has been considered further in this impact assessment due to the presence of Koala feed trees within the Study Area, and the known Koala population that occurs within Bungonia Gorge (section 4.6.2).

The Southern Myotis was not detected in the anabat and harp traps within the Study Area. This could be attributed to the lack of waterways within the Study Area for which the species uses for foraging habitat. The BioNet Atlas specifies that land within 200 metres of watercourses which contains pools greater than 3 metres in width, should be mapped and be considered further in relation to the Southern Myotis area of habitat. However, within the Study Area, only the site of the proposed Marulan Creek Dam Inundation Area along Marulan South Creek contains a watercourse with sporadic pools. Vegetation within this area is predominately non-native open pasture, and as such, does not provide the surrounding foraging habitat suitable for this species. Furthermore, the creek and pools would still be present following development, as the Project would not result in the drying of the creek and water flow. Given these reason, the species has not been considered further in this impact assessment.

The Eastern Bent-wing Bat has been regarded as an ecosystem credit species for this assessment, as breeding habitat, which triggers the 'species credit' component, was absent from the Study Area. Breeding habitat as listed on the NSW BioNet Atlas includes: caves, tunnels, mines or other structures known or suspected to be used by the species. None of these features would be impacted by the Project, and as such does not trigger the 'species credit' component. Given the Eastern Bent-wing Bat has been nominated in the SEARs for further consideration, further assessment has been provided in section 4.6.3 despite it being an ecosystem credit species.

Similarly, the Grey-headed Flying Fox was not recorded during the field survey, and the 'species credit' component is only triggered where there are breeding camp sites. As no breeding camp sites were located within the Study Area, the species has been regarded as an ecosystem credit species in this assessment.

A number of additional threatened fauna have the potential to occur within the Study Area but were not recorded, most likely due to their potential use of the Study Area or wider locality being limited to sporadic occurrences (e.g. nomadic birds) (Appendix 1).

Table 9. Threatened fauna recorded during the survey

Scientific Name	Common Name	BC Act	EPBC Act	Location and expected use of Study Area	Species credit or ecosystem credit species
Stagonopleura guttata	Diamond Firetail	V	-	Northern Overburden Emplacement Area and east and west of Study Area. Would likely use parts of the Study Area regularly. Preference for Box Gum Woodland.	Ecosystem
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Recorded throughout Study Area and adjacent areas where bat survey was	Dual credit species - Ecosystem/Species credit requirement.

Scientific Name	Common Name	BC Act	EPBC Act	Location and expected use of Study Area	Species credit or ecosystem credit species
				conducted. Would likely use the Study Area to forage regularly.	The Species credit component is only triggered if breeding habitat is present. No breeding habitat is present in the Study Area, nor would any be impacted by the Project. As such, the species is regarded as an Ecosystem credit species.
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V	-	Possible recording from Western Overburden Emplacement. If present may use Study Area with some regularity for foraging but likely in low numbers.	Ecosystem
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Single possible recording from Western Overburden Emplacement. If present may use Study Area with some regularity for foraging but likely in low numbers.	Ecosystem
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Recorded throughout the Study Area and adjacent areas where bat survey was conducted. Would likely use the Study Area to forage regularly.	Species
Petroica boodang	Scarlet Robin	V	-	Recorded between Western Overburden Emplacement and Northern Overburden Emplacement. Expected to occur throughout woodland/forest areas.	Ecosystem
Mormopterus norfolkensis	Eastern Freetail Bat	V	-	Recorded between Western Overburden Emplacement and Northern Overburden Emplacement. Expected to occur throughout woodland/forest areas.	Ecosystem
Threatened fauna recorded outside of Study Area					
Falsistrellus tasmaniensis?	Eastern False Pipistrelle	V	-	Recorded to the west of the Study Area in Box Gum Woodland. If present would be expected to forage in the Study Area on occasion.	Ecosystem
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Recorded within Bungonia Gorge. Would be expected to forage in the Study Area on occasion.	Ecosystem / dual credit species with species credit component attributed the species being triggered if breeding habitat in living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground occurs. These attributes were absent from the Study Area and therefore the Glossy Black-cockatoo is an ecosystem credit species.
Kerivoula papuensis	Golden-tipped Bat	V	-	Recorded to the south of disturbance areas. If present would be expected to forage in the Study Area, but rarely.	Ecosystem
Myotis macropus	Southern Myotis	V	-	Not recorded within the Study Area. Was recorded within the Bungonia Gorge outside the area to be impacted by the Project.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Location and expected use of Study Area	Species credit or ecosystem credit species
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Expected to forage in the Study Area.	Species credit requirement (breeding/roost habitat) is absent from Study Area. Therefore is regarded as ecosystem credit species.
Phascolarctos cinereus	Koala	V	V	Previous reliable anecdotal evidence of Koalas from disturbance areas but would have limited use of such areas or comprise a very small number of individuals (e.g. a single Koala).	Species
Tyto tenebricosa	Sooty Owl	V	-	Could potentially forage in the Study Area, but rarely.	Ecosystem / dual credit species with species credit component attributed the species being triggered if breeding habitat in Living or dead trees with hollow greater than 20cm diameter occurs in the Study Area. These attributes were absent from the Study Area and therefore the species is an ecosystem credit species.
Ninox strenua	Powerful Owl	V	-	Could potentially forage in the Study Area.	Ecosystem / dual credit species with species credit component attributed the species being triggered if breeding habitat in Living or dead trees with hollow greater than 20cm diameter occurs in the Study Area. These attributes were absent from the Study Area and therefore the species is an ecosystem credit species.
	Rufus Fantail	-	M		-
Neophema pulchella	Turquoise Parrot	V	-	Could potentially forage in the Study Area, but rarely.	Ecosystem
Daphoenositta chrysoptera	Varied Sittella	V	-	Recorded and expected to use the Study Area with some regularity given proximity and frequency of records in similar habitat.	Ecosystem
Petaurus australis	Yellow-bellied Glider	V	-	Could potentially forage in disturbance areas, but rarely.	Ecosystem

4.6 Species credit fauna

As discussed in section 4.5.1, the survey resulted in only one species credit fauna being recorded within the Study Area: the Large-eared Pied Bat. The Koala, due to the presence of feed trees and proximity to the Koala population of Bungonia Gorge, has also been considered further as discussed below.

4.6.1 Large-eared Pied Bat habitat in the Study Area

The Large-eared Pied Bat was recorded at all of the anabat survey locations within, and adjacent to the Study Area. As such, portions of native vegetation within the Study Area have been considered foraging habitat for the species.

Not a significant amount of information is known about the Large-eared Pied Bat, however, as indicated on the BioNet Atlas, the species is regarded as a 'species credit' species as it cannot be reliably predicted to occur on a site based on vegetation and other landscape features.

Breeding habitat, which as described on the BioNet Atlas as including PCTs associated with the species within 100m of rocky areas containing caves, overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings. As the site, does not occur within 100 metres of any of these features known to contain the species, breeding habitat is unlikely to be present within the Study Area.

One cave is known to occur within 900m of the Study Area, known as Main Gully Spring (Bauer and Bauer 1998). The cave is located beneath the Mine and in periods of high discharge this cave acts as an overflow. A number of chambers and tunnels are described as occurring in this cave by Baeuer and Bauer (1998) including a chamber 1 m x 2.7 m wide.

Main Gully Spring is a potential bat roosting site. It could not be inspected during the current field survey due to safety and access issues. However, a site inspection by Boral representitives accompanied by an experienced caver was undertaken in August 2017 at the base of the cave, and approximately 10 meteres inside the entrance. During the site inspection, approximately 5 microbats were observed. It was not possible to determine the species from photographs that were provided. As such, it is not possible to state with certainty that a maternal roost could not be established for Large-eared Pied Bat.

Whilst microbats were recorded it is unlikely that long-term maternity roosts would be established in the Main Gully Spring cave due to its limited size and occasional inundation of most, if not all parts of the cave in times of high flow.

Regardless of whether bat roosting or breeding occurs within the cave, it is highly unlikely that the Main Gully Spring Cave would experience any impact associated with the Project. This is due to the distance of the subject cave from the Mine expansion activities that involve mining and blasting which is to occur over 900 metres to the north. There has been an ongoing history of mining within the existing south pit throughout which any roosting bats would have persisted if present. The Project is not forecast to increase noise or vibration to the subject cave or any other known caves in the locality.

The Large-eared Pied Bat is known to forage in a range of vegetation types, including dry and wet sclerophyll forest, grassy woodland, Callitris dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country (Hoye & Dwyer 1995; Pennay 2002; DECC 2007). Foraging habitat on fertile soils (or within fertile valleys) is also considered an important overall requirement for the Large-eared Pied Bat (Pennay 2008), however the species has been recorded extensively within sandstone associated vegetation, indicating that whilst foraging habitat on fertile soils is likely to be important, foraging would by no means be confined to such areas.

As such, the area of foraging habitat within the Study Area includes PCTs with a 'moderate condition' class, and 'Acacia condition' class. PCTs that have been assigned a 'poor' or 'non-EEC water dependant' condition class have been excluded from the foraging habitat given these habitat types are not described in BioNet Atlas nor the Recovery Plan as being areas of important foraging. Approximately 140.3 ha of habitat for the

Large-eared Pied Bat has therefore been mapped within the Study Area. This area has been regarded in this assessment as the Species polygon for the Large-eared Pied Bat, which has been addressed later in the report to generate the species credit required for the Project.

The impacts to foraging habitat for the Large-eared Pied Bat are discussed further in section 6.2.4.

4.6.2 Koala habitat in the Study Area

Surveys and collection of anecdotal evidence of Koala sightings conducted within the Study Area and surrounds as part of this assessment revealed that Koalas have been sighted sporadically within the south of the Project site over the past decade, with a Koala observed every 2- 3 years around the Mine (pers. comm. Grant Thompson – Boral).

Scat surveys, spotlighting, call-playback and tree surveys did not identify repeated or on-going use of trees within any of the proposed development areas, however a single Koala was recorded whilst spotlighting to the east of the existing Mine (outside of direct impact area) and multiple Koalas was heard bellowing during aquatic surveys of Bungonia Gorge during November 2014 (Figure 15). Summarily, whilst it is known that Koalas occur within proposed development areas to the west of the existing Mine and that a variety of feed trees exist within them, it is likely that very low densities of Koalas occur, or that Koalas use the areas only whilst moving through the landscape.

There are 137 Koala records from the Bionet Atlas within a 10 km radius of the Study Area (Figure 16). The majority of these records (105) are from the Bungonia National Park and Bungonia State Conservation Area (SCA) which occur approximately 1 - 4 km south of the Project site. The large number of records from the Park can largely be attributed to establishment of a monitoring program based on park visitors and staff reporting Koala sightings. However, the program has not allowed for a reliable estimate of Koala numbers in the area (pers. comm. Audrey Kutzner NSW NPWS). Nonetheless the area where the majority of Koala records occur is considered one of the primary known active sites for a Koala population centred along the Shoalhaven Gorge and extending approximately 40 km to the south of the Study Area towards Nerrigan and approximately 30 km east towards Tallowa Dam (Allen 2002). The population area encompasses large areas of Morton National Park. Within the Shoalhaven Gorge population area, it has been estimated that some 7,500 ha of secondary koala habitat exists (the same habitat status as habitat within the Project site under the classification scheme used within Allen 2002), supporting between 80 and 150 Koalas (Allen 2002). The Shoalhaven Gorge Koala population was described as a low-density population utilising secondary habitat, spread at least in patches and consisting of breeding associations linked by the movements of dispersing young (Allen 2002). Of direct relevance to the Project site, it was noted that west of the gorge human disturbance is greater and that Koala densities may be very low in such areas (Allen 2002).

North and west of the protected areas around the Bungonia and Shoalhaven gorges Koala records within the Bionet Atlas are very limited, with sporadic observations from private land and along roadsides, one being from the Mine and two additional records (including road-kill) each from around the townships of Marulan and Tallong. These areas are more disturbed predominantly private tenure. They generally have been developed traditionally for agriculture. It is clear that Koalas are able to travel through such areas and feed trees, including primary feed trees, are available to them throughout such areas. Targeted Koala survey in these areas (private land on the tablelands) is likely to have been minimal and therefore actual Koala distribution and abundance within such areas is poorly known. Therefore, whilst it is acknowledged that limits exist regarding predictions of Koala distribution and abundance within the locality, given previous disturbance resulting in fragmented vegetation, and the lack of Koala records within the higher elevation areas away from the protected areas around the Bungonia and Shoalhaven gorges, it is considered unlikely that active Koala areas (with permanent and moderate to high densities of Koalas) such as those within the Bungonia National Park/SCA would extend into the Project site.

Whilst the Koala was not recorded within the Study Area during the targeted surveys, it is recognised given previous sightings throughout the locality, that the Koala may use the habitat features of the Study Area on occasion. In order to determine the area of habitat within the Study Area that the Koala may utilise, the area of occupancy has been determined by considering the density and composition of preferred feed trees listed as primary, secondary and tertiary feed species under the National Recovery Plan for the Koala (DEC 2008). Occupiable habitat was considered as areas where either two or more known feed tree species occurred, or a single feed species occurred and occupied more than 50% of the canopy cover within a 400 m^2 floristic quadrat. Highly disturbed and substantially cleared areas were excluded as habitat.

The area of habitat has been split into areas deemed poor/unsuitable (very limited use/if any), moderate (contains Koala feed trees however is limited in movement due to steepness of terrain), and good (containing Koala feed trees with relatively limited obstacles in regards to movement). The Koala has therefore been attributed to an area of 132.4 ha of occupiable habitat within the Study Area (Figure 16). This area has been regarded in this assessment as the Species polygon for the Koala, which has been addressed later in the report to generate the species credits required for the Project.

4.6.3 Eastern Bent-wing Bat

The Eastern Bent-wing Bat was identified in the SEARs as a species requiring further consideration.

Eastern Bent-wing Bats were recorded frequently during echolocation surveys within the area surveyed, occurring at all sites where recordings were made (Appendix 5). Nightly Eastern Bent-wing Bat recordings showed consistent arrival and departure times with bats typically recorded from around 8:20 pm in the evening until 5:50 am the following morning during the survey in early February 2015. It is expected that the majority of recorded bats arrived from the Drum Cave roost site where exit times for bats between the 10th and the 12th of February in 2004 were concentrated from 8:00 pm to 8:45 pm with a peak around 8:15 – 8:30 pm (Law and Chidel 2004).

The Study Area is situated approximately 3.7 km north of a major breeding cave and maternity roost for the Eastern Bent-wing-bat known as Drum Cave. Drum cave is one of four known major maternity roosts for the species and is suspected contain between 10,000 and 15,000 individual bats (Law and Chidel 2004). Other caves in the vicinity are known to act as roost habitat for Eastern Bent-wing Bats, however maternity roosts have not been recorded in surrounding caves.

As discussed previously in relation to the Large-eared Pied Bat, Main Gully Spring (Bauer and Bauer 1998) which occurs within 900 m of the Study Area is unlikely to contain long-term roosting due to the water inundation within the cave. It is assumed unlikely that long-term maternity roosts would be established in Main Gully Spring due to its limited size and occasional inundation of most if not all parts of the cave in times of high flow. However, given the lack of previous survey of this cave, it is not possible to state with certainty that a maternal roost could not be established for Eastern Bent-wing bat within Main Gully Spring. Regardless, as is the case with the Large-eared Pied Bat, the cave is located away from the Study Area and would not experience any impact associated with the Project. This is due to the distance of the subject cave from the Mine expansion activities that involve mining and blasting which is to occur over 900 metres to the north.

Foraging habitat for Eastern Bent-wing Bat would be similar to that of the Large-eared Pied Bat, occupying 140.3 ha within the Study Area. Foraging habitat in the locality is considered important for the Eastern

Bent-wing Bat due to the large population dependant on the roost site known from the area (Drum Cave). While foraging habitat of the type to be removed is considered important for both species, such habitat is considered locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. It is estimated that 33, 837 ha of native vegetation exists within the locality of the Study Area (within a 10 km radius of the Project site). Regardless, the 'species credit' component associated with this species is only triggered with impacts to breeding features (such as caves, tunnels, mines, culverts or other structures known or suspected to be used for breeding). As such, Eastern Bent-wing Bat is regarded as an 'ecosystem credit' species for this assessment.

4.7 EPBC Act listed fauna

A total of 35 EPBC Act listed fauna were considered in the assessment based on the database reviews detailed in section 4.1. Of these species, nine were considered to have a moderate to high likelihood to utilise the habitat features of the Study Area for foraging.

Three EPBC Act Vulnerable listed fauna that have foraging habitat within the Study Area include the Koala, Large-eared Pied Bat and Grey-headed Flying Fox. Both the Koala and large-eared Pied Bat have been discussed in detail in sections above. The Grey-headed Flying Fox is only likely to utilise the Study Area on occasion for foraging. No roosting camp sites were observed in the Study Area, nor known to occur within close proximity to the Study Area.

Threatened amphibians generated in the database searches include the Giant Burrowing Frog, Green and Golden Bell Frog and Littlejohn's Tree Frog. After considering the habitat requirements for these species, all have been regarded as unlikely to occur in the Study Area given the lack of suitable habitat (Appendix 1). It should be noted that none of these species have been previously recorded within the locality, and were not detected during amphibian surveys within more ideal habitat within the Shoalhaven Gorge. Based on the habitat requirement, none detection during surveys, coupled with the absence of records within the locality, all three threatened amphibians are regarded as being absent from the Study Area and therefore have not been considered further.

Threatened birds with limited potential to occur in the Study Area listed as either Critically Endangered, Endangered or Vulnerable under the EPBC Act include the Regent Honeyeater, Australasian Bittern, Curlew Sandpiper, Painted Honeyeater, Swift Parrot, Eastern Curlew and Australian Painted Snipe. None of these species were detected during the bird surveys completed as part of this assessment, and with the exception of the Australasian Bittern, none have been recorded previously within the locality. Only one record provided on the BioNet Atlas for the Australasian Bittern occurs approximately 2.5 kilometres to the south-east of the Study Area within native vegetation of the Bungonia State Conservation Area. Unlike the Study Area, the site of this record contains relatively intact native vegetation and is part of an extensive native vegetation corridor. Based on the specific habitat requirements of each of the species (Appendix 1), and the lack of detection during targeted surveys, it is likely that the habitat features within the Study Area would only be used on an intermittent basis for foraging. The extensive native vegetation that occurs throughout the land to the south and east within Morton National Park and Bungonia State Conservation Area are likely to offer greater habitat availability for each of the species. As such, the species have been given a low likelihood of occurrence within the Study Area (Appendix 1).

During the field survey, no migratory species listed under the EPBC Act were recorded. However, a number of listed migratory species have been recorded from the locality and in some cases have the potential to fly over the Study Area (see Appendix 1). Species include: Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, and Rufous Fantail. The Vulnerable EPBC Act species – the Large-eared Pied Bat, and

Grey-headed Flying Fox also have potential foraging habitat throughout the Study Area. Impacts of the Project on these EPBC Act listed species are considered further in section 5.

No migratory fauna, as listed on the EPBC Act, were recorded during the survey. A number of additional listed migratory species have been recorded from the locality and in some cases have the potential to use habitat within the Study Area. These species include: Great Egret, Cattle Egret, Rufous Fantail, Rainbow Bee-eater, Fork-tailed Swift and Black-faced Monarch. Impacts of the Project on these species are considered in section 5.3.6.

4.8 State Environment Planning Policy 44 – Koala Habitat

The State Environment Planning Policy 44 – Koala Habitat (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline:

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and

(b) by encouraging the identification of areas of core koala habitat, and

(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.

SEPP 44 Koala habitat applies to Local Government Areas (LGAs) listed in Schedule 1 of SEPP 44, and where the development has an area of more than 1 hectare.

The Study Area occurs within the Goulburn Mulawaree Local Government Area (LGA) which is not listed in Schedule 1 of SEPP 44. However, the Mulawaree LGA is listed in Schedule 1 which was amalgamated with Goulburn LGA in 2004. As such, the SEPP applies to the Study Area.

Under SEPP 44, potential Koala habitat includes: '*areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component*'. Of the Trees listed in Schedule 2, only *Eucalyptus tereticornis* and *E. viminalis* applies to the Study Area. However it should be noted that *E. tereticornis* is likely a hybrid in the Study Area with *E. blakelyi X.* These trees are scattered throughout the Study Area amongst *E. bosistiana, E. melliodora* and *E. eugeniodes.* The trees would meet at least 15% of the total number of trees within the Study Area, and therefore the habitat present is regarded as potential Koala habitat under the SEPP 44.

Core Koala habitat means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population. Surveys and collection of anecdotal evidence of Koala sightings conducted within the Study Area as part of this assessment revealed that Koalas have been sighted sporadically surrounding the Study Area over the past decade, with Koalas observed every 2- 3 years around the mine (pers. comm. Grant Thompson – Boral).

The Koalas sighted are quite likely to have been from the Bungonia National Park and Bungonia State Conservation Area population (Bungonia population) which is a well-known population which extends along the Shoalhaven Gorge and extending approximately 30 km to the south of the Study Area (e.g. Allen 2002). The Koala population occurs approximately 2 km south of the Study Area with the majority of records within the gorge/valley. This population would undoubtedly be regarded as occurring within core habitat given the number of records, and known breeding population.

The Bungonia population is separated from the Study Area by the Bungonia Gorge, a limestone gorge approximately 350 m deep. The steepness of the gorge would limit connectivity between the main known breeding area of Koalas in the locality (Bungonia population) and the Study Area, however there are records of the Koala from both sides of the gorge (albeit very limited from the northern side) and connectivity to the Study Area exists indirectly, west of the main gorge area.

North and west of the protected areas around the Bungonia Gorges, Koala records within the NSW Atlas of Wildlife are very limited with sporadic observations from private land and along roadsides, one being from the Marulan South Limestone Mine and two additional records (including road-kill) each from around the townships of Marulan and Tallong. These areas are more disturbed, predominantly private tenure. They generally consist of more fertile areas that have been developed traditionally for agriculture. It is clear that Koalas are able to travel through such areas and feed trees including primary feed trees are available to them throughout such areas.

Despite the limits regarding Koala distribution and abundance, given previous disturbance resulting in fragmented vegetation and the lack of Koala records within the higher elevation areas away from the protected areas around the Bungonia and Shoalhaven gorges, it is considered unlikely that active Koala areas (with permanent and moderate to high densities of Koalas) such as those within the Bungonia population would occur.

Within the Study Area, no Koala observations are known. Scat surveys, spotlighting, call-playback and tree surveys did not identify repeated or on-going use of trees within the Study Area. Therefore, whilst it is known that Koalas can occur on occasion within these areas of potential habitat similar to that of the Study Area near the existing mining operations, it is unlikely that a resident population of Koalas would rely on the habitat features of the Study Area on a regular basis. As such, ‘core habitat’ within the Study Area is unlikely.

5. Avoidance and site justification

In accordance with the BAM, proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a Project on biodiversity values. This section of the report outlines how Boral has considered avoidance in Project design.

5.1 Avoidance – Design Process

In order to demonstrate the reason for the Study Area placement, and why the impacts on biodiversity are occurring, it is important that Boral justify the Project through considering alternatives. As detailed in chapter 7 and 28 of the EIS, evaluation of Project alternative site locations, and selecting one is a difficult and important process in planning a new project or a 30-year continuation of mining at the oldest and largest limestone mine in Australia.

As detailed in chapter 7 and 28 of the EIS, evaluating alternatives and arriving at the preferred Project is not a perfect science with a clear set of criteria that can be applied to arrive at the ideal outcome that achieves a harmonious balance between the three pillars of true environmentally sustainable development. Evaluating alternatives is granular, subjective, two steps forward – one step back, influenced by conflicting priorities and objectives of different legislation, stakeholders and even cultures. Evaluating alternatives requires a polycentric decision making approach where the environmental, social and economic impacts of each alternative are considered to lesser or greater degrees based on the potential level of impact and then a value judgement is made on which alternative should be adopted and why certain environmental, social or economic values should receive greater consideration than others. In regards to the Project, there are 17 environmental issues each requiring specialist consideration as detailed in the EIS for the Project.

Chapter 7 and 28 of the EIS details and documents the process of considering Project alternatives which has been informed by Boral and their mine planners expertise and experience in open cut mining, detailed technical studies, cost benefit analysis, and stakeholder engagement.

In summary, in the initial phases of Project design in relation to determining Project constraints (including biodiversity constraints) and determining Project risks (including biodiversity impacts and offsetting) incorporated the following core tasks:

- **Risk, project definition and constraints workshop:** Two all-day risk, project definition and constraints workshops were attended by Boral's mining and planning teams, all technical study leads, the EIS delivery team and an independent 'Challenger' – a mining approvals specialist appointed to challenge the Project team. At the workshops, the Project team of over 30 experts, were introduced to Boral's broad objective of "continuing mining limestone at the site", then they considered key issues associated with their fields of expertise, and developed an environmental, social and economic values and constraints framework to inform development of the 30-year mine plan and associated infrastructure.

  This workshop approach to defining the Project scope at the commencement of the SSD approval process, allowed the implications of one decision, influenced by a certain issue to be considered by the other 17 technical specialists, the 'Challenger' and Boral's mining and planning teams, in order to ascertain the impacts on the other issues. This facilitated in-depth discussion and consideration of why one issue should be attributed greater value than another issue. In regards to biodiversity, vegetation mapping completed by Niche of the Boral landholdings, identified areas of native vegetation, and areas of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, and areas of habitat corridors are important considerations.

- **Stakeholder and community engagement:** Stakeholder and community engagement has been undertaken over a four-year period and has been considered carefully in developing the proposed 30-year mine plan and in deciding which issues should be attributed greater value than others.
- **Ongoing Project team meetings and communication:** Regular project team meetings have been held to update Boral's mine planning and operations team and all technical study leads on outcomes from other technical studies and issues raised through the stakeholder and community consultation process. Through this process, the weighting of the values assigned to each issue identified in the early project constraints and definition phase, and possibly changed due to early stakeholder and community input, is revisited and revaluated and a decision made as to whether further changes should be made.
- **Environmental risk assessment:** The approach for the environmental impact assessments have considered the hierarchy of avoid, manage, mitigate and offset. Specifically:
    - During preliminary planning, where environmental features with high value and significance were identified that could be avoided, Boral revised the project design to avoid impacts to these areas by relocating infrastructure (such as internal roads, overburden emplacements and ancillary infrastructure); and
    - Where environmental features could not be avoided and would be directly impacted, it was assumed that these areas would be impacted, and the EIS prepared on this basis with a view to identify best practice measures to manage, mitigate or offset the impact.
- **Preliminary environmental risk analysis:** A preliminary environmental risk analysis was undertaken as part of the Preliminary Environmental Assessment (Element, April 2015) to identify the key potential environmental factors or impacts associated with the Project. The preliminary environmental risk analysis was informed by the risk, project definition and constraints workshop, early stakeholder and community engagement, early mine planning and specialist study desktop research and site based investigations. Biodiversity received a high risk given the occurrence of native vegetation and habitat, including the TEC White Box Yellow Box Blakely's Red Gum. A priority matrix was then developed, and ranked each risk, including that of biodiversity, in terms of likelihood of occurrence and for the perceived consequence of effects if left unmanaged. Detailed of this matrix are provided in the EIS.

5.2 Alternatives to the Project

Based on the results of the risk assessment and preliminary studies, alternative designs were considered, however were dismissed largely dictated by the availability of the resource location, Boral owned land, within the development consent boundary, that is not required for other mining operations, and is located as far as possible from constraints such as neighbouring residences. Each of the alternatives are detailed below along with the reason for dismissal, and justification for the current Project design. Biodiversity values of each alternative are discussed where relevant.

5.2.1 Alternative - No longer proceed with development

In terms of avoiding impacts on biodiversity, no longer proceeding with the Project would obviously have a positive benefit to biodiversity as clearing of vegetation and habitat would be avoided. As detailed in the EIS, looking at a larger picture, without securing SSD approval for the 30-year mine plan and the continuation of mining, the mine will cease to operate after 26 February 2023, when CML 16 expires resulting in the following negative impacts:

- the loss of approximately 191 direct full time employment jobs across Boral Cement operations in the Southern Highlands;
- loss of an estimated 229 other related jobs, throughout NSW;
- loss of approximately 364 direct and indirect jobs within NSW;
- loss of net social benefits to Australia of between \$488M and \$643M, and net social benefits to NSW of between \$166M and \$321M;
- a potential 60% shortage in cement sold in NSW and a potential 30% shortage in concrete sold in Sydney;

- sterilisation of a valuable resource (remaining limestone resource estimated at 640 Mt with approximately 438 Mt available for mining); and
- significant implications to Boral's business, the NSW economy and construction industry in general, as well as local employees and service providers.

Without the Project it is also unlikely that:

- Marulan South Road would be upgraded including widening, vertical alignment and pavement improvements and improvements to resident's driveways and bus pick up and turning areas;
- there would be the same level of knowledge gained about Aboriginal occupation in the area;
- the significant Cultural heritage site along Marulan Creek would have been identified;
- additional knowledge of historic mining practices at the site and life at Marulan South would be obtained; and
- the south pit would be backfilled to the extent proposed leaving the mine pit visible to views from Bungonia National Park and the Bungonia Lookdown in perpetuity.

Potential key local positive impacts of ceasing mining operations, rehabilitating disturbed areas and using the site for conservation purposes include:

- avoiding clearing approximately 182.4 ha of native vegetation and associated habitat, including 88.6 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, 132.4 ha of Koala habitat and 140.3 ha of Large-eared Pied Bat habitat;
- reduced dust and noise emissions from the site;
- reduced traffic on Marulan South Road, especially heavy vehicles;
- reduced erosion risk and therefore suspended solids in surface water runoff resulting in improved water quality in receiving water;
- avoiding disturbance or loss of Aboriginal heritage sites; and
- avoidance of various historic heritage items associated with previous mining operations.
- Although these may be positive impacts for the site and local area, unless the deficit in limestone based products left by the cessation of mining at Marulan South is met entirely by foreign imports, it is likely that this national limestone deficit would need to be met by starting new greenfield limestone mines elsewhere in NSW and Australia. It is unlikely that establishing a new greenfield limestone mine elsewhere with the same production capacity as the Marulan South Limestone Mine, would be economically viable due to the significant establishment costs in todays terms compared to importing clinker from overseas and would have any less environmental, social and economic impact. For example, starting a new greenfield limestone mine would require disturbing a substantial area to establish the pit, processing plants and associated infrastructure. Whereas these significant disturbances are already established at the mine. Also, the mine was started in 1869 and people moved to the area to work at the mine and established the previous Marulan South village just to service the mine. Therefore, it could be said that the mine is part of the fabric and culture of the Marulan South area.
- Also, importing all limestone or limestone based products from overseas may reduce environmental and social impacts at a local and possibly regional level but are likely to result in far greater environmental and social impacts at a global level as limestone and limestone products would most likely be imported from third world countries where planning, environmental and social regulations are far less onerous than in Australia.

5.2.2 Alternative - Mine Plan 1

The original mine plan (known as MP 1) was developed to target the eastern limestone and some of the Mt Frome limestone. MP 1 was developed on the understanding of the limestone geology extent (vertical and horizontal), configuration (angle of vertical dipping) and quality in 2014/2015 and achieved a limestone to overburden ratio of 1:>1. Earlier stakeholder consultation, technical studies and EIS preparation was based on MP 1 and the EIS prepared for MP 1 was due for lodgement with DP&E in mid 2016. This mine footprint had a similar impact to biodiversity compared to the current Project, in that a large amount of native vegetation (>120 hectares of native vegetation) would need to be cleared, including that of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, habitat for the Koala and Large-eared Pied Bat.

5.2.3 Mine Plan 2 – Preferred Project

Drilling undertaken in 2016 started to show that the extent and configuration of the various limestone bodies were different to the mines previous understanding. The results of the drilling were significant enough for Boral to cease the SSD process, commission further drilling and revisit the mine plan. Further drilling was completed in early 2017 which filled knowledge gaps, especially on the northern extent of the limestone bodies and a revised mine plan (known as MP 2) was developed. MP 2 achieved an overburden to limestone ratio of around 1:0.9 which results in a significant reduction from MP 1 in the amount of overburden that needs to be removed and emplaced to extract the same amount of limestone. MP 2 was therefore adopted as the preferred mine plan and is the Project described in this EIS, the impacts of which are detailed in section 6.

5.2.4 Mine Plan 3

With the far greater understanding of the extent and configuration of the limestone bodies from the extensive drilling program, during development of MP 2, Boral also investigated possibilities of focusing mining in the northern half of the pit and mining the limestone beneath much of the southern processing infrastructure (known as MP 3). This option required the relocation of significant existing infrastructure including the primary crusher, conveyors, transfers and the rail spur. This would also result in the northern edge of the pit being very close to the heart of the processing area and offices which may result in unacceptable blasting and vibration impacts. Preliminary calculations for this northern mine plan option only achieved a limestone to overburden ratio of 1:>1. Due to the significant capital costs of relocating and rebuilding infrastructure and the less than ideal overburden to limestone ratio, this option was not pursued further, and as such a biodiversity impact assessment was not investigated in significant detail. It was initially thought that MP 3 would significantly reduce out-of-pit overburden emplacements as much of the southern part of the pit could be used for in-pit overburden emplacement, however not only would this sterilise significant resource but development of the southern part of the north pit restricted backfilling of the south pit until later in the mine staging, resulting in substantial out-of-pit overburden emplacement, not dissimilar in size to those required under MP 1 and MP 2.

5.3 Alternatives to Project components

Boral considered various other options for pit development, overburden emplacement, mine water supply and reducing the disturbance footprint were considered during the mine planning process. As detailed below, many of these alternatives were ruled out due to economic and viability grounds.

5.3.1 Focus on eastern limestone and mining eastern batters and south pit rim

An option that was considered briefly during the mine planning process but dispelled quickly due to the enormity of its potential social, environmental and/or economic impact, involved focusing mining on the eastern limestone body and mining the eastern batters and southern pit rim. Although this may have achieved a better limestone to overburden ratio and targets the highest grade limestone body, it would require daylighting the pit to Barbers Creek gorge to the east and Bungonia Creek gorge to the south. Biodiversity impacts associated with this design include the following:

- Increased potential for sedimentation into Barbers Creek and Bungonia creek potentially impacting amphibian habitat downstream.
- Impacts to Bungonia Creek gorge, potentially impacting upon roosting habitat for Large-eared Pied Bat and Eastern Bentwing Bat.
- Disturbance would be in close proximity to Main Gully Spring Cave.
- Impacts to relatively benchmark condition vegetation that has not been impacted by historic grazing or clearing.

5.3.2 Establishing overburden emplacements outside of Boral's landholdings

Another option that was also considered during the mine planning process and also dispelled quickly due to the enormity of its potential social, environmental and/or economic impact involved purchasing extensive areas of privately owned land and establishing overburden emplacements outside of Boral's current landholdings. As the plateau lands to the west and far north-west of the mine support areas of native vegetation, Boral would have to approach owners of private land that is cleared of native vegetation. However much of this cleared land supports viable agricultural and other commercial businesses and even if some of these landowners were willing sellers, hauling overburden and creating over-burden emplacements to the west or far north-west would:

- consume substantially more land than the preferred Project as the overburden emplacements would likely have a larger disturbance footprint as they would need to be lower due to increased visibility from sensitive receivers, and buffer lands would also need to be purchased around the emplacements;
- result in significantly greater noise, air quality, visual and traffic impacts; and
- be economically unviable due to the significant land acquisition and overburden haulage costs.

5.3.3 Disposal of overburden off-site

Consideration was given to transporting all overburden from the mine to other disused mines and quarries and/or projects requiring substantial fill off-site. High level evaluation of this alternative estimates annual costs to transport overburden off-site to a void within 200 km of the mine would cost up to $75 M per annum or over $2 billion over the Project life. Not only will this render the cost of mining unviable, but off-site disposal of overburden is constrained by:

- The number of train paths allocated to Boral's Marulan South Operations along the Main Southern Railway. Up to six train paths per day are allocated to the mine and are used/reserved entirely for transporting limestone products. It is unlikely that Boral would be able to acquire the number of additional train paths required to also transport overburden from the mine by train;
- Capacity at the mine and on Boral's private rail line. Even if enough train paths could be acquired, there is not enough time each day to load and transport along Boral's private railway line, all the limestone product trains, Peppertree Quarry trains and an additional five overburden trains per day; and
- The availability of void space to backfill. With the number of major infrastructure projects in the Sydney region at the moment, which are forecasted to continue for some time, and the substantial tunnel boring projects forecast in the future that generate significant volumes of surplus material, there is and will continue to be significant competition for any available void space for spoiling overburden/fill material, especially near a railway line.

5.3.4 Mine water supply including Marulan Creek Dam

Boral considered numerous alternatives to meet the mines water demand which included:

- Damming water in the south pit. This was discounted as a viable alternative as:
    - the pit floor is porous and would have to be sealed;
    - the south pit would not be able to be used for overburden emplacement requiring additional out-of-pit emplacements which may result in further areas of biodiversity impact, and exposing

  - the entire mine pit to views from Bungonia National Park and in particular the Lookdown in perpetuity; and
  - The pumping head (vertical height that water would need to be pumped) is extreme.
- Establishing a groundwater extraction well (pumping bore) network to the north of the mine, between the mine and Peppertree Quarry. It was predicted that although it could potentially supplement it, an extraction well network would not produce sufficient water to meet the mine's water demand.
- Establishing an in-stream dam in Marulan Creek to the north of the mine. Constraints to the location of the dam included land ownership, and the steep, incised section of Marulan Creek to the east as it nears Barbers Creek gorge. The proposed Marulan Creek Dam was initially designed in the ideal location from both geotechnical and volume perspectives. However, the Aboriginal heritage assessment and consultation process identified a cultural site immediately below the preferred dam wall location and after consultation with relevant Aboriginal parties, the dam wall was redesigned and moved further upstream to entirely avoid and establish a buffer to the cultural site.

5.3.5 Steeper overburden emplacement batters & higher emplacements

In designing the overburden emplacements, consideration was given to steepening the emplacement batters to increase the height of the emplacements to hold the required volume of overburden while reducing the disturbance footprint. Geotechnical and other advice from soils, erosion and rehabilitation specialists advised against making the batters too steep as this would significantly increase the erosion, sedimentation and water quality risks associated with the Project and would reduce the likelihood of successful rehabilitation and establishing a long term stable vegetated landform.

5.4 Final footprint

Due to the justification provided above, Boral cannot reasonably avoid impacts to native biodiversity and as such need to mitigate the potential indirect impacts associated with the Project, and offset for all residual biodiversity impacts accordingly.

Mitigation measures to be undertaken by Boral have been detailed in section 6.3, and impacts requiring biodiversity offsetting have been detailed in section 6.8.

6. Impact Assessment

6.1 Impact Summary

The Project would affect biodiversity, including threatened biodiversity through both direct and indirect impacts during construction and operation. The majority of impacts on biodiversity would occur during construction from clearing of native vegetation and removal of habitat.

The direct and indirect impacts associated with Project and measures to offset and manage biodiversity in the long term are outlined in the following sections.

6.2 Direct Impacts

The following residual direct impacts would result from the Project:

- Clearing of native vegetation and associated habitat, conservatively estimated to be 182.4 ha.
- The area of clearing includes impacts to 88.6 ha of White Box Yellow Box Blakely’s Red Gum Grassy Woodland, which is listed as a TEC.
- Clearing of species credit fauna habitat for the following:
    - Koala habitat estimated to be 132.4 ha
    - Large-eared Pied Bat estimated to be 140.3 ha.
    - One individual of *Solanum celatum* (species polygon amounts to 0.1 ha)

A discussion of these direct impacts has been provided below.

6.2.1 Direct impact to native vegetation and habitat

The Project would result in the clearing of 182.4 ha of vegetation regarded as ‘native vegetation,’ as defined in the BAM. The majority of vegetation likely to be affected by the Project has been subject to historic logging, grazing, and other agricultural activities, and is therefore thinned in areas, and dominated in areas by Serrated Tussock. This is evident in all condition classes of PCT1334 Yellow Box - Blakely's Red Gum grassy woodland which has been subjected to grazing and clearing pressures.

Various portions of the site have also been planted with Acacia species and a number of eucalypts including *Eucalyptus tereticornis, E. amplifolia. E. melliodora* and *E. eugeniodes.*

In total, the area attributed in this assessment as a moderate condition class (canopy present) is 132.4 ha, and the area attributed to a poor/planted condition class is 50.0 ha. A further 70 ha is non-native vegetation and includes portions of the existing Mine pit, roads, etc.

6.2.2 Direct impact to White Box Yellow Box Blakely’s Red Gum Grassy Woodland

The Project would result in a direct impact to 88.6 ha of the TEC White Box Yellow Box Blakely's Red Gum Grassy Woodland. As discussed in section 3.2.5, the TEC has been attributed to three different condition classes that make up PCT1334 Yellow Box - Blakely's Red Gum grassy woodland.

The TEC is located within the areas proposed for the Northern Overburden Emplacement and Western Overburden Emplacement on the gentle slopes and relatively flat terrain.

The TEC to be impacted is in a modified state, due to previous land clearing, grazing, feral pest grazing, over abundant herbivore grazing, and due to the abundance and spread of Serrated Tussock. This is a common theme for the TEC, as throughout its range, the TEC has been reduced in area and highly fragmented because of clearance for cropping and grazing and pasture improvement due to the ecological community’s occurrence on fertile soils. Very few high quality remnants remain anywhere across its former range. The EPBC Policy Guidelines (DoE 2014) state that over 90% of the original extent of this ecological community has been cleared. This is supported by OEH (2014) who regarded the equivalent Biometric Vegetation Type to be 90% cleared, and Thomas et al. (2000) estimate that within South-Eastern NSW 59,468 ha remain from the pre-1750 extent of 1,012,052 ha (approximately 94% cleared).

The areas of the TEC within the Study Area are already fragmented by access roads, infrastructure and non-native vegetation (Figure 12). This is a common theme for the TEC which is already highly fragmented in the locality (Tozer et al. 2006 mapping of map unit 24 shown in Figure 9). The Project will lead to increased fragmentation of the ecological community in the local context through the combination of the emplacement areas, however connectivity will be retained within contiguous habitat around the periphery of the Study Area.

As the TEC is regarded as a Serious and Irreversible Impact (SAII) candidate entry under the BAM, further consideration of the impacts on the TEC have been provided in section 6.7.

An Assessment of Significance under the EPBC Act has also been completed for impacts on the TEC (Appendix 8). The Assessment concluded that a significant impact was likely, and thus triggering the need to offset the impacts under the EPBC Act (section 7).

6.2.3 Direct impact to Koala habitat

A discussed in section 4.6.2, the Koala is expected to use portions of the Study Area on a limited basis.

Impacts from the Project largely relate to the removal of foraging and dispersal habitat that has been defined as being critical to the survival of the Koala under the EPBC Act (DoE 2014; Appendix 7). Habitat mapped as good and moderate habitat potential, totalling 132.4 ha (Figure 16), contained either two or more known feed trees (listed as primary, secondary or tertiary species under the species Recovery Plan (DECC 2008)) or a single feed species that occupied more than 50% of a 400 m^2 floristic quadrat.

Such habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The proposal includes the removal of 132.4 ha of such habitat (good and moderate areas shown on Figure 16), which through application of the guidelines is considered a significant impact under the EPBC Act (see Appendix 8 MNES Assessments of Significance).

Due to the apparent limited use of the Study Area and its extremely small extent in relation to similar habitat for the Shoalhaven Gorge Koala population (7,500 ha), it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven Gorge) such that a decline would occur or that the population is placed at risk of extinction. Active sites for this population are concentrated within protected areas and the Study Area is not thought to provide a link between active areas within the population’s distribution or to any other Koala population.

As the Koala is regarded as a SAII candidate entry under the BAM, further consideration of the impacts on the Koala have been provided in section 6.7.

An Assessment of Significance under the EPBC Act has also been completed for impacts on the Koala (Appendix 8). The Assessment concluded that a significant impact was likely, and thus triggering the need to offset the impacts under the EPBC Act (section 7).

6.2.4 Direct impact to Large-eared Pied Bat habitat

As detailed in section 4.6.2, 140.3 ha of foraging habitat for the Large-eared Pied Bat would be impacted by the Project. No breeding habitat would be impacted by the Project.

The Large-eared Pied Bat is known to forage in a range of vegetation types, including dry and wet sclerophyll forest, grassy woodland, Callitris dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country (Hoye & Dwyer 1995; Pennay 2002; DECC 2007). Almost all records of the species are within several kilometres of cliff lines or rocky terrain, indicating that foraging habitat is limited to approximately 3 kilometres from clifflines. Foraging habitat is locally common given the species forages on a wide range of vegetation types, and given much of the land to the east of the Study Area which is centred along sandstone outcrops of Bungonia Creek and the Shoalhaven River are protected within Bungonia State Conservation Area, and Morton National Park. These areas provide well connected, intact remnant habitat for the Large-eared Pied Bat along Bungonia Creek and the Shoalhaven River. However it is noted that intact habitat (remnant undisturbed vegetation) within three kilometres of cliff lines and rock outcrops is scattered to the west and north of the Study Area compared to that of the east of Bungonia Creek and south in Bungonia Gorge.

Potential breeding habitat within Main Gully Spring Cave seems unlikely due to the cave being frequently inundated by water to act as a roost site. Regardless, the cave is located away from the Study Area and would not experience any impact associated with the Project. This is due to the distance of the subject cave from the Mine expansion activities that involve mining and blasting which is to occur over 900 m to the north. There has been an ongoing history of mining within the existing south pit throughout which any roosting bats would have persisted if present. The Project is not forecast to increase noise or vibration to the subject cave or any other known caves in the locality.

Foraging habitat is locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. Within a 10 km radius of the Project site it is estimated that 33, 837 ha of native vegetation exists within the locality of the Study Area.

The removal of the foraging habitat associated the Project is unlikely to be critical to the overall species survival or the local occurrence of the species given the protection of foraging habitat for the Large-eared Pied Bat within Bungonia State Conservation Area and Morton Nation Park that occurs within the locality. The removal of foraging habitat is not likely to reduce the population of the Large-eared Pied Bat given the protected habitat available. Whilst not in the immediate term, it is worth noting that the site would be rehabilitated following decommissioning to a woodland structure, thus providing foraging habitat for the Large-eared Pied Bat.

As the Large-eared Pied Bat is regarded as a SAII candidate entry under the BAM, further consideration of the impacts on the Large-eared Pied Bat have been provided in section 6.7.

An Assessment of Significance under the EPBC Act has also been completed for impacts on the Large-eared Pied Bat (Appendix 8). The Assessment concluded that a significant impact was unlikely to occur. A biodiversity offset under the EPBC Act is therefore not proposed for the impacts toward the Large-eared Pied Bat, however the species would be subsequently offset in accordance with the BAM to satisfy the BC Act offsetting requirement (section 7).

6.2.5 Direct impact to foraging habitat for the Eastern Bent-wing Bat

As discussed in section 4.6.3, no breeding habitat for the Eastern Bent-wing Bat occurs within the Study Area and as such, does not need to be considered further in a BDAR Assessment. However, the species was nominated in the SEARs for further consideration, and as such, we have expanded upon our findings toward the species in this section.

Like that of the Large-eared Pied Bat, 140.3 ha of habitat for the Eastern Bentwing Bat will be directly impacted by the Project. Foraging habitat in the locality is considered important for the Eastern Bent-wing Bat due to the large population dependant on the roost site known from the area (Drum Cave). While foraging habitat of the type to be removed is considered important for the species, such habitat is considered locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. Within a 5 km radius of the Project site it is estimated that 8713 ha of native vegetation exists within the locality of the Study Area. Whilst not a requirement of the BAM, a SAII for the Eastern Bentwing Bat has been completed in order to satisfy the requirement of the SEARs. The SAII has been provided in Appendix 6.

6.2.6 Direct impacts to EPBC Act listed fauna

As discussed above, the Project is likely to result in a significant impact to one EPBC Act listed fauna species: the Koala. Significant impacts to the Large-eared Pied Bat are considered unlikely.

As a precautionary and conservative approach, this assessment has also provided Assessments of Significance for impacts to threatened, migratory and relatively mobile EPBC Act listed fauna, which on occasion, may fly over the Study Area, or use it for foraging on an intermittent basis.

Assessments of Significance have been completed in Appendix 8 for the following EPBC Act listed threatened or migratory species: Fork-tailed Swift, Great Egret, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail and Grey-headed Flying Fox. The Assessments of Significance have concluded that a significant impact to these species is unlikely.

An Assessment of Significance was also completed for the Regent Honeyeater given the DoEE have regarded the site to be important habitat for the species. However the Assessment concluded that a significant impact for the species was unlikely due to the following:

- The species was not detected in the Study Area and surrounds during targeted survey
- The species has only been detected three times in the past 36 years within the Bungonia region that may suggest that the species potential usage of the Study Area is likely to be marginal/low.
- The closest historic records include the following:
    - Approximately 4.8 km south of the Study Area near Lockdown Road, Bungonia. This record was in made in 2005 within a gully environment near Bungonia Creek weir.
    - Approximately 5 km south of the Study Area near the Bungonia State Conservation Area office. This record was made in 1998.
    - Approximately 11.9 km south of the Study Area within private property. This record was made in 1983.
- The Project is unlikely to increase fragmentation for any population of the species.
- The species has potential habitat conserved within Morton National Park and Bungonia State Conservation Area, which occurs within the locality of the Project. Therefore the Project would not significantly limit the amount of potential habitat for the species within the immediate locality.

6.3 Managing indirect impacts

Indirect impacts will occur within and adjacent to the subject site (area of direct impact) as a result of Mine construction and operation. Such impacts will largely operate on a short to medium timeframe (i.e. the life of the Mine) and will be minimised where possible through management procedures. A range of indirect impacts are likely to, or could, occur as a result of the Project including:

- increased noise, dust and light from Mine construction and operational activities
- loss of connectivity and fragmentation of habitats at a regional scale through clearing of intact areas of native vegetation within the Study Area
- erosion or sedimentation in areas adjoining construction and operational activities
- increased spreading of weed propagules
- increased edge-effects for surrounding vegetated areas
- changes in vegetation composition and structure as well as available fauna habitats due to altered fire regimes (more or less frequent fire).

The indirect impacts described above are variable in terms of the distance they may extend from the actual subject site, and quantifying the exact distance is not possible.

To account for a quantitative measure of indirect impacts, a 100m buffer has been placed around the subject site. This buffer would likely encapsulate the potential spread of weeds, edge effects in surrounding vegetated areas, erosion, dust, intensive light spill, and sedimentation during construction and operation.

Quantifying the indirect impacts associated with noise, and vibration present difficulties, however, as discussed in Table 10, are unlikely to result in any significant impacts to biodiversity.

The specific indirect impacts and how they relate to the ecology of the Study Area, along with corresponding mitigation measures are discussed in detail in Table 10. The mitigation measures provided would be consistent with industry best practice to ensure that mitigation is effective. Monitoring of the effectiveness of the mitigation measures would be incorporated as part of the management actions associated with the Project.

In addition to this, due to buffer areas that have been incorporated into the subject site, some of the potential indirect impacts would be completely, or partially contained within the subject site detailed in this assessment. Within this assessment, informal buffers were applied to account for a range of geotechnical and logistical constraints, and to provide some flexibility to account for minor changes during Mine design. The general buffer distances adopted when developing the disturbance areas for the Project are detailed in Table 10.

Table 10. Indirect impacts and mitigation measures

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation	Mitigation measure	Expected success of mitigation measure
Edge effects	The establishment of the Project may create a number of new edges along all boundaries of the Study Area, in particular areas where there are no existing buffers (roads, existing emplacements, cleared area) between the disturbance and areas of woodland/native vegetation. Given edge effects are variable in terms of the distance they may extend from the actual subject site, it is difficult to provide a precise area of potential disturbance associated with the potential indirect impacts. This assessment has estimated that the edge effects may occur approximately 50 metres from the Study Area boundary, into woodland/native vegetation immediately adjacent. Areas in particular which may result in exposure to indirect impacts include bushland to the direct south of the in-pit part of the Southern Overburden Emplacement, and bushland to the west of the Western Overburden Emplacement. Isolated parcels of vegetation which occur in between the proposed emplacements and the Mine pit would also be exposed to edge effects. For the most part, these areas are already subject to weed invasion. The new edges could facilitate the establishment and spread of introduced plant species, however this would be managed accordingly.	Varying distance from subject site. Potentially occurring within 50 metres of disturbance area throughout the active life of the Project.	Demarcation fo the boundary of vegetation clearing at the edge of the Study Area where it occurs within 5 metres to native vegetation. Signposting will be used to inform Project personnel and site visitors of areas of conservation value to restrict entry or inform behaviour that will reduce incidental interactions with fauna. Weed management and pest management and monitoring to be implemented in Biodiversity Management Plan. Sedimentation management to be applied in areas that may result in runoff during construction and operation.	Active weed, and pest management are anticipated to be successful at managing edge effects from the Project.
Weeds	Weeds have the opportunity to establish themselves in areas of disturbed vegetation. The greatest establishment of weeds are in areas already disturbed or subject to agricultural land use. All areas exhibited varying condition and weed abundance. The greatest abundance occurs within the Western Overburden Emplacement, northern section of the Northern Overburden Emplacement and the surrounding land. The Project has the potential to increase or lead to the establishment of weed species where they do not currently exist through the operation of machinery during construction and operation. New weed species can potentially be introduced as a result of the movement of construction vehicles and materials into the Study Area. Areas more likely to be exposed to weed increases are areas of native vegetation that occur immediately adjacent to the Study Area, in particular areas to the east of the Study Area.	Variable depending on topography. However, typically would occur within close proximity to disturbance area.	Weed management and monitoring to be implemented in Biodiversity Management Plan. Weed management would be active in preventing the spread of weeds caused by construction and operation of the Project therefore preventing edge effects. At present Boral is undertaking aerial weed spraying to maximise weed control coverage.	Active weed control methods are likely to be successful in managing the spread of weeds within adjacent areas.
Erosion and sedimentation	Erosion of soils during construction and operation of the Project may involve the following:	Variable depending on	Adequate sediment controls applied where appropriate.	Sedimentation control is known to reduce sedimentation spills.

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation	Mitigation measure	Expected success of mitigation measure
	• Alteration of soil structure beneath infrastructure items, and roads (these have been taken into consideration within the Study Area calculations). • The increase of surface water flow from the Study Area during rain events into the woodland areas to the north and south may result in erosion. • The deposition of soil particulates in drainage lines and within remnant vegetation as a result of the Project is unlikely to be significant. Mitigation measures will be put in place during the construction and operation to limit the erosion and sedimentation caused by the Project. With the mitigation measures in place, it is likely that the potential for erosion and sedimentation would be contained within the subject site.	topography and operation.	Procedures for the management of spills throughout the Study Area including the requirements for vehicles to carry spill kits. Surface water flows were designed to follow natural drainage (Advisian 2018), therefore are unlikely to create new gullies/drainage channels. The change to bedrock flows into and out of the alluvium of Shoalhaven River is negligible and is expected to be undetectable (AGEC 2018). Sediment basins proposed to reduce sedimentation and flows. Details provided in the Project's specialist studies. The rehabilitated landforms will be designed to shed water without causing excessive erosion or increasing downstream pollution (LAMAC 2018).	Surface water flows have been designed to follow natural drainage.
Dust	Dust from the Project has been assessed by Todoroski Air Sciences (2018). In summary, the assessment predicts that there is a low potential for dust impacts to occur at the privately-owned residences surrounding the Mine with dispersion modelling predicting no exceedances of the various dust criteria that the assessment utilised. Whilst the assessment did not specifically assess the impacts to biodiversity related criteria, it is unlikely that dust from the Project would be extensively dispersed throughout the locality. It is likely that dust accumulation would occur immediately adjacent to the subject site. Research shows that the impacts of dust on vegetation can have negative impacts, however the impacts of increased levels of dust on animals are unknown (Farmer 1993). Farmer (1993) anticipated that dust may increase the susceptibility of plants and vegetation to secondary stresses, such as drought, insects and pathogens, or allow penetration of toxic metals or phytotoxic gaseous pollutants. Any potential impact from dust is likely to be localised and confined to the immediate vicinity of the subject site.	Variable depending on wind conditions. Potential for dust emissions likely throughout life of Mine.	Dust impacts will be mitigated through the onsite use of water suppression and the progressive rehabilitation of the subject site. Further, vegetation clearing protocols for the Project will seek to minimise exposed areas with the potential to generate dust by completing vegetation clearing as close to mining as practical.	Successful implementation of dust control would minimise dust. Current dust suppression mitigation works are on-going at the Mine

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation	Mitigation measure	Expected success of mitigation measure
Noise	Noise impacts have been occurring from the current operations since the Mine began. Such historic impacts have subjected fauna immediately surrounding the existing Mine to noise levels which may have deterred them from occupying areas immediately adjacent to the existing Mine footprint. Literature supports that noise can have impacts on fauna. For example, research has found that traffic noise can mask the important contact calls of the budgerigar, canary, and Zebra Finch, (Lohr et al. 1998). Parris and Schneider (2008) found that it was increased volumes of noise and not increased volumes of traffic that were important. Various studies have indicated that changes in bird calls in response to traffic noise are twofold, either the birds change the characteristics of their call to avoid interaction of the sound of the call with the created sounds or they limit calling to periods when the levels of noise are reduced. In terms of the Project, noise likely to be generated was assessed by Wilkinson and Murray (2018). Whilst the noise assessment did not address the impact of the Project noise upon fauna, the conclusions from the assessment were based on a comparison to human noise criteria. Conclusions include that the Project would not result in exceedance of noise criteria to humans during operation; no exceedance of relevant noise criteria for off-site traffic noise would occur. Given fauna have historically been exposed to noise impacts immediately surrounding the Study Area for many years (since 1869) due to the ongoing mining operations at the site, the Project is unlikely to result in any significant decline or edge effects toward fauna and their habitats within the locality.	Variable depending on wind conditions. Potential for noise impacts likely throughout life of Mine.	The Project would reduce noise by the following: ▪ A Noise Management Plan be developed and implemented throughout the life of the Project which will serve to further reduce the noise exposure at surrounding residences and to fauna occupying surrounding bushland. ▪ It is proposed that future operation of the Mine would incorporate an ongoing attended noise monitoring program, as required, throughout its operational life.	Details explored in Wilkinson and Murray (2018).
Vibration	Vibration from the blasting associated with the Project is unlikely to result in any impacts to the fauna habitat including the Karst systems and caves known to occur within the Locality, particularly in Bungonia Conservation Reserve and Bungonia National Park based on the following: ▪ Blasting is currently conducted within the existing Mine which occurs closer to the National Parks than where the proposed blasting would take place. ▪ No reported impacts from the current blasting are known to occur within the Karst systems or known caves.	Unlikely to occur outside of disturbance area, or immediately surrounding the area of the blast.	The Mine currently monitors its blasts. The Project would require this monitoring to continue. In the unlikely event that blasting impacts result in reported damage to Karst systems of caves within the Locality, such impacts should be reviewed.	Currently not an issue.

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation	Mitigation measure	Expected success of mitigation measure
	▪ It is considered unlikely that microbat roosting habitat within Main Gully Cave (detailed in section 4.6) would be impacted by the Project due to the distance of the subject cave from the Mine expansion activities that involve mining and blasting, which is to occur approximately 600 m north of the southern tip of the existing south pit (approximately 900 m from the identified cave). ▪ There has been an ongoing history of mining within the existing south pit throughout which any roosting bats would have persisted if present. The Project is not forecast to increase noise or vibration to the subject cave or any other known caves in the locality.			
Increased artificial lighting	As detailed in Richard Lamb & Associates (RLA 2018) three types of lighting are currently operating at the Mine: general and security lighting, lighting for safe mining activities and vehicle guidance lighting and headlights. Each of these lighting types would be required for the Project. The light from the existing Mine would continue with the Project resulting in localised effect of illuminating features adjacent to the vehicles particularly as they move (e.g. trees or rock faces), constant low intensity lighting as a result of security lighting around the existing facilities, and luminance as a result of the mining activities. Lighting may also be reflected off surfaces causing the illumination of secondary features such as fauna habitat. As detailed in RLA (2015), much of these impacts would be minimised through lighting design and directional lighting. Research and anecdotal evidence indicate potential for artificial lighting to influence the behaviour of both nocturnal and diurnal species. Influences of artificial night lighting on behaviour and community ecology are less well-recognised (Longcore and Rich 2004). The potential impacts of artificial lighting on any particular species and the severity will vary depending on the ecology of the species, the predator – prey relations, the distance of the core population from the source of light and the reaction of that species to light disturbance. In general, artificial lighting impacts on birds include the disruption of nesting sites or the altered choice of nesting sites, disruption of roosting, the altered timing of a dawn chorus and general disturbance.	Variable depending on the type of light source (e.g. vehicles, construction guidance lighting etc.). Details provided in RLA (2018).	RLA (2018) recommend that during the course of the Project a strategy relating to lighting be introduced to reduce lighting to the lowest level possible that also maintains an appropriate standard of safety and security and to minimise obtrusive lighting. Type 2 mobile lighting used for in-pit works would employ lamps that produce light in the red or yellow areas of the spectrum rather than the blue or white and be shrouded as much as possible to reduce lateral spread of the light and excess reflection of light, as well as being directed downward. A strategy is also required for control of the potential visibility of type 3 lighting associated with night time use of vehicles in the Project, specifically the potential for headlight or directional lighting during development or contouring of overburden emplacements at night, if that occurs. It is therefore recommended that for each new lift on the western and south-western	Mitigation measures likely to be successful at reducing light spill.

Indirect impact	**Likely impact from the Project**	**Potential extent of the indirect impact prior to mitigation**	**Mitigation measure**	**Expected success of mitigation measure**
	The impact of artificially lit nocturnal migratory birds is well documented (Longcore et al. 2008; Poot et al. 2008). Birds are known to become disoriented and entrapped by artificial lights. The disorientation of nocturnally migrating birds by lights results in either direct mortality or depletion of energy reserves (Poot et al. 2008). The lighting impacts has been occurring from the existing operations for many years. The current Project would likely result in a slight increase in the amount of light from the operations and during construction, however fauna of the immediate vicinity have been exposed to such impacts historically given the current Mine operation. Whilst it is indicated by research that potential impacts may arise from artificial light, given the history of lighting impacts in the Study Area, it is unlikely that the Project would result in any significant decline or edge effects toward fauna and their habitats within the locality.		edges of the Western Overburden Emplacement, or the northern margins of the Northern Overburden Emplacement, overburden emplacement should begin at the margins of the lift relative to potential view directions and then progress in rows behind the margin, providing a light barrier to vehicle headlights. Overburden emplacement work will also be carried out at night in the South Pit, where light spill will be increasingly controlled by the work being generally below view lines and also shielded by walls of the Pit. Some light will be visible at times, however because of the use of these areas being largely confined to daylight hours, it is considered that the above strategy would be successful in mitigating light spill of type 3 light from vehicles.	
Fire	Historically, arid zone bushfires tend to be associated with a proficient growth of native grasses following large rain events. During summer, following rain events, dry swards of grasses pose a bushfire hazard when placed near a source of ignition. Vehicles driven through long grass and hot exhaust may attribute to fire ignition. This may occur during construction and operation of the Project particularly during the hotter months.	Potential to be widespread in locality, though unlikely.	The Bushfire Management Plan will incorporate bushfire management protocols to prevent and deal with the potential for bushfire.	Given the existing Mine operations have not resulted in any significant fires, the implementation of the Bushfire Management Plan would likely assist in fire prevention.

6.4 Biodiversity Management Plan

A Biodiversity Management Plan (BMP) would be prepared to inform and manage various activities throughout the life of the Project in order to protect and manage important biodiversity values. Key commitments to be covered by the BMP include threatened species management, pest and weed management, native vegetation clearing protocols, fauna handling and site hygiene practices.

The BMP will include specific protocols dealing with any potential interaction between the Project activities and threatened flora or fauna species during the life of the Project. The BMP will include directions for survey, monitoring and management of key threatened species known or considered to be potentially impacted by the Project and protocols for reporting and managing any unforeseen threatened species occurrences within the Project site. Measures designed to mitigate impacts on threatened species would be monitored for success.

Impacts arising from activities associated with the 30 year Mine plan will primarily relate to vegetation clearing. Boral proposes to undertake the following mitigation and management actions during development of the 30 year Mine plan.

Key components of the BMP would include details in relation to the following:

Fencing and signposting

Fencing and/or the use of highly visible rope or tape boundaries or alternative effective markings e.g. 2m high timber posts with brightly coloured tops will be used to delineate the boundary of vegetation clearing at the edge of the Study Area where mining activities occur within 5 metres of native vegetation.

Signposting will be used to inform Project personnel and site visitors of areas of conservation value to restrict entry or inform behaviour that will reduce incidental interactions with threatened species - e.g. speed limits along access roads to reduce potential for fauna vehicle strikes.

Employee Education and General Environmental Controls

Employees and contractors would be educated on and required to implement the following controls, to avoid or at least minimise potential environmental impacts associated with the construction of the Project:

- minimise dust generation by minimising the extent and time that bare soil is exposed and by appropriate dust suppression
- procedures for the management of hydrocarbon and/or chemical spills throughout the Study Area including the requirements for vehicles to carry spill kits
- ensuring vehicles remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process and in on-going Project discussions
- management and removal of all rubbish from the Study Area.

Vegetation Clearance Protocol

A vegetation clearing protocol would be provided in the BMP. The vegetation clearing protocol would include the following:

- Prior to clearing of grassland, a survey will be conducted for ground dwelling fauna and to remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed.
- Prior to clearing of remnant hollow-bearing trees, suitably qualified personnel are to be engaged to supervise felling. All hollow-bearing trees that are accessible safely from the ground are to be checked

and identified fauna relocated. Hollows higher up and not accessible from the ground are to be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate.

- Any fauna displaced during clearing are to be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so).
- In an event that fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service (WIRES) will be contacted to handle and collect fauna for appropriate care and rehabilitation.

Pest and weed management

The BMP would include a section relating to pest and weed management activities of the Project and will include:

- Management protocols for feral animals such as foxes, goats, rabbits and cats within the rehabilitation areas.
- Management protocols for the identification of noxious or important environmental weeds within areas to be cleared (in order to avoid transporting weeds to rehabilitation areas or other parts of the site).

6.4.1 Rehabilitation

The disturbance area would be progressively rehabilitated in accordance with a Rehabilitation Management Plan which will be developed following approval. The rehabilition will create a stable landform that does not result in sediment laden runoff or fugitive dust emissions, blends well with the adjacent natural landscapes of the Morton National Park and Bungonia State Conservation area and re-establishes a native bushland dominated by White Box Yellow Box Blakely’s Red Gum Grassy Woodland species, which outcompetes invasive weed species.

The Rehabilitation Management Plan will need to include biodiversity management measures associated with the Project in order to protect and manage important biodiversity values. Currently, the Marulan South Limestone Mine Continued Operations Project – Soil, Land Resources and Rehabilitation Assessment (LAMAC 2018) discusses key commitments relating to threatened species management, pest and weed management, fire management and site hygiene practices.

6.4.2 Fire management

Boral currently have a Bushfire Management Plan (Boral 2015) which is part of the Mine emergency procedures for their Mine Operations. Fire prevention and suppression are detailed within the Plan including emergency protocols should a fire occur. This Plan would be updated to reflect the Project following approval.

6.5 Cumulative impacts

Cumulative impacts are the successive, incremental and combined impacts (both positive and negative) of an activity on the environment (Franks et al., 2010). They can arise from the compounding activities of a single operation given the interaction of that operation with past, current and future activities that may or may not be related to the existing development. Cumulative impacts may also arise through the interaction of one development with other types of activities and industries, such as grazing and broad scale agriculture.

In relation to the Project, the cumulative impacts are considered to be the total impact on the environment that would result from the Project plus any additional impacts likely to occur due to subsequent projects that are of a similar nature or that are partly or wholly contingent on the Project. Identifiable cumulative impacts to be considered in the locality include current and future operations by Holcim Lynwood Quarry approximately 10 km to the north, and Gunlake Quarry approximately 15km to the north of the Mine.

At a regional scale, the Project site occurs within the Tablelands landscape of the Southern Rivers Bioregion of which approximately 44 % is occupied by the Goulburn Mulwaree LGA (ELA 2007). Agriculture is the main land use within the LGA which makes up 56% of the total area. Clearing has occurred predominately in the more fertile lands and along riparian zones. This is consistent with the Project with grazing land occurring along the proposed Marulan Creek Dam proposed Marulan Creek Dam Inundation Area and Western Overburden Emplacement. Only a small portion of the LGA (8%) is part of formal reserves and the remaining native vegetation represents only a small proportion of the pre-European vegetation. The main threat to remaining vegetation and to important ecosystem functions carried out by riparian zones and wetlands has been attributed to further clearing associated with agricultural practises and rural residential development in agricultural areas (ELA 2007), rather than Mine associated clearing or impacts.

Whilst the Project will result in degradation to native vegetation within the Southern Rivers Bioregion, the Project will also involve an offset that will contribute to in-perpetuity managed conservation areas within the Bioregion. This will contribute to objectives within the CMA's catchment action plan (Southern Rivers CMA 2013); within the Southern Rivers Bioregion it is proposed that an increase of 11,000 hectares to at least 41,000 hectares of land managed for conservation is to be achieved.

6.6 National Parks and Conservation Areas within the Locality

6.6.1 Bungonia National Park and State Conservation Reserve

Bungonia National Park (770 ha) occurs approximately 250 m to the south of the Study area, and the Bungonia State Conservation Reserve (3,285 ha) extends from the National Park's southern and western boundaries (Figure 1). Collectively, the reserves cover an area from the gorges of Jerrara and Bungonia Creeks southwards along the western side of the Shoalhaven River gorge to Paradise Creek. The State Conservation Area lies adjacent to the very large natural area of Morton National Park. These conservation areas are important as they contain a wide range of karst features including dolines, blind valleys, springs, tufa deposits, solution forms, a slot canyon and over 175 cave entrances. A variety of speleothems (cave formations) occur in the caves including stalactites, stalagmites, helictites, flowstone, pool formations and cave coral. The reserves also support a variety of threatened species including an active Koala population.

Potential issues raised in DECCW (2010) Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water, in relation to Bungonia National Park and Bungonia State Conservation Reserve have been addressed in Table 11. In summary, the Project is unlikely to result in any impacts to the conservation areas due to the following:

- No vegetation clearing will take place within the Bungonia National Park or State Conservation Area as a result of the Project. The nearest vegetation clearing would occur approximately 300 m north of the National Park boundary, which is separated from the conservation areas by a gorge, and bushland. Given the distance from the Study Area, edge effects associated with vegetation clearing as documented in section 6.2.1 are not expected to affect the National Park or State Conservation Reserve.
- It is also unlikely that the Project would increase vibrations or noise to the extent that the Karst features of the conservation areas (including known and potential bat roosts) would be impacted. The proposed Study Area is further away from such features than where existing blasting currently takes place within the southern end of the South Pit. No known damages have been reported from the existing activity toward karst systems within the National Park. Significant impacts to groundwater quality are not expected and are not anticipated to impact karst systems.

- The Project's surface water flows would eventually flow into Bungonia Creek which occurs directly to the north of the conservation areas. The Advisian (2018) Surface Water Assessment for the Project predicts no change in the catchment areas draining to Bungonia Creek as this area currently drains into the pit void. As such, no significant impacts to fauna habitat along the proposed route into Bungonia Creek are likely to occur.
- Similarly, Advisian (2018) predicts that post-mining the flow regime in Main Gully is predicted to be comparable to pre-mining conditions, and to be improved significantly from current conditions in which a large proportion of the catchment drains to the South Pit.
- Advisian (2018) also predicts changes in flow regime as a result of the Project are not expected to have a significant adverse impact on Tangarang Creek or the tributaries that receive runoff from the overburden emplacements.
- The Koala population known to occur within the Bungonia National Park and State Conservation Area are unlikely to be impacted by the proposed removal of potential habitat within the Study Area, given the availability of habitat with the conservation areas and surrounding environment.

6.6.2 Morton National Park

Morton National Park is located 750 m – 2 km east of the Mine on the eastern side of Barbers Creek. The current reserved area is 199,690 ha. The National Park is known to contain a variety of threatened biodiversity; of particular relevance to this assessment are *Solanum celatum, Pomaderris cotoneaster* and the Koala.

As per the above assessment for Bungonia National and the Bungonia State Conservation Area, the potential issues raised in DECCW (2010) Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water, in relation to Morton National Park have been addressed in Table 11. The conclusions were similar to those listed above, with the Project unlikely to result in any impacts to the conservation areas due to the following:

- No vegetation clearing will take place within Morton National Park. The nearest vegetation clearing would be approximately 750 m west of the National Park boundary, which is separated from the subject site by Barber's Creek and bushland. Given the distance from the Study area, edge effects associated with vegetation clearing as documented in section 6.2.1 are not expected to affect the National Park.
- The Project's surface water flows would eventually flow into Bungonia Creek which occurs directly to the north of the conservation areas. The Advisian (2018) Surface Water Assessment for the Project predicts no change in the catchment areas draining to Bungonia Creek as this area currently drains into the pit void. As such, no significant impacts to fauna habitat along the proposed route into Bungonia Creek are likely to occur. As such, no corresponding impact to fauna habitat which adjoin the National Park is anticipated.
- Similarly, Advisian (2018) predicts that post-mining the flow regime in Main Gully is predicted to be comparable to pre-mining conditions, and to be improved significantly from current conditions in which a large proportion of the catchment drains to the South Pit.
- Advisian (2018) also predicts changes in flow regime as a result of the Project are not expected to have a significant adverse impact on Tangarang Creek or the tributaries that receive runoff from the overburden emplacements.
- The Koala population known to occur within the Morton National Park is unlikely to be impacted by the proposed removal of potential habitat within the Study Area, given the availability of habitat within the National Park and surrounding environment.
- The populations of *Solanum celatum* and *Pomaderris cotoneaster* known to occur within the National Park would not be impacted by the Project.

Table 11. Issues raised in DECCW (2010) in relation to Bungonia National Park and State Conservation Reserve and Morton National Park

Issue	Risk identified in DECCW (2010)	Potential impact from Project on Bungonia National Park, State Conservation Reserve and Morton National Park?
Erosion and sediment control	Removal of vegetation and disturbance of groundcover from construction activities will expose the soil and increase the risk of erosion. Eroded sediments, including those from soil stockpiles, may be transported downstream or down slope and deposited on vegetation and in creeks, rivers, wetlands and other aquatic habitats. Changes to the hydrology of streams outside the reserve system, including from activities on land that may not immediately adjoin reserves, can impact on land managed by OEH by: • increasing the intensity and frequency of flows as a result of clearing vegetation • increasing the area of impermeable surfaces.	Unlikely due to the following: • The stormwater management and sediment and erosion control system has been designed to relevant standards to prevent erosion or sedimentation within the National Parks and Conservation Reserve as a result of the Project. These erosion and sedimentation control measures would be implemented prior to works commencing and maintained for the duration of mining related activities, and until the site has been rehabilitated. • Surface water flows would follow the natural flow regime to prevent the formation of unnatural gullies and drainage channels. • Areas of vegetation to be retained would be demarcated as no-go zones during Mine development and operation to prevent unauthorised access. • Disturbed areas would be rehabilitated and appropriately stabilised as soon as possible.
Stormwater runoff – Nutrient levels are minimised, and stormwater flow regimes and patterns mimic natural levels before reaching OEH land.	The discharge of stormwater to OEH land poses a threat to the values of land and downstream environments by: • dispersing litter and pest species (especially weeds) • altering nutrient composition and pollutant levels, which can damage native vegetation and aquatic ecosystems, reduce water recreation safety and promote weed growth • causing potential erosion and sedimentation in watercourses, particularly where new developments have led to an increased volume and concentration of flow.	Unlikely due to the following: • The stormwater management and sediment and erosion control system has been designed to relevant standards to trap sediment and other pollutants, preventing the discharge of poor quality water from the site that could impact negatively on water quality of receiving waters. • Waste generated by the site operations will be appropriately managed in accordance with industry standards and a protocols provided in the BMP to prevent litter being dispersed off site through stormwater runoff and wind. • All hazardous substances e.g. hydraulic oils, fuels and chemicals (including herbicides) will be stored in accordance with relevant industry standards to prevent contamination of soils and surface water runoff. • The Project's surface water flows would eventually flow into Bungonia Creek which occurs directly to the north of the conservation areas. The Advisian (2018) Surface Water

		Assessment for the Project predicts no change in the catchment areas draining to Bungonia Creek as this area currently drains into the pit void. As such, no significant impacts to fauna habitat along the proposed route into Bungonia Creek are likely to occur. • Similarly, Advisian (2018) predicts that post-mining the flow regime in Main Gully is predicted to be comparable to pre-mining conditions, and to be improved significantly from current conditions in which a large proportion of the catchment drains to the South Pit. • Advisian (2018) also predicts changes in flow regime as a result of the Project are not expected to have a significant adverse impact on Tangarang Creek or the tributaries that receive runoff from the overburden emplacements. • Given the proposed surface water flows follow the natural hydrology of the landscape and the increase in flow would only result in a localised change to the current state of the drainage line, no significant impacts to fauna habitat along the existing creeks are likely to occur. As such, no corresponding impact to fauna habitat which adjoin the conservation areas are anticipated.
Wastewater/sewage	Not relevant to assessment	Effluent from the office and workshop facilities is treated by a licenced on-site wastewater treatment system. Treated effluent is disposed of by irrigation onto a designated effluent irrigation area. The “machine shop”/primary crusher septic tank is inspected and pumped out weekly by an accredited waste disposal contractor. The “Fettler’s shed” and “Club” units are serviced by adsorption trenches. No new on-site wastewater management systems are proposed as part of the Project. .
Management implications relating to pests, weeds and edge effects	Development adjoining OEH land has the potential to significantly affect the operation or management of OEH land, resulting in damage to conservation values and cost implications for future management. Development may result in: • increased informal and inappropriate access (such as by trail-bike riders) • increase in invasive species and decline in biodiversity and ecosystem health (such as dieback)	Unlikely due to the following: • Site layout is proposed within the existing Mine site. Most of the development occurs to the west of the Mine and thus away from the National Parks and Conservation Areas. • Pest management protocols would be included in the BMP and would be implemented as part of the Project. • A buffer of over 350 m at the closest point occurs between the proposed vegetation clearing and the Bungonia National park and State Conservation Reserve.

	• impacts on areas of particular environmental sensitivity, including Aboriginal and historic heritage sites, watercourses and threatened species habitat • disturbance and predation by domestic pets or stock animals. Clearing of vegetation (including aquatic vegetation) along or near the boundary of OEH land can lead to edge effects such as: • increased drying of soils and consequent changes to vegetation at the land boundary • decline in fauna that are sensitive to changes in vegetation along newly created edges • increased predation in the vicinity of the OEH land boundary associated with aggressive species in open situations (such as nest predation by ravens and currawongs).	• A buffer of over 750 m at the closest point occurs between the proposed vegetation clearing and the Morton National Park. • Weed management protocols would be included in the BMP. Buffer currently exists between the Study Area and the conservation areas. • Unlikely to result in a decline in fauna within the conservation areas as a result of the Project.
Fire and the location of asset protection zones All asset protection measures are within the development area, and there is no expectation for OEH to change its fire management regime for the land it manages.	OEH recognises fire as a natural and recurring factor which shapes the environment. However, it also acknowledges that altered fire regimes may pose a significant threat to life, property and other values including biodiversity, cultural heritage and tourism, and that the onset of climate change may exacerbate these risks. Fire management is one of the most important tasks in managing protected areas.	Unlikely. The Mine has a Bushfire Management Plan in place which will be revised if necessary on approval of the Project. All mining activities associated with the proposed continuation of operations at the stie for the next 30 years do not involve activities closer to the Bungonia State Conservatuon area or the Mornton National Park. Thefore, the continued operations at the Mine will not require a change to the bushfire management approach implemented by OEH in the neighbouring conservation lands. The Bushfire Management Plan would provide a strategy to manage bushfires within the confines of Boral Landholdings and not rely on the management actions of OEH within the conservation areas.
Boundary encroachments and access through OEH land. No pre-construction, construction or post-construction activity occurs on land managed by OEH.	OEH land is not to be used: • to access development sites • to store materials, equipment, workers' vehicles or machinery • for maintenance access after development. Unauthorised access to OEH land can have direct physical impacts on the conservation values of parks, such as those due to the removal of vegetation, erosion and soil disturbance. If such access continues or other encroachments occur (such as the construction of buildings, car-parks or roads), this can have long-term implications affecting park	No impacts likely based on the following: • No access for construction is required to occur within the National Parks or Conservation Reserve. • Any access for environmental monitoring (e.g. water quality sampling in Bungonia Creek, Barbers Creek and the Shoalhaven River) would be arranged with relevant OEH and NPWS officers. • No construction would take place within the Reserves. • The Project would not lead to an increase in encroachment and unauthorised access through the National Park or conservation reserve.

	planning, park management (for example fire protection) and public use and enjoyment.	
Visual, odour, noise, vibration, air quality and amenity impacts.	These impacts may particularly affect native fauna (for example, noise, vibration and lighting may disrupt foraging and breeding habits).	A Biodiversity Management Plan would be developed detailing measures that would be taken to minimise indirect impacts, including mitigation measures discussed in section 6.3.
Threats to ecological connectivity	The above issue may result in a decrease in connectivity within the OEH land.	The Study Area does not directly adjoin the National Parks and Conservation Reserve. The impacted areas would be rehabilitated post works, so connectivity values would be re-established.

6.7 Serious and irreversible impacts

As detailed in section 10.2 of the BAM, the determination of serious and irreversible impacts (SAII) on biodiversity values is to be made by the consent authority in accordance with the principles set out in the BC Regulation. To assist the consent authority, the guidance document titled 'Guidance to assist a decision-maker to determine a serious and irreversible impact' includes criteria that enable the application of the four principles set out in clause 6.7 of the BC Regulation to identify the species and ecological communities that are likely to be the subject of serious and irreversible impacts. All potential SAII entities that would be impacted by the proposed development need to address the SAII criteria which would assist the consent authority with the review of impact to SAII.

Threatened species which have potential to experience a SAII as a result of the Project include impacts to:

- White Box Yellow Box Blakely's Red Gum Woodland TEC
- Koala habitat and
- Large-eared Pied Bat habitat.

SAII assessment criteria have also been completed for the Eastern Bentwing Bat, given the species was nominated in the SEARs as requiring further consideration.

The SAII assessment criteria in relation to White Box Yellow Box Blakely's Red Gum Woodland TEC, Koala habitat, Large-eared Pied Bat habitat and Eastern Bentwing Bat habitat has been provided in Appendix 6.

6.8 Quantifying offset requirements

The BAM identifies the BAM Calculator as the appropriate tool for quantifying the offsets required in both Ecosystem Credit and Species Credit terms. A calculation of the nature and extent of offset credits required due to biodiversity impacts associated with the Project has been undertaken using the BAM Calculator.

6.8.1 Summary of ecosystem credits required

The ecosystem credits to be retired for the Project, as determined by the Biodiversity Credit Calculator, are shown in Table 12. The Biodiversity Credit Calculator outputs have been provided in Appendix 7.

Table 12 : Ecosystem credit requirements

Vegetation zone no.	Plant Community Type (PCT)	Vegetation formation	Vegetation class	Condition identifier input used in calculator	Vegetation Integrity Loss	Total (ha)	Credits required	Total credits required
1	PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	Grassy Woodlands	Southern Tableland Grassy Woodlands	Medium	40.4	48.8	985	1466
2				Poor	23.7	31.9	378	
3				Acacia	26.1	7.9	103	
4	PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	Dry Sclerophyll Forests (Shrub/grass subformation)	Central Gorge Dry Sclerophyll Forests	Medium	45.6	57.9	990	1042
5				Poor	18.3	7.5	52	
6	PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open	Dry Sclerophyll Forests		Medium	454	13.7	233	260

Vegetation zone no.	Plant Community Type (PCT)	Vegetation formation	Vegetation class	Condition identifier input used in calculator	Vegetation Integrity Loss	Total (ha)	Credits required	Total credits required
7	forest on ridges, north east South Eastern Highlands Bioregion (SR624)	(Shrubby sub-formation)	South East Dry Sclerophyll Forests	Poor	27.2	2.6	27	
8	731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524)	Grassy Woodlands	Southern Tableland Grassy Woodlands	Medium	540	12.0	325	325
9	PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) – Best fit equivalent based on surrounding land use and previous Tozer et al. (2006) mapping	Grassy Woodlands	Southern Tableland Grassy Woodlands	Non EEC_water dependent	0	0.1	0	0
10	Non-native	-	-			70.0	0	0
	Total					252.4	3,093	3,093

6.8.2 Summary of species credits required

Offsets required for species credit species are shown in Table 13. Species credits are required for the *Solanum celatum,* Koala and Large-eared Pied Bat.

Table 13: Species credit species requirements

Species Credit Species	Cleared habitat area (ha)		Required credits	Total
Solanum celatum	778_Medium	45.6	2	2
Koala - (*Phascolarctos cinereus*)	731_medium	54.1	325	2941
	778_medium	45.6	1320	
	1150_medium	45.4	311	
	1334_medium	40.4	985	
Large-eared Pied Bat - (*Chalinolobus dwyeri*)	731_Medium	54.1	12	4567
	778_Medium	45.6	57.9	
	1150_Medium	45.4	13.7	
	1334_Acacia_plantings	26.1	7.9	
	1334_Medium	40.4	48.8	

7. Offset strategy

Under the BAM, an offset strategy is not required to be submitted with the BDAR, as the credits are to be formally retired with the establishment of a Biodiversity Stewardship Site, or payment into the Biodiversity Conservation Trust (BCT) Fund. However, as noted in the DoEE Supplementary SEARs, a biodiversity offset strategy is required to be included in the Biodiversity Assessment.

7.1 One offset package to satisfy the NSW and EPBC Offset Requirements

Under the BAM, the biodiversity offsets must provide benefits to biodiversity to compensate for the adverse impacts of an action. Biodiversity offsets assist in achieving long-term conservation outcomes while providing development proponents with the ability to undertake actions that have unavoidable impacts on biodiversity.

Unavoidable impacts to biodiversity are those impacts that are residual (i.e. impacts that remain after impact avoidance, management and mitigation measures are employed to reduce the type or magnitude of biodiversity impacts). Section 5.1 of this report outlines the design changes that Boral has implemented through the feasibility and pre-feasibility stages of the Project. Section 6.3 to Section 6.4.2 of this report outline the management and mitigation actions that Boral will employ to further reduce direct and indirect impacts to biodiversity values as a result of this Project.

This section of the report describes the approach to biodiversity offsetting proposed for the Project in accordance with the BAM and Commonwealth offsetting requirements.

Based on the results of the MNES Assessments of Significance contained in this report, the Project would result in a significant impact to White Box Yellow Box Blakely’s Red Gum Grassy Woodland and the Koala. As such, the biodiversity offset proposed would satisfy both the State and Commonwealth offsetting requirement for both threatened entities.

7.2 Proposed offset strategy

Boral propose to offset the Project using two properties, which would be established as Stewardship Sites under the BAM to provide in-perpetuity protection and management of biodiversity values. The properties are listed in Table 14 and detailed below.

Table 14. Offset liability properties

Offset liability	Area of impact	Credits required	Stewardship Sites		Percentage of offset liability met		BCT Payment fund – option for State offset requirement
			Property 1 – Boral owned (BCT Case No. 0001191)	Property 2 – Private owned (BCT Case No. 00011444, 00011437, 00011449, 00011453)	NSW offset liability	Commonwealth liability	
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) – associated TEC as listed under the BC Act and EPBC Act.	88.6	1466	-	>1500 credits	100%	100%	Not proposed however is an option for State offset liability, however cannot be used for Commonwealth.
PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	65.4	1042	>2000 credits	-	100%	N/A	Not proposed however is an option for State offset liability
PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)	16.3	260	>300 credits	-	100%	N/A	Not proposed however is an option for State offset liability
731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524)	12.0	325	-	-	100%	N/A	Yes – option for State offset liability.
Solanum celatum	0.1	2	-	-	100%	N/A	Yes – option for State offset liability.
Koala	132.4	2941	936 ha habitat Approx 2000 credits	-	68%	100% - as the area of habitat exceeds that required per EPBC Act policy calculator	Yes – payment into the fund proposed for remaining 32% credits
Large-eared Pied Bat	140.3	4567	936 ha habitat Approx 2500 credits	-	55%	100% - as the area of habitat exceeds that required per EPBC Act policy calculator	Yes – payment into the fund proposed for remaining 45% credits

7.2.1 Property 1 (Boral owned) – Biodiversity Credit Case No. 0001191

Boral has purchased a 1,000 hectare property within the Bungonia subregion for the purposes of offsetting for the current Project. The details of the property have been withheld from this assessment for confidentiality reasons, however can be provided in a separate report to the Departments should it be required.

To date, Niche have completed field surveys on the property in accordance with the BAM, and fauna surveys (spotlighting and anabat recording) to determine the presence of Koala and Large-eared Pied Bat.

The field surveys confirmed the presence of a Koala population on the site (four individuals recorded), and Large-eared Pied Bat foraging habitat (captured using anabat devices located in all habitat types of the property).

The area of both Koala and Large-eared Pied Bat habitat available on the site that would be managed in perpetuity is approximately 936 hectares. In particular, management would focus on feral animal control given the presence of feral dogs throughout the area.

The Biodiversity values at the site would satisfy the following biodiversity offset liabilities:

- PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)
- The EPBC Act offset requirement for the Koala and Large-eared Pied Bat as 936 hectares of habitat would be retained which meets that of the EPBC Act Policty Calculator.
- Partial offset for the State credits offset liability for the Koala and Large-eared Pied Bat, with residual credit requirements to be paid into the BCT Fund or market.

To date, reporting and Biodiversity credit calculations have been completed, which will be submitted to the BCT for review.

7.2.2 Property 2 (private owned) - Biodiversity Credit Case No. 00011444, 00011437, 00011449, 00011453

In order to satisfy the offset liability for PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) and subsequent EPBC listed White Box Yellow Box Blakely's Red Gum Grassy Woodland, Boral have negotiated the security of credits within a 360 hectare property containing the TEC. The property would contain four separate stewardship sites given the subdivision of the land. Four Biodiversity Stewardship Site applications has been submitted to the BCT for this site (Case no. 00011444, 00011437, 00011449, 00011453) which is currently being reviewed by the BCT.

Through the retirement of credits at the site, the offset liability for the Project would be met for both the State and Commonwealth TEC requirement as the site meets 100% of the Commonwealth offset liability using the EPBC Act Policy Calculator.

7.2.3 BCT Payment Fund

Boral may consider payment into the BCT Payment Fund for any residual State offsetting requirements associated with the Koala and Large-eared Pied Bat that are not generated at the Boral owned offset site. Boral may also pay into the BCT Payment Fund for impacts to non-threatened PCTs.

8. Conclusion

This report provides a BDAR in accordance with the BAM in order to address the potential impacts associated with the Project.

The Project will result in the disturbance of 182.4 ha of native vegetation, of which all has been historically cleared for logging, or grazed. Indirect impacts may include dust, noise, erosion and sedimentation which will be mitigated by measures provided in section 5.1 of this report.

During the field survey one TEC - White Box Yellow Box Blakely’s Red Gum Woodland was found to occur within the Study Area. Three condition classes were attributed to the TEC to assist with offsetting the impacts. The Project will result in disturbance to approximately 88.6 ha of the TEC listed under the BC Act and EPBC Act of with the majority of the vegetation comprised of highly degraded condition classes and assisted regeneration areas comprising of planted tubestock among native pasture. An offset for the impact on this TEC has been proposed as per the requirements of the BAM. This TEC would be offset according to the requirements of the BAM.

A further 93.8 ha of native vegetation would also be offset in accordance with the BAM.

One threatened flora – *Solanum celatum* was recorded within the Study Area and would be removed by the Project. No other threatened flora are likely to be present given the lack of habitat and absence of threatened flora during the field survey.

Twenty-six threatened and migratory fauna are considered to be affected by the Project. Most of these species are likely to utilise the foraging habitat of the Study Area on an intermittent basis. No further assessment of impact is required for the ecosystem credit species based on the requirements of the BAM and the offsetting of the associated PCTs Ecosystem Credit Species under the BAM which do not require further assessment of impact as they would be offset with their associated PCTs.

The Koala and Large-eared Pied Bat are the only listed Species Credit Species which require an offset for the Project given their detection within, or adjacent to the Study Area.

Those threatened fauna species which are listed under the EPBC Act that were attributed a moderate to high likelihood of occurrence within the Study Area include: Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Large-eared Pied Bat, and Grey-headed Flying Fox. An EPBC Act Assessment of Significance for each of these species has been completed and concluded that a significant impact to the Koala was possible. A significant impact on the remaining EPBC Act listed threatened fauna was determined to be unlikely.

Mitigation measures associated with indirect impacts have been proposed, will be included in various management plans that will be prepared and/or updated on approval of the Project and will be implemented on site during construction and operations associated with the contunation of mining over the next 30 years.

The BAM identifies the Biodiversity Credit Calculator as the appropriate tool for quantifying the precise nature of the offsets required in both ecosystem and species credit terms.

The ecosystem credits required to offset the Project equate to the following:

- Total of 1,466 credits for PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)
- Total of 1,042 credits for PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)

- Total of 260 credits for PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (SR624)
- Total of 325 credits for PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (SR524).

The species credits required for the Project include:

- A total of 2,941 credits for the removal of 132.4 hectares of Koala habitat
- A total of 4,567 credits for the removal of 140.3 hectares of Large-eared Pied Bat habitat.
- A total of 2 credits for the removal of 0.1 ha of Solanum celatum (based on a buffer of 30 metres around the one individual recorded as per the requirements of the BAM).

An offset strategy has been discussed in section 6. Boral propose to offset the Project using a range of offsetting mechanisms.

References

Advisian (2018) Marulan South Limestone Mine Continued Operations Surface Water Assessment, Prepared for Boral Cement Limited – October 2018.

Allen, C. (2002). Distribution Surveys, Habitat Assessment and Management Recommendations for the Koala (Phascolarctos cinereus) in the Shoalhaven Gorge Region of NSW. Unpublished report on behalf of NSW NPWS.

Bauer, J. & Bauer, P. (1998). Under Bungonia. JB Books, Oak Flats, N.S.W.

Benson, D. & L. McDougall (1996). Ecology of Sydney plant species Part 4: Dicotyledon family Fabaceae. Cunninghamia. 4(4):553-756. Sydney: Royal Botanic Gardens.

Boral Cement Limited (2015) Marulan South Limestone Mine and Peppertree Quarry Bushfire Management Plan)

Bureau of Meteorology Commonwealth of Australia 2015. Marulan South weather observations http://www.bom.gov.au/climate/averages/tables/cw_049002.shtml.

Department of Environment http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66633 Access February 2018.

Department Environment and Conservation (2004). Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Working Draft. NSW Department of Environment and Conservation.

Department Environment and Conservation (2007). Threatened Species assessment guidelines – the assessment of significance. NSW Department of Environment and Conservation.

Department Environment and Conservation (2008). Recovery plan for the Koala (*Phascolarctos cinereus*). NSW Department of Environment and Conservation.

Department of Primary Industries http://www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what-current Accessed February 2015.

Department of the Environment (2014). EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory). Commonwealth of Australia, 2014.

Department of Environment (undated). EPBC Act Policy Statement White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Grassland.

Department of Environment, Climate Change and Water (NSW) (2009). National Recovery Plan for Pomaderris cotoneaster (*Cotoneaster ulrushes*), Department of Environment, Climate Change and Water (NSW), Hurstville.

Department of Environment, Climate Change and Water (NSW) (2009). Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians.

Department of Environment, Climate Change and Water (NSW) (2010). Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water.

Department of Environment, Climate Change and Water (NSW) (2010). Draft National Recovery Plan for White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Department of Environment, Climate Change and Water NSW, Sydney.

Department of Environment, Climate Change and Water (NSW) (2011). National Recovery Plan for White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Department of Environment, Climate Change and Water NSW, Sydney.

Department of Sustainability Environment Water Population and Communities, (2012). Environment Protection and Biodiversity Conservation Act. Environmental Offsets Policy. Commonwealth Department of the Sustainability Environment, Water, Population and Communities. February 2018.

ELA (2007). Goulburn Mulwaree Biodiversity Strategy Volume 1. Report prepared for Goulburn Mulwaree Council.

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and development of Version 5.1 – Summary Report. Environment Australia, Canberra.

Farmer, A.M (1993). The effects on dust on vegetation – a review, Environmental Pollution, 79, 63-75.

Daniel M. Franks , David Brereton & Chris J. Moran (2010) Managing the cumulative impacts of coal mining on regional communities and environments in Australia, Impact Assessment and Project Appraisal, 28:4, 299-312

Harden, G.J. (ed) (1990). Flora of New South Wales Volume 1. Royal Botanic Gardens and New South Wales University, Sydney.

Harden, G.J. (ed) (1992). Flora of New South Wales Volume 3. Royal Botanic Gardens and New South Wales University, Sydney

Harden, G.J. (ed) (1993). Flora of New South Wales. Volume 4. Royal Botanic Gardens and New South Wales University, Sydney.

Harden, G.J. (ed) (2002). Flora of New South Wales. Volume 2. Revised Edition. Royal Botanic Gardens and New South Wales University, Sydney.

Harden, G.J. & Murray, L.J. (eds) (2000). Supplement to Flora of New South Wales. Volume 1. Royal Botanic Gardens and New South Wales University, Sydney.

Hoye G.A. and Dwyer P.D. (1995). Large-eared pied bat *Chalinolobus dwyeri*. Pp. 510-511 in R. Strahan (Ed.) The Mammals of Australia. Reed Books, Chatswood, NSW.

LAMAC Management (2015). Marulan South Limestone Continued Operations Soil, Land Resources and Rehabilitation Assessment, September 2015 – Prepared for Boral Resources NSW.

Lamb (2015). Marulan South Limestone Continued Operations, Visual Impact Assessment Prepared for Boral Resource NSW.

Law and Chidel (2004). Summer counts of the Large Bent-wing Bat at Drum Cave, Bungonia – 2003-2004. Unpublished Report – Research & Development Division State Forests of New South Wales.

Lohr, B., Dooling, R.J., (1998). Detection of changes in timbre and harmonicity in complex harmonic stimuli by zebra finches (*Taeniopygia guttata*) and budgerigars (*Melopsittacus undulatus*). J. Comp. Psychol. 112, 36–47.

Longcore, T., and C. Rich. (2004). Ecological light pollution. Frontiers in Ecology and the Environment 2(4):191–198.

Longcore, T., Aubrecht, C., C. D. Elvidge, D. Ziskin, and C. Rich. (2008). “When the lights stay on” – A novel approach to assessing human impact on the environment. Earthzine.

Niche (2014). Marulan limestone Mine Biodiversity feasibility assessment, Prepared for Element Environment and Boral Cement May 2014.

Niche (2018a). Marulan South Project aquatic assessment for the Environmental Impact Statement. Unpublished report prepared for Boral Cement Ltd. April 2015.

Niche (2018b). Marulan South Project stygofauna and groundwater depend ecosystem assessment for the Environmental Impact Statement. Unpublished report prepared for Boral Cement Ltd. April 2015.

OEH (undated). White Box Yellow Box Blakely’s Red Gum Woodland (White Box Yellow Box Blakely’s Red Gum Woodland) Action Statement. Available online at http://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?ProfileID=10837. Accessed 23 February 2018.

OEH (2011). BioMetric Vegetation Types Database.

http://www.environment.nsw.gov.au/resources/nature/BioMetric_Vegetation_Type_CMA.xls.

OEH (2012a). NSW Threatened Species Information. http://www.environment.nsw.gov.au/threatenedspecies/. NSW Office of Environment and Heritage.

OEH Threatened Species Profiles (2018). Threatened Species Profiles http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx.

OEH (2014a). Framework for Biodiversity Assessment; NSW Biodiversity Offsets Policy for Major Projects. State of NSW and Office of Environment and Heritage.

OEH (2014b). PCT Biometric Vegetation Types Database

OEH (2014). Letter from the OEH Chief Executive to the Director of Planning, Land and Community – NSW Mining dated 19 December 2014 regarding the application of the NSW Biodiversity Offsets Policy for Major Projects – clarification of the mechanisms for securing an offset site available to major projects approved after 1 October 2014.

OEH (2016). Threatened flora survey guidelines. State of NSW and Office of Environment and Heritage.

OEH (2017). Biodiversity Assessment Method. Published by Office of Environment and Heritage for the NSW Government. Dated 25 August 2017.

Office of the Commissioner for Sustainability and the Environment (2004). http://reports.envcomm.act.gov.au/SoE2004/GoulburnMulwaree/landuse.htm.

Pennay, M. (2002). “Large Pied Bat *Chalinolobs dwyeri*”. Brigalow Belt South Stage 2 Vertebrate Fauna Survey, Analysis and Modelling Projects. Appendix 2 pages 38 -39. Resource and Conservation Division, Planning NSW, Sydney.

Pennay, M. (2008). A maternity roost of the Large-eared Pied Bat *Chalinolobus dwyeri* (Ryan) (Microchiroptera: Vespertilionidae) in central New South Wales Australia. Australian Zoologist. 34:564-569.

Parris, K. M., and A. Schneider. (2008). Impacts of traffic noise and traffic volume on birds of roadside habitats. Ecology and Society 14(1): 29. [online] URL: http://www.ecologyandsociety.org/vol14/iss1/art29/.

Poot, H., B. J. Ens, H. de Vries, M. A. H. Donners, M. R. Wernand, and J. M. Marquenie. (2008). Green light for nocturnally migrating birds. Ecology and Society 13(2): 47.

Scientific Committee NSW (2002). White box yellow box Blakely’s red gum woodland – endangered ecological community listing NSW Scientific Committee – final determination

Southern Rivers Catchment Management Authority (2013). Catchment Action Plan 2013 – 2023. State of NSW. Available online: http://www.southeastlandcare.org.au/wp-content/uploads/2013/07/CAP-2023-final-version-WEB.pdf . Accessed February 2018.

State Environmental Planning Policy No. 44 – Koala Habitat Protection.

Thomas, V., Gellie, N. & Harrison, T. (2000). Forest ecosystem classification and mapping for the Southern CRA region, Volume II Appendices. NSW National Parks & Wildlife Service, Southern Directorate. A report undertaken for the NSW CRA/RFA Steering Committee.

Todoroski Air Sciences Pty Ltd (2015). Marulan South Limestone Mine Open Cut Mine Extension Project Air Quality Impact Assessment, Prepared for Boral Resources.

Tozer MG, Turner K, Simpson C, Keith DA, Beukers P, Tindall D, Pennay C (2006). Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0. (Department of Environment and Conservation and Department of Natural Resources: Sydney).

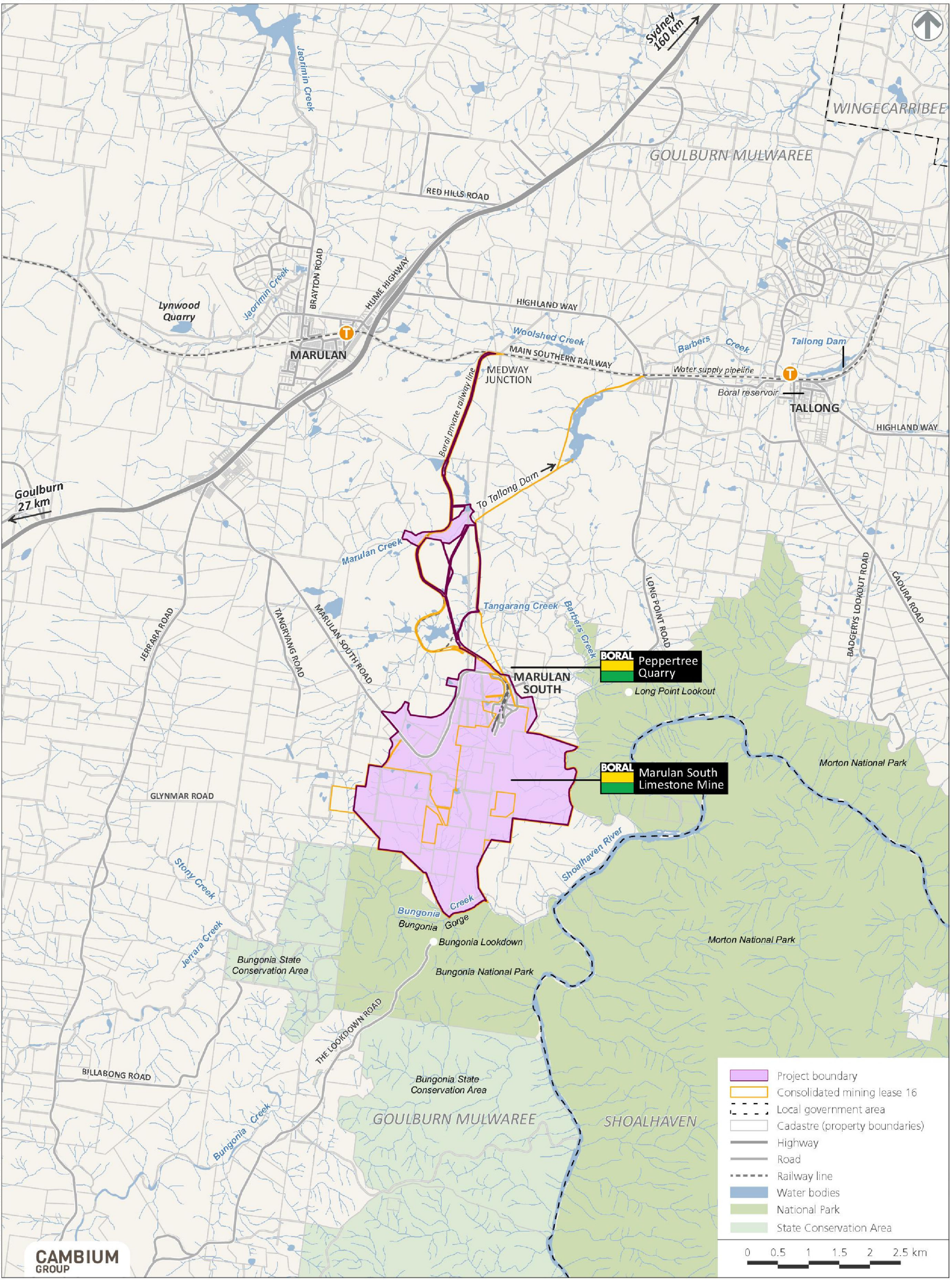
Wilkinson and Murray (2015). Marulan South Limestone Mine Open Cut Mine Extension Project Noise and Blasting Assessment, Prepared for Boral Resources.

Figures

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

Regional context

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



DISCLAIMER
Cambium Group Pty Ltd disclaims all liability for all claims, expenses, losses, damages, and costs any person/company may incur as a result of their/its reliance on the accuracy or completeness of this document or its capability to achieve any purpose. © Cambium Group Pty Ltd 2018

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

031140_EIS_180820_v05

Regional context

Marulan South Limestone Mine Continued Operations

FIGURE 1

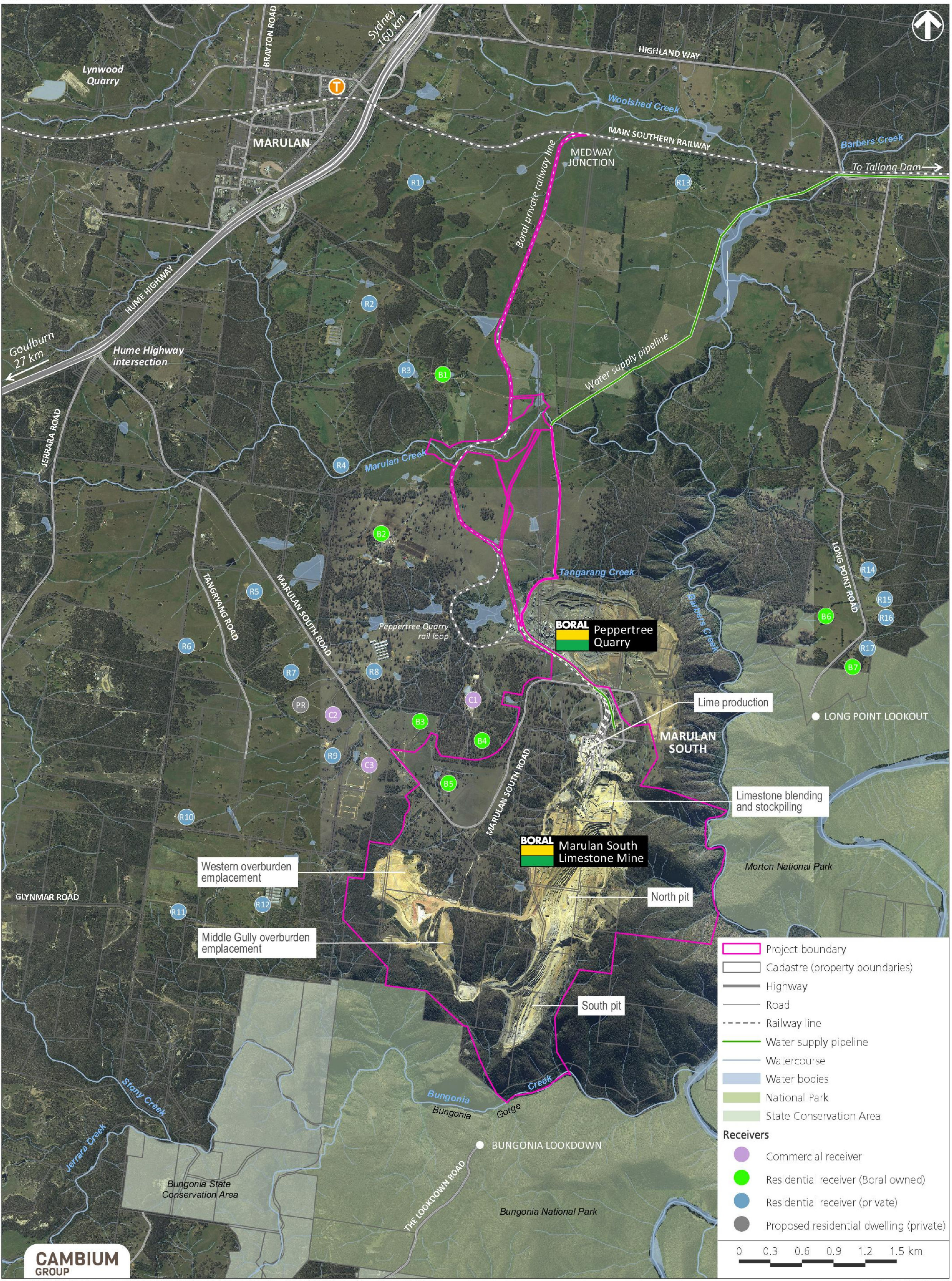
niche
Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_1_element.mxd

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

Local context

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



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

031140_EIS_180830_v05

Local context

Marulan South Limestone Mine Continued Operations

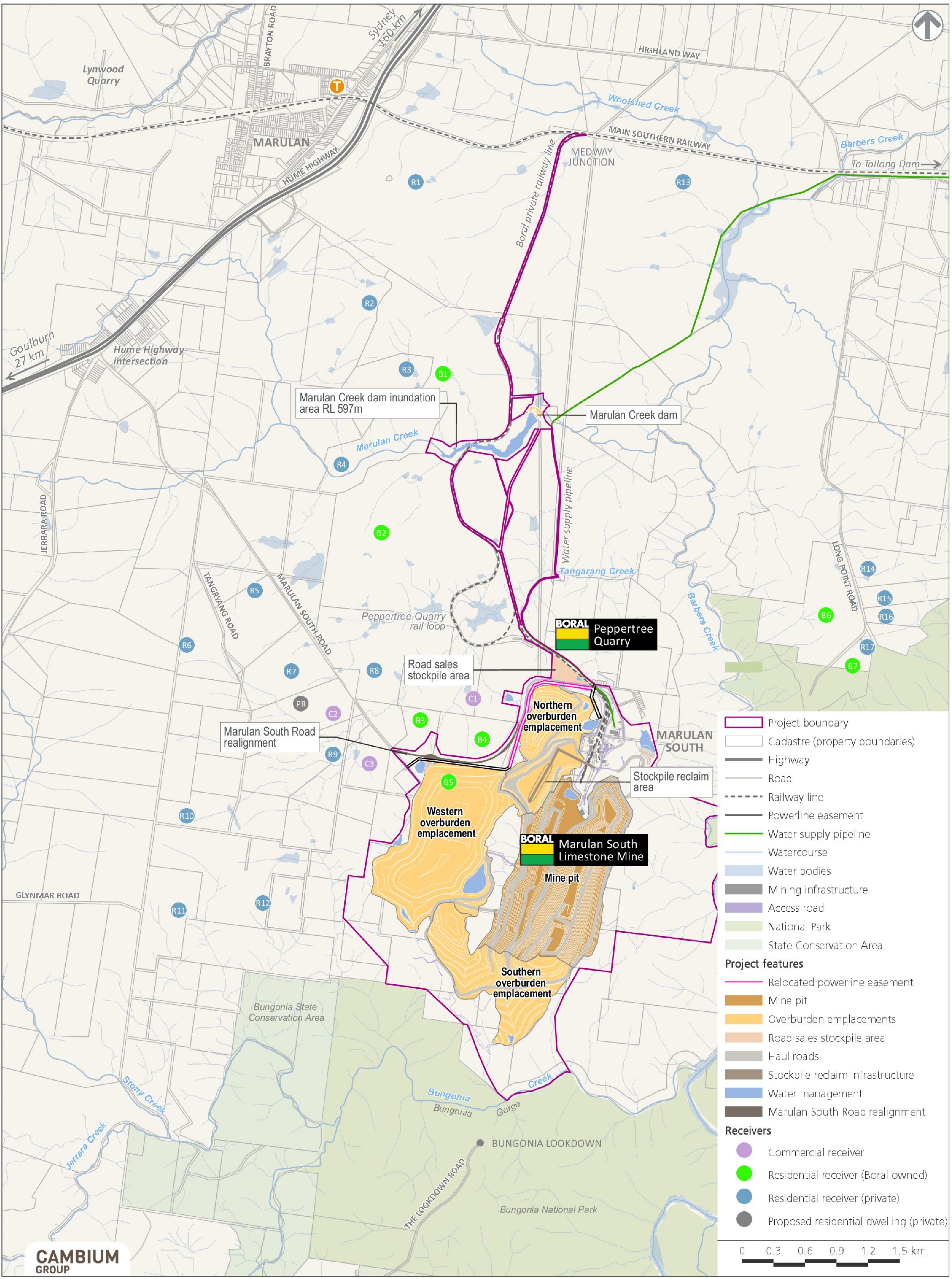
FIGURE 2

Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_2_element.mxd

Figure
The Project

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



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

031140_EIS_180831_v05

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

The Project

Marulan South Limestone Mine Continued Operations

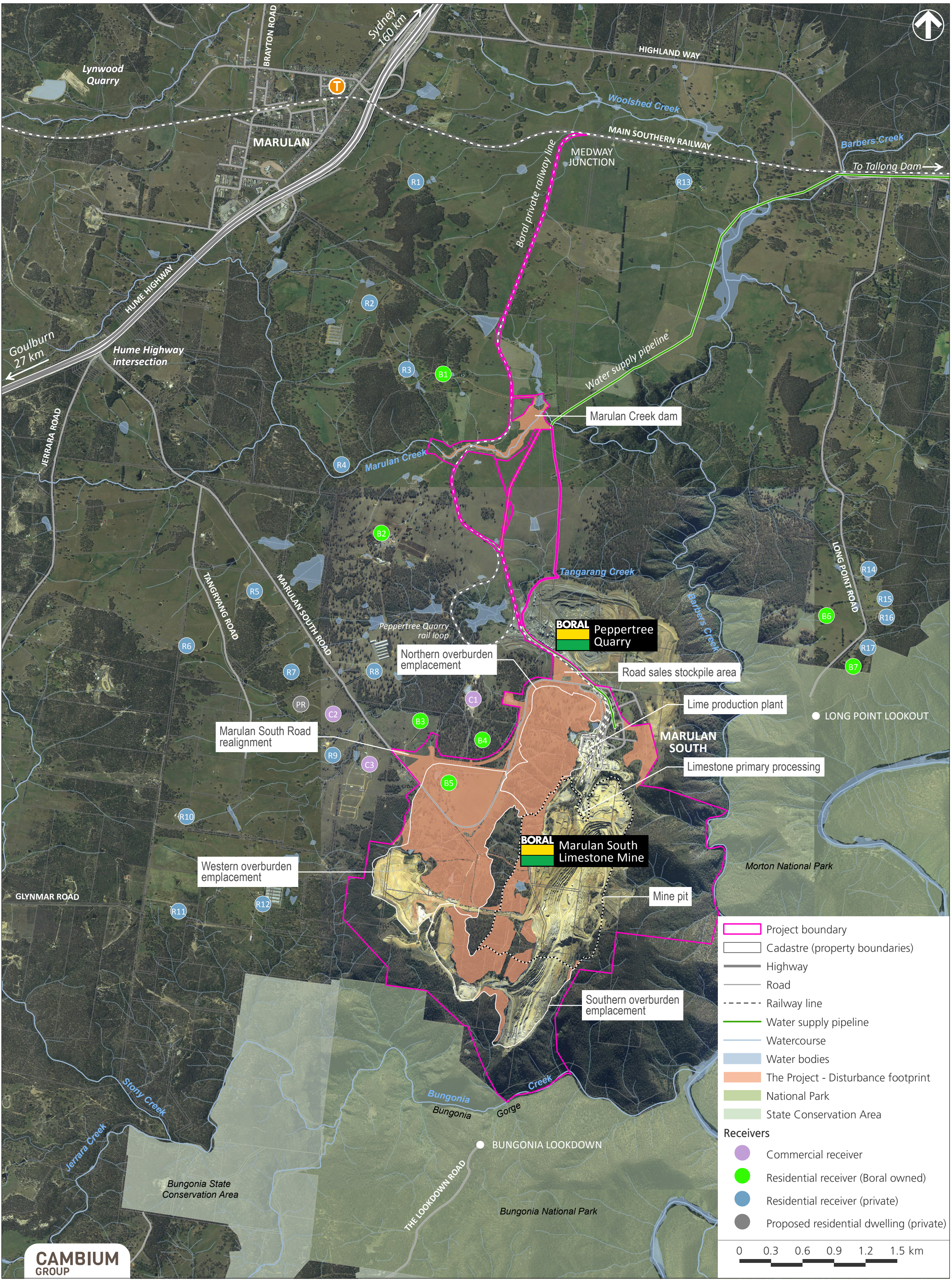
FIGURE 3

niche
Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_3a_element.mxd

The Project - Disturbance footprint

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



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

031040_EIS_180830_v04

The Project Disturbance Footprint

Marulan South Limestone Mine Continued Operations

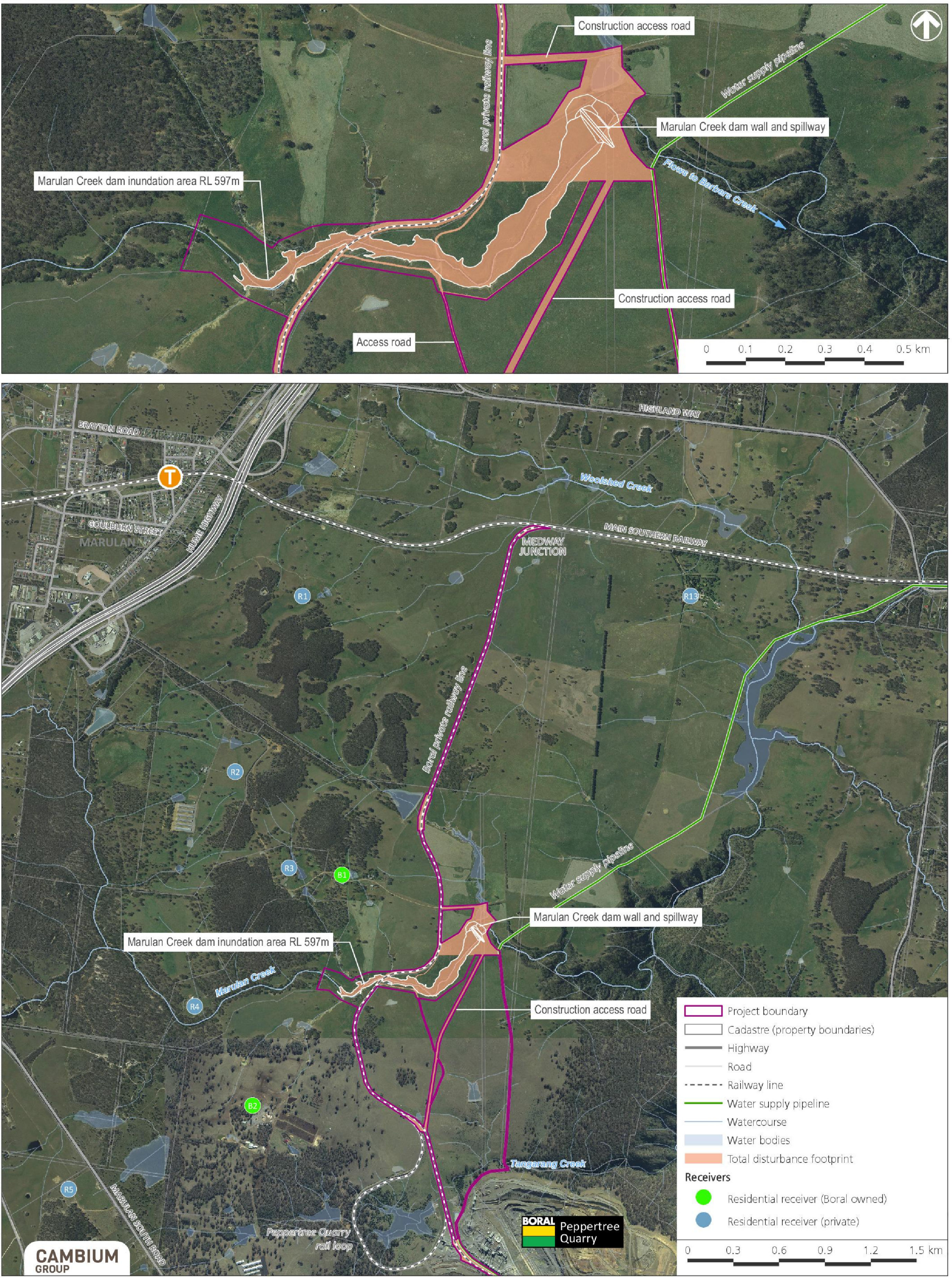
FIGURE 4

niche Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_3b_element.mxd

Marulan Creek Dam - Disturbance footprint

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



DISCLAIMER
Cambium Group Pty Ltd disclaims all liability for all claims, expenses, losses, damages, and costs any person/company may incur as a result of their/its reliance on the accuracy or completeness of this document or its capability to achieve any purpose. © Cambium Group Pty Ltd 2018

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

031140_EIS_180830_v03

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

Marulan Creek Dam - Disturbance footprint

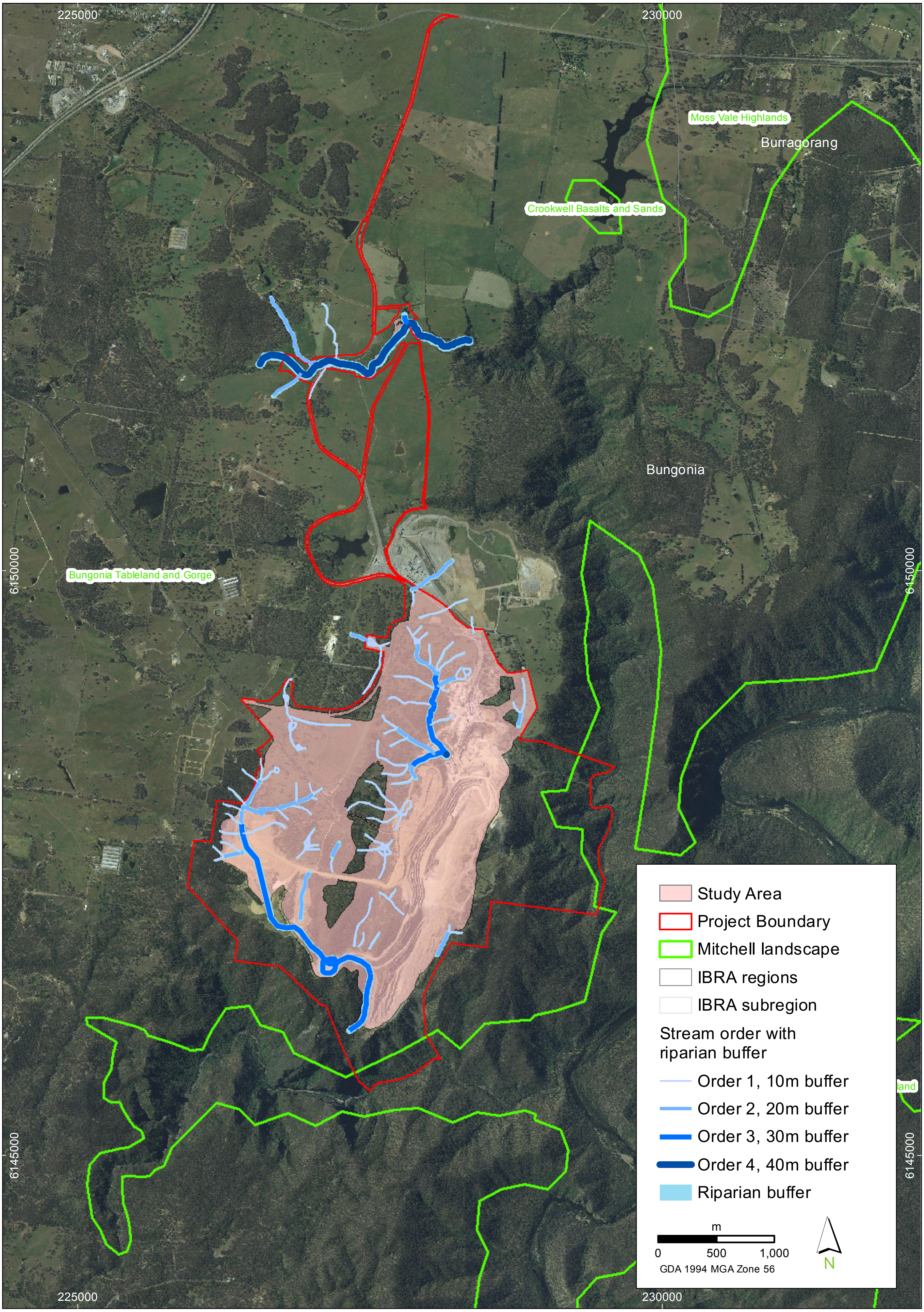
Marulan South Limestone Mine Continued Operations

FIGURE 5

niche
Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_4_element.mxd

Drawn by: PR Project Manager: LB Project Number: 2155 Date: 02/10/2018 T:\SpatialWorking\LB\2155\BDAR Figures\2155_Figure_5_sitemap.mxd

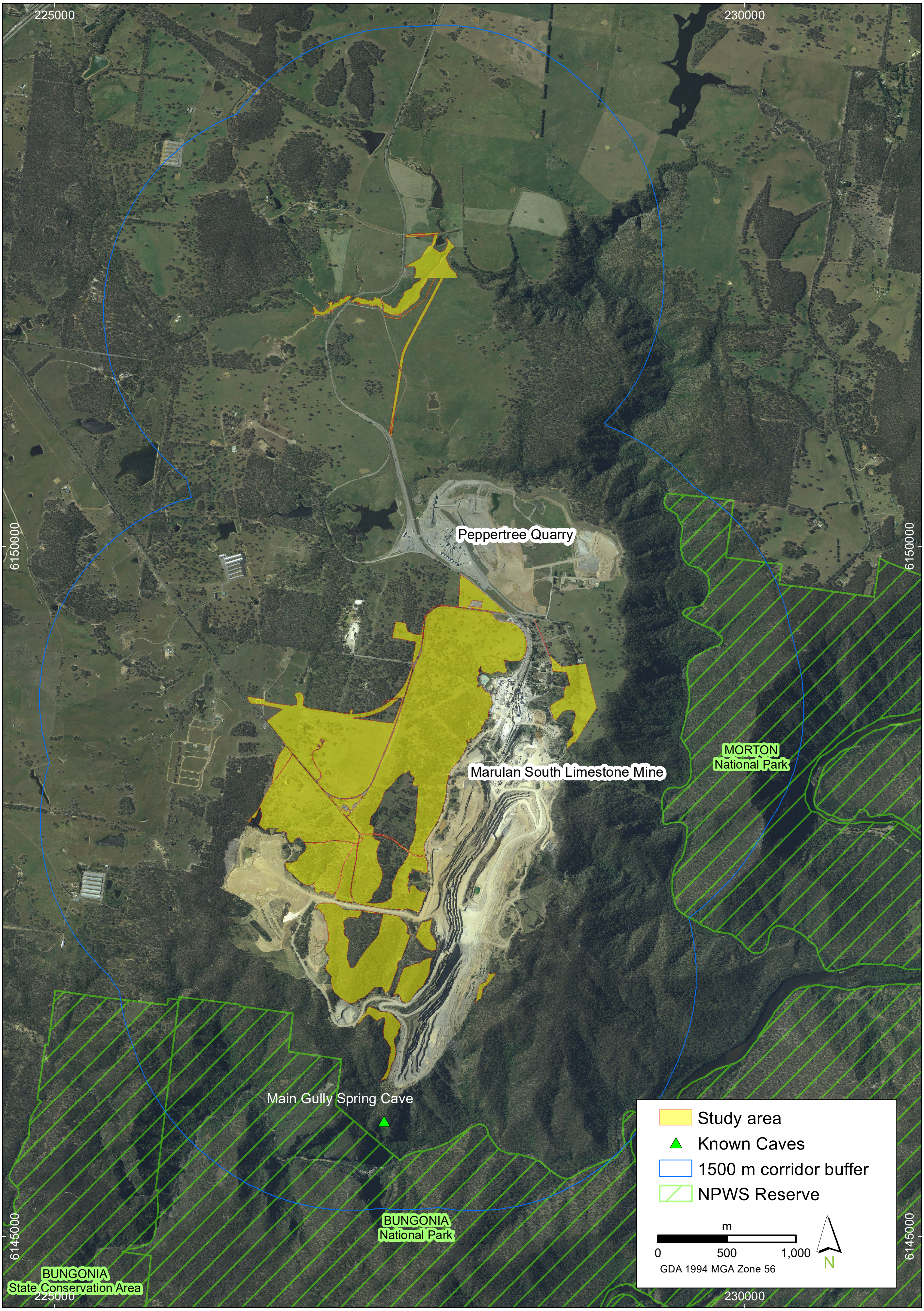


Site map of Marulan South Project

Marulan South Limestone Mine Continued Operations

niche
Environment and Heritage

FIGURE 6



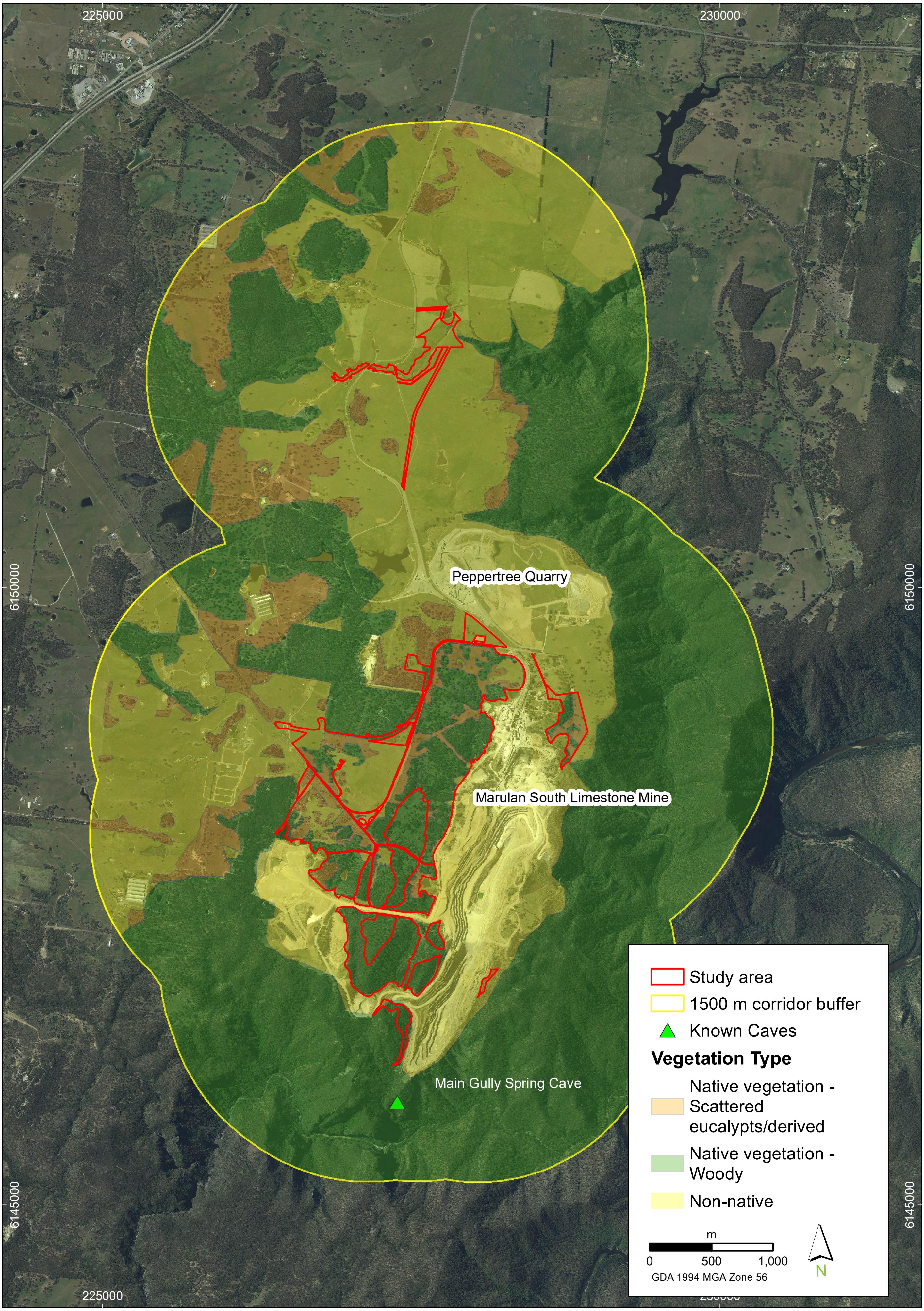
Drawn by: PR Project Manager: LB Project Number: 3577 Date: 11/7/2018 T:\Spatial\Working\LB\2155\BDAR Figures\3557_Figure_6_locationmap.mxd

Location Map

Marulan South Limestone Mine Continued Operations

FIGURE 7

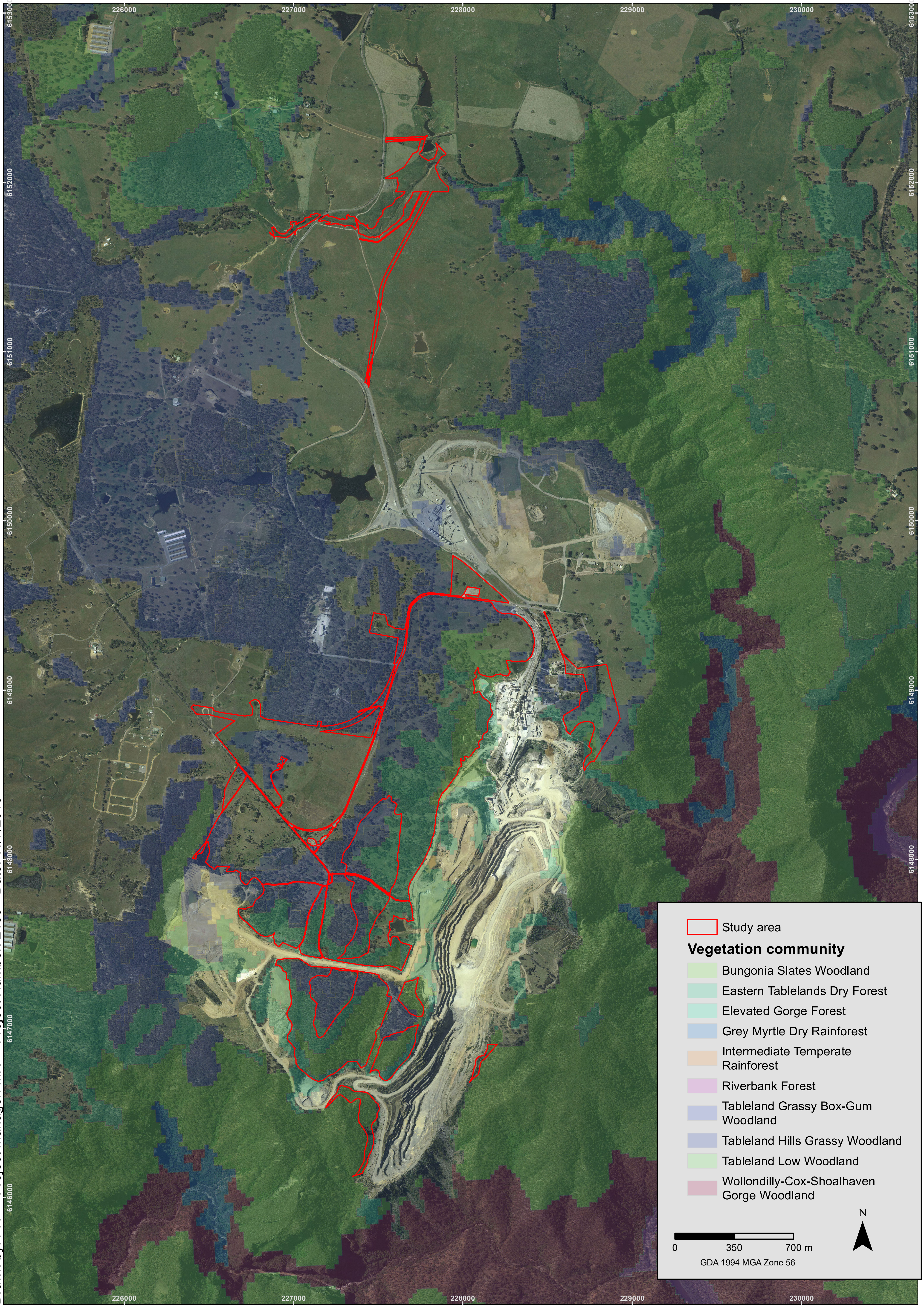
Drawn by: PR Project Manager: LB Project Number: 3557 Date: 11/7/2018 T:\SpatialWorking\LB\2155\BDAR Figures\3557_Figure_7_locationmap.mxd



Location map with 1500 m buffer

Marulan South Limestone Mine Continued Operations

FIGURE 8



Drawn by: PR Project Manager: MR Project Number: 2155 Date: 11/7/2018

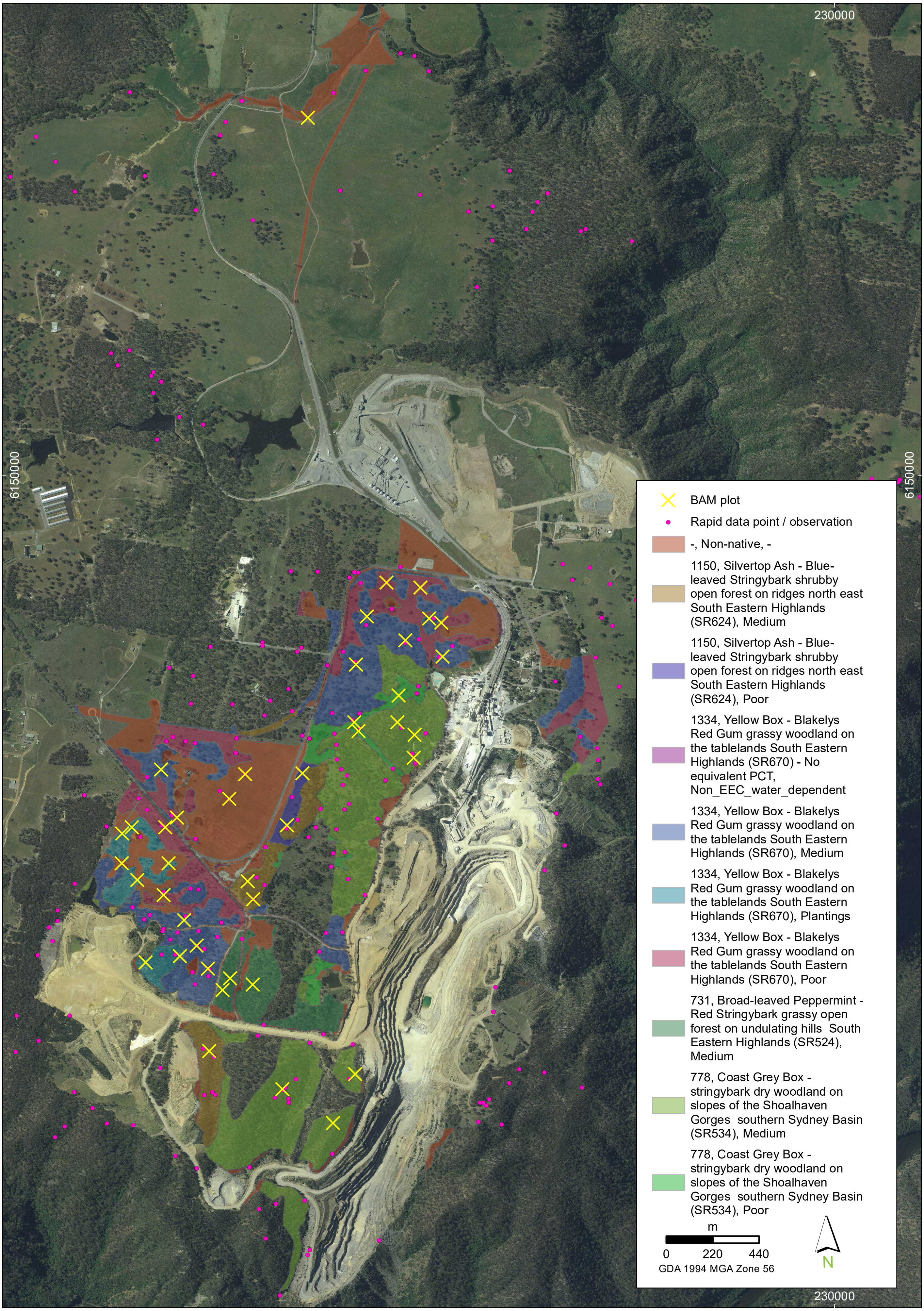
Tozer et al (2006) Native Vegetation of South-east NSW

Marulan South Limestone Mine Continued Operations

FIGURE 9

Imagery: (c) Boral (November 2018)

Path: T:\SpatialWorking\LB\2155\BDAR Figures\2155_Figure_8_SCIVI.mxd



Drawn by: PR Project Manager: LB Project Number: 3557 Date: 3/7/2019 T:\SpatialWorking\LB\2155\BDAR Figures\3557_Figure_10_validated vegetation map.mxd

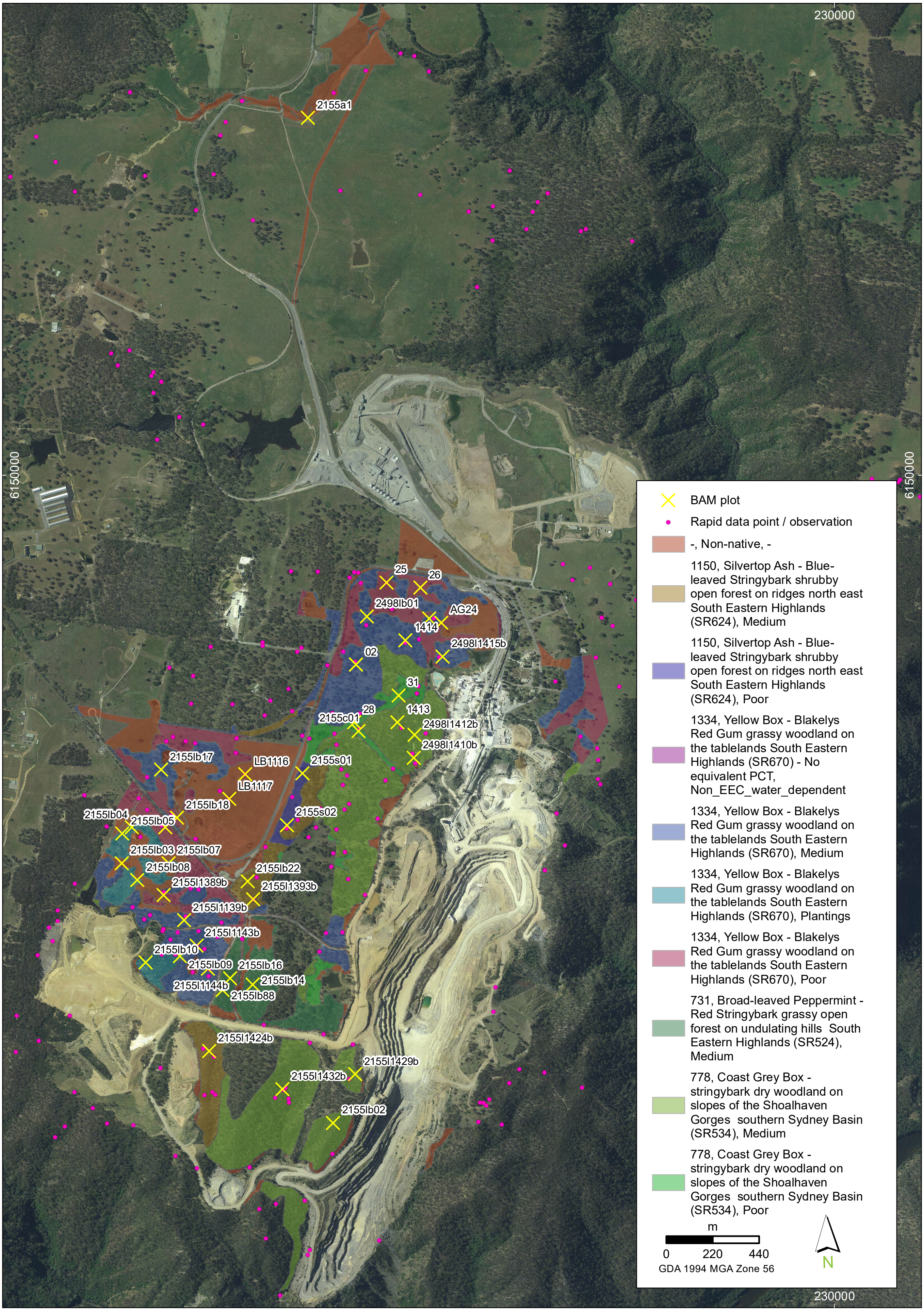
Validated vegetation mapping

Marulan South Limestone Mine Continued Operations

FIGURE 10

niche Environment and Heritage

Drawn by: PR Project Manager: LB Project Number: 3557 Date: 3/7/2019 T:\Spatial\Working\LB\2155\BDAR Figures\3557_Figure_10_validated vegetation map.mxd



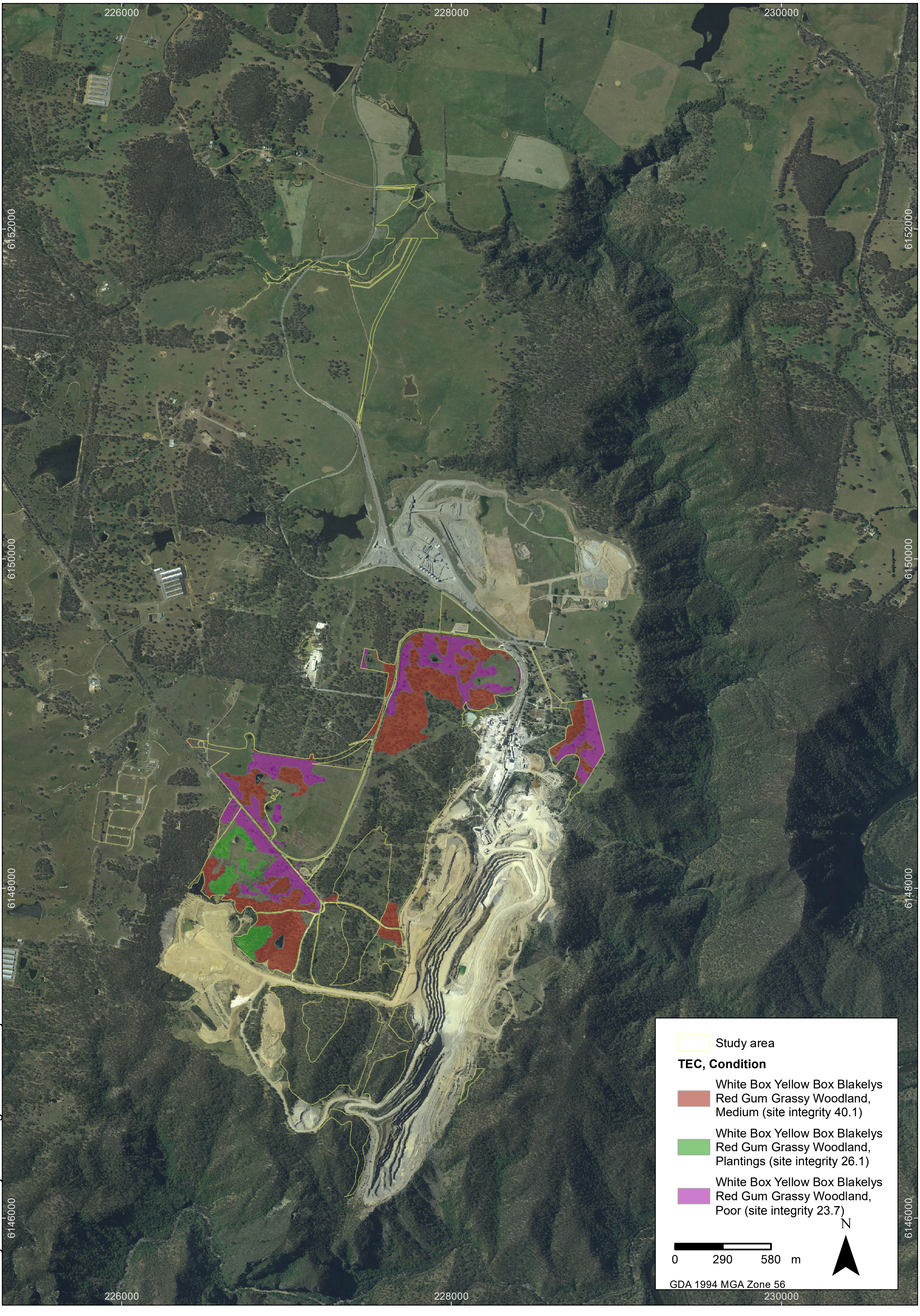
Validated vegetation mapping

Marulan South Limestone Mine Continued Operations

FIGURE 10

niche
Environment and Heritage

Drawn by: PR Project Manager: LB Project Number: 3557 Date: 11/7/2018



Threatened Ecological Communities (SAII)

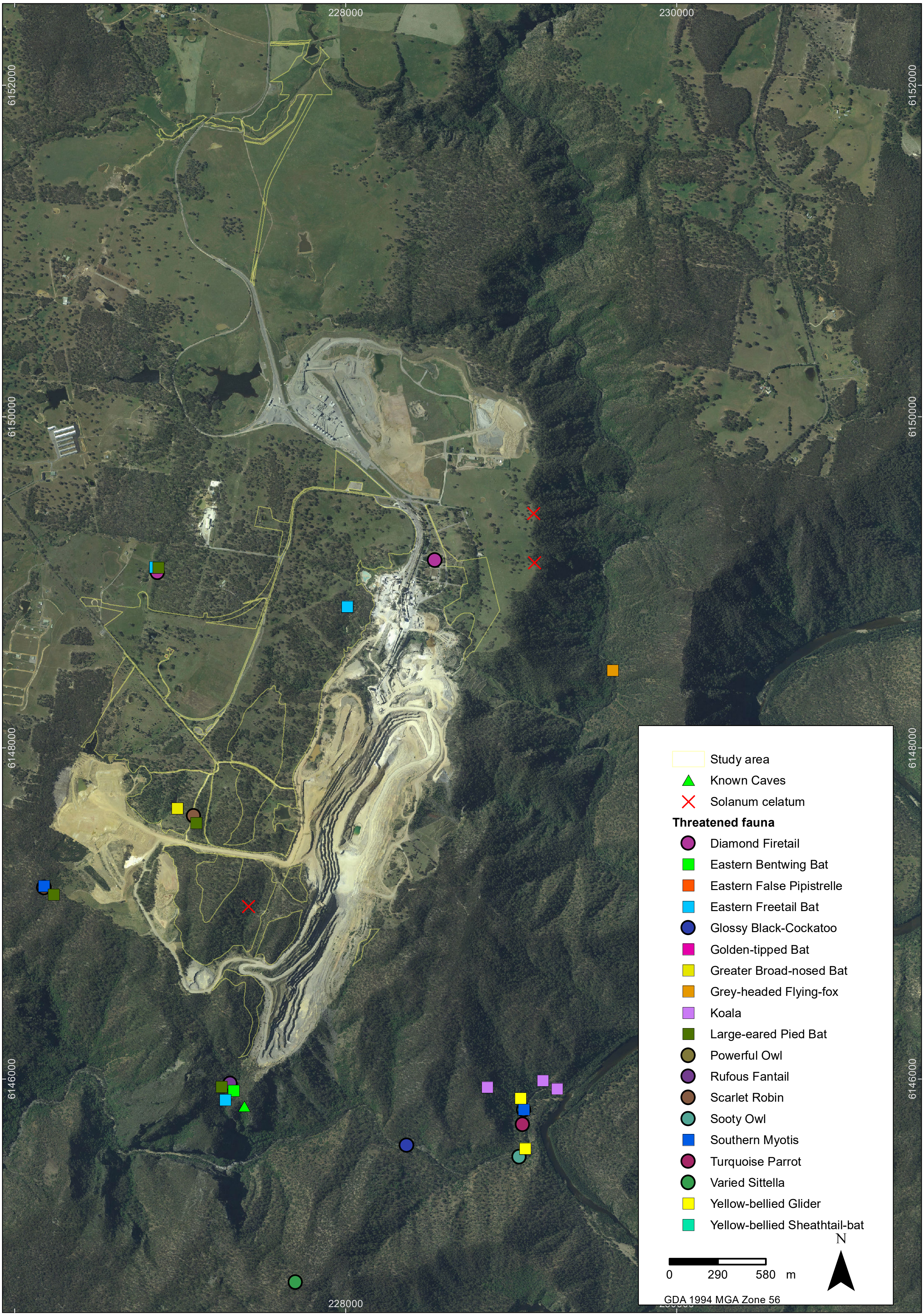
Marulan South Limestone Continued Operations Project

FIGURE 12

Path: T:\SpatialWorking\LB\2155\BDAR Figures\3557_Figure_11_TEC.mxd

Imagery: (c) Boral 2014

Drawn by: PR Project Manager: LB Project Number: 2155 Date: 3/7/2019



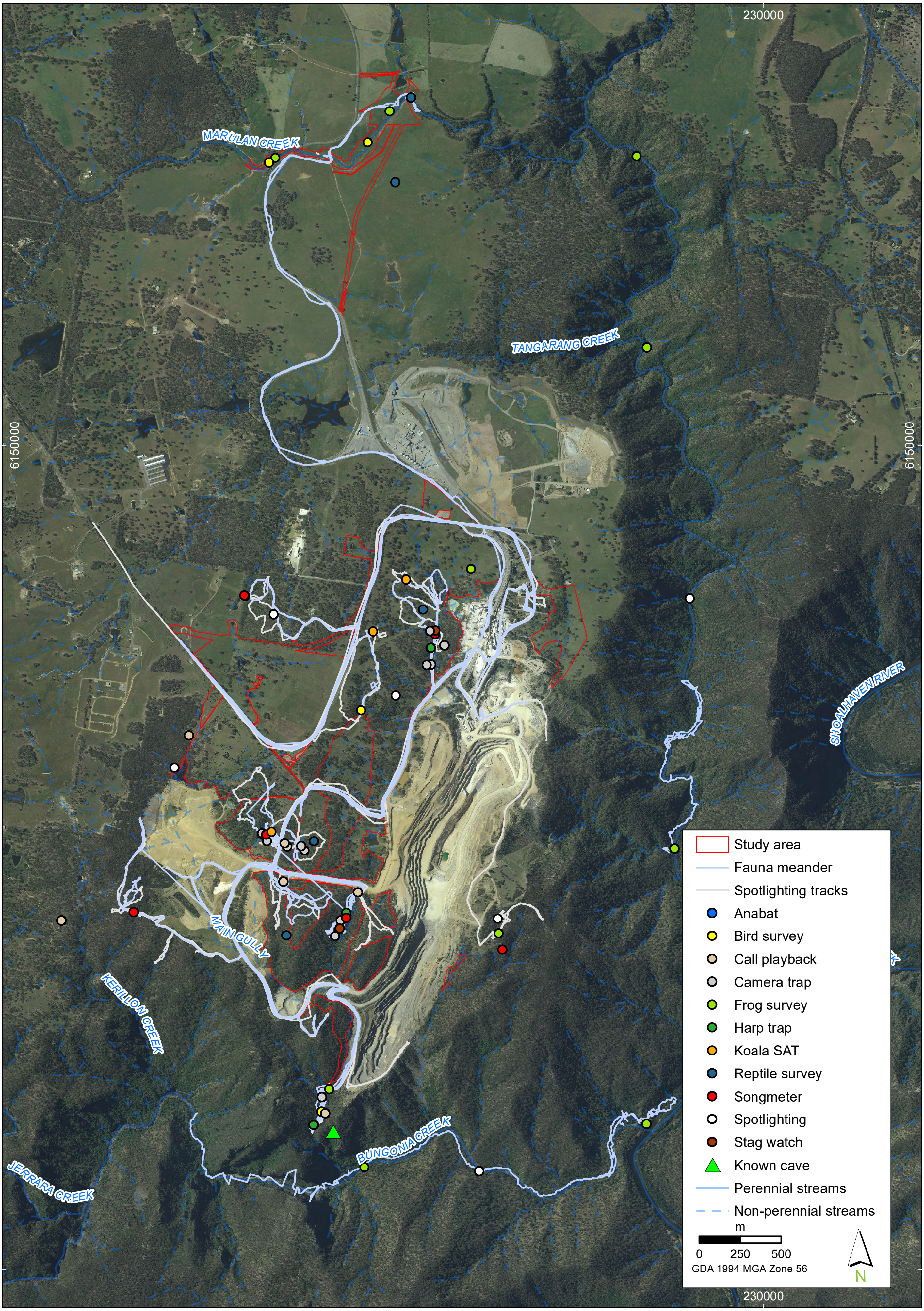
Threatened flora and fauna recorded

Marulan South Limestone Mine Continued Operations

FIGURE 13

Path: T:\SpatialWorking\LB\2155\BDAR Figures\2155_Figure_13_Threatened fauna recorded.mxd

Imagery: (c) Boral 2014



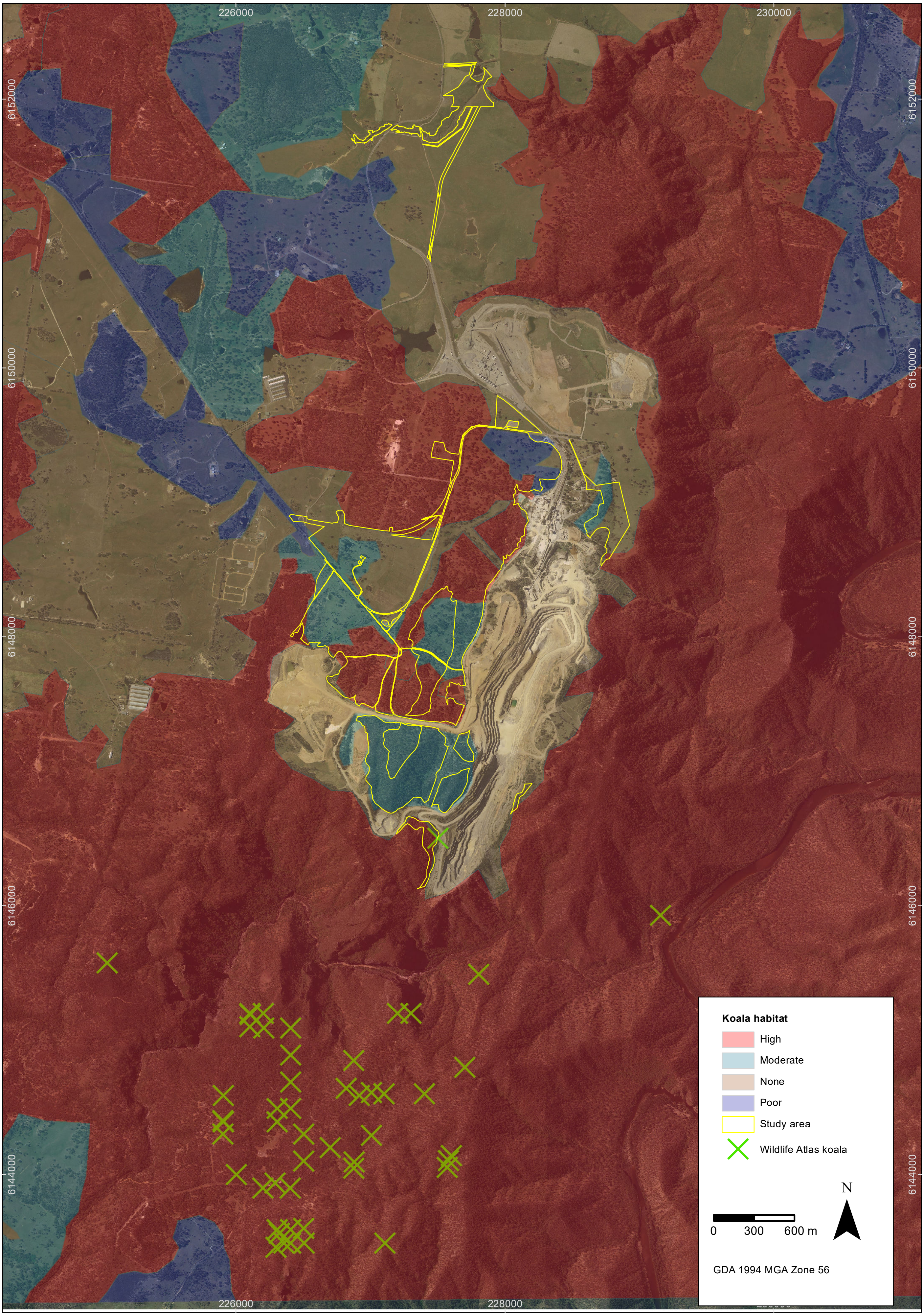
Drawn by: PR Project Manager: LB Project Number: 2155 Date: 3/7/2019 T:\SpatialWorking\LB\2155\BDAR Figures\2155_Figure_12_fauna survey effort.mxd

Fauna survey effort

Marulan South Limestone Mine Continued Operations

FIGURE 14

Drawn by: PR Project Manager: LB Project Number: 2155 Date: 11/7/2018



Koala Habitat

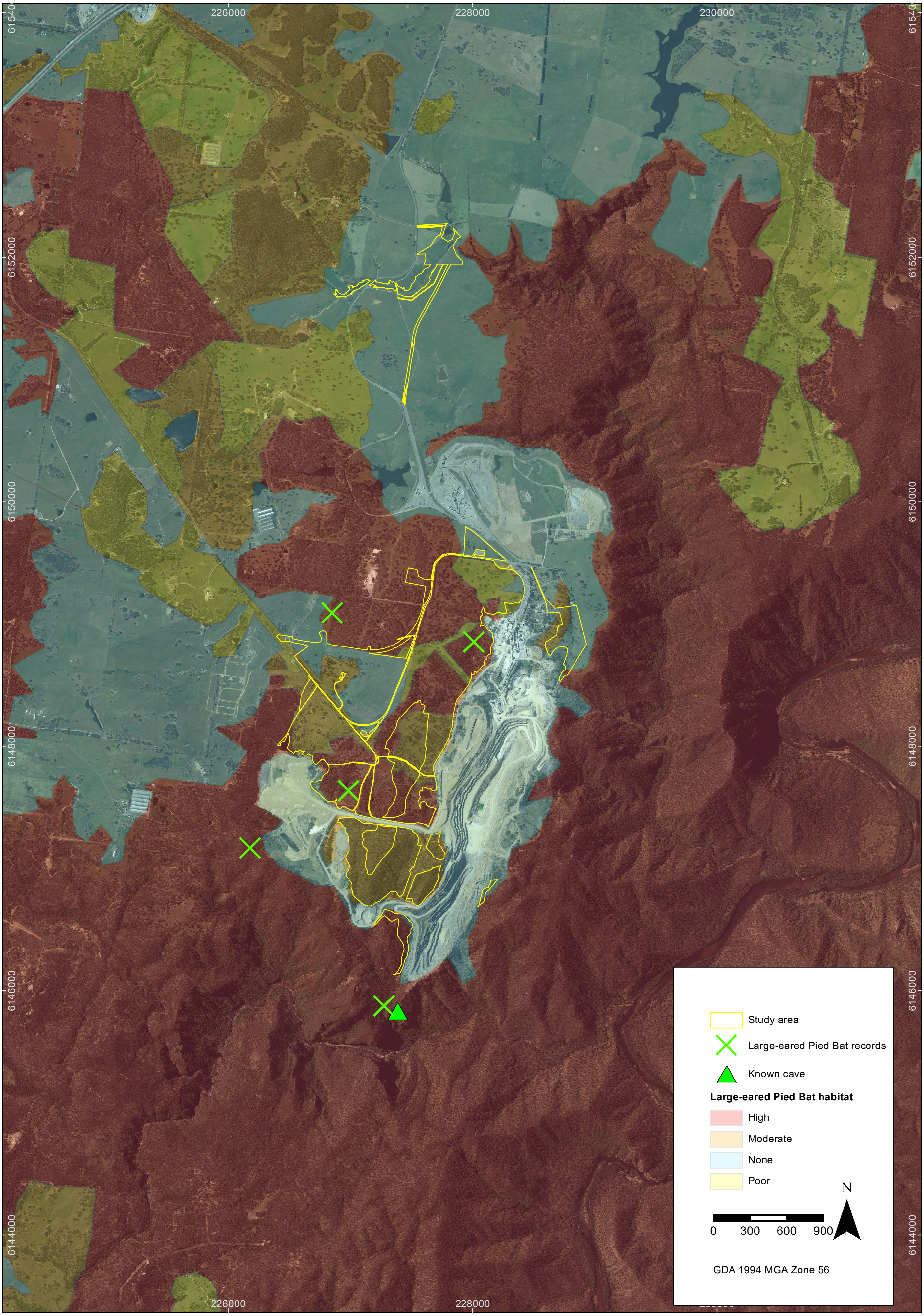
Marulan South Limestone Mine Continued Operations

FIGURE 15

Path: T:\SpatialWorking\LB\2155\BDAR Figures\2155_Figure_14_Koalahabit.mxd

Imagery: (c) Boral 2014

Drawn by: PR Project Manager: LB Project Number: 2155 Date: 11/7/2018



Large-eared Pied Bat habitat

Marulan South Limestone Mine Continued Operations

FIGURE 16

Path: T:\SpatialWorking\LB\2155\BDAR Figures\2155_Figure_15_LEPBhabit.mxd

Imagery: (c) Boral 2014

Appendix 1. Likelihood of occurrence

Threatened flora likelihood of occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
Acacia bynoeana	Bynoe's Wattle	V	V	*A. bynoeana* occurs mainly in heath and dry sclerophyll forest (Morrison & Davies 1991). The substrate is typically sand and sandy clay, often with ironstone gravels and is usually very infertile and well-drained. The species seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds.	Low – habitat not suitable within Study Area and unlikely to remain undetected during survey if present.
Acacia flocktoniae	Flockton Wattle	V	V	This species grows in dry sclerophyll forest on low nutrient soils derived from sandstone. Associated species include *Acacia stricta* and *Podolobium ilicifolium*. Altitude is 500-1000 m asl, average annual rainfall is 800-1200 mm (Benson & McDougall 1996). This species has isolated occurrences from Mt Wilson and Little Hartley south to Yerranderie and Picton, in the Cental Tablelands of NSW Specific cited locations include: Little Hartley, Megalong Valley, Mt Victoria, Kiaramba Ridge, Byrnes Gap (near Yerranderie), Scotts Main Range, Nepean R. and Yerranderie (Benson & McDougall 1996; Orchard & Wilson 2001).	Low – habitat not suitable within Study Area based on the absence of associated species. The species is relatively conspicuous and unlikely to remain undetected during survey if present.
Caladenia tessellata	Thick-lipped Spider-orchid	E	V	Found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. Known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. Known to favour low, dry sclerophyll woodland (for example open Kunzea woodland) with a heathy or sometimes grassy understorey on clay loams or sandy soils. The population at Braidwood occurs in dry, low Brittle Gum (*Eucalyptus mannifera*), Inland Scribbly Gum (*E. rossii*) and *Allocasuarina* spp. woodland with a sparse understorey and stony soil.	Low – no records within 10km of subject site. There is some marginal habitat on subject site, however given the species was not detected during survey, the species is unlikely to be present.
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Grows in swamp-heath on sandy soils, chiefly in coastal districts, south from the Gibraltar Range. The Leafless Tongue-orchid has been reported to occur in a wide variety of habitats including heathlands, heathy woodlands, sedgelands, Xanthorrheoa spp. plains, dry sclerophyll forests (shrub/grass sub-formation and shrubby sub-formation), forested wetlands, freshwater wetlands, grasslands, grassy woodlands, rainforests and wet sclerophyll forests (grassy sub-formation). Soils are generally considered to be moist and sandy, however, this species is also known to grow in dry or peaty soils.	Low – occurs within a variety of habitats however it was not detected during field survey and no records occur within 10 km of subject site.

---

[3] As described in OEH Threatened Species Profiles (2018). Threatened Species Profiles http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx, unless otherwise stated.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
Diuris aquilis	Buttercup Doubletail	E	V	The species is known from fewer than 20 small and fragmented populations between Braidwood and the Blue Mountains in the central and southern tablelands of NSW. The species previously occurred in the Liverpool area of western Sydney but has not been located there in over 100 years. Only three populations, containing a total of less than 50 individuals, occur within a conservation reserve, Kanangra-Boyd National Park. The remaining populations are restricted to remnant vegetation along roadsides and within agricultural lands. Buttercup Doubletail favours montane eucalypt forest and low open woodland with a grassy heathy understory, and secondary grassland, growing in gravelly clay-loam, often on gentle slopes	Low – no records within the locality. Only known from 20 fragmented populations, none of which occur near the Study Area. The species can occur within Box Gum Woodland habitat, however was not detected during the field survey which was completed during the known flowering time for the species.
Diuris tricolor		V	-	Sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the north of NSW. Localities in the south include Red Hill north of Narrandera, Coolamon, and several sites west of Wagga Wagga. Condobolin-Nymagee road, Wattamondara towards Cowra, Eugowra, Girilambone, Dubbo and Cooyal, in the Central West. Pilliga SCA, Pilliga National Park and Bibblewindi State Forest in the north and Muswellbrook in the east. Associated species include C*allitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta*, Ironbark and Acacia shrubland. The understorey is often grassy with herbaceous plants such as Bulbine species.	Low – no records within the locality. No habitat within the Study Area. The species was not detected during the field survey which was completed during the known flowering time for the species.
Eucalyptus aggregata	Black Gum	V	-	Found in the NSW Central and Southern Tablelands, with small isolated populations in Victoria and the ACT. Has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands in the lowest parts of the landscape, on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Also occurs as isolated paddock trees in modified native or exotic pastures. Often grows with other cold-adapted eucalypts, such as Snow Gum or White Sallee (*Eucalyptus pauciflora*), Manna or Ribbon Gum (*E. viminalis*), Candlebark (*E. rubida*), Black Sallee (*E. stellulata*) and Swamp Gum (*E. ovata*). Black Gum usually occurs in an open woodland formation with a grassy groundlayer dominated either by River Tussock (*Poa labillardierei*) or Kangaroo Grass (*Themeda australis*), but with few shrubs.	Low – Recorded over 2 km to the north-east of the subject site within Conservation Area. Relatively conspicuous species and unlikely to remain undetected during field survey.
Eucalyptus aquatica		V	V	Found primarily in the Penrose area near Goulburn where all records are either from State forest or private property. There is also one record from within Morton National Park. Occurs as scattered plants on open, swampy flats.	Low – habitat not suitable within Study Area and unlikely to remain undetected during survey if present.
Eucalyptus macarthurii	Paddys RiverBox	V	-	A moderately restricted distribution, recorded from the Moss Vale District to Kanangra Boyd National Park. In the Southern Highlands it occurs mainly on private land, often as isolated individuals in, or on the edges of paddocks. Isolated stands occur in the north west part of the range on the Boyd Plateau. The only known record in the	Low – recorded over 5 km to the west. Relatively conspicuous species which is unlikely to remain undetected during survey.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
				conservation estate is within Kanangra Boyd National Park. Occurs on grassy woodland on relatively fertile soils on broad cold flats.	
Genoplesium baueri	Yellow Gnat-orchid	-	E	The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Currently the species is known from just over 200 plants across 13 sites. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Grows in dry sclerophyll forest and moss gardens over sandstone.	None – no suitable habitat. No records. Not detected during field survey.
Genoplesium plumosum	Tallong Midge Orchid	CE	E	Occurs exclusively in heathland, generally dominated by common fringe-mytre and parrot-peas. Grows on very shallow soils or within mosses on sandstone conglomerate shelves. Plants exist only as a dormant tuber for much of the year, with leaves or fruiting stems dying back in winter. Reproduces by seed and has no mechanism for vegetative reproduction.	Low – the disturbed area is not along sandstone shelves.
Genoplesium superbum	Superb Midge Orchid	E	-	The Superb Midge Orchid is restricted to the Central and Southern Tablelands of NSW where it has been recorded from 2 locations near Nerriga, c. 20 km apart, and north of Wallerawang. Some plants occur in Morton National Park. The Superb Midge Orchid occurs predominantly in wet heathland on shallow soils above a sandstone cap but has also been found in open woodland interspersed with heath and dry open shrubby woodland.	No – no habitat present at site. No records within the locality. The species is restricted to the Central and Southern Tablelands of NSW where it has been recorded from 2 locations near Nerriga, c. 20 km apart, and north of Wallerawang. Surveys completed during the recommended survey period (February). Not recorded during field survey.
Grevillea molyneuxii	Wingello Grevillea	V	E	This species has only been recorded in low heathland on sandstone, where it grows in skeletal soil on flat, wet sandstone shelves above dissected valleys.	None – no suitable habitat.
Haloragis exalata subsp. *exalata*	Square Raspwart	V	V	Occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the central coast, south coast and north-western slopes botanical subdivisions of NSW. The species appears to require protected and shaded damp situations in riparian habitats.	Low – not detected during field survey. Habitat marginal within disturbance area.
Kunzea cambagei	Cambage Kunzea	V	V	Restricted to damp, sandy soils in wet heath or mallee open scrub at higher altitudes on sandstone outcrops or Silurian group sediments.	None – no potential habitat.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
Lepidium hyssopifolium	Aromatic Peppercress	E	E	Currently, the species is known from near Bathurst and Bungendore, in the South Eastern Highlands Bioregion Historically, the Aromatic Peppercress has been recorded from the Northern and Central Tablelands, with an atypical specimen from Cooma on the Southern Tablelands (Harden 2000). The Central Tablelands records are from the Bathurst area; the Northern Tablelands collections are from Gostwyck, near Armidale, and there was an 1884 record from 'near Maryland', though this record may have been from either NSW or Queensland, as the Maryland Station once extended over the border. Most other records have been found to be misidentifications. Generally, the Basalt Pepper-cress is known to establish on open, bare ground with limited competition from other plants. The Basalt Pepper-cress was previously recorded from Eucalypt woodland with a grassy ground cover, low open Casuarina woodland with a grassy ground cover and tussock grassland. Recently recorded localities have predominantly been in weed-infested areas of heavy modification, high degradation and high soil disturbance such as road and rail verges, on the fringes of developed agricultural land or within small reserves in agricultural land. Many populations are now generally found amongst exotic pasture grasses and beneath exotic trees such as the Radiata Pine (*Pinus radiata*) and Monterey Cypress (*Cupressus macrocarpus*), often associated with other species of Lepidium. The lack of competition from other shade-tolerant species allows the Basalt Pepper-cress to persist.	Low – despite having marginal habitat present, there are no records within 10 km. Unlikely to be present.
Leucochrysum albicans var. *tricolor*	Hoary Sunray	-	E	Occurs in a wide variety of grassland, woodland and forest habitats, generally on relatively heavy soils. The Hoary Sunray occurs at relatively high elevations in woodland and open forest communities, in an area roughly bounded by Goulburn, Albury and Bega. The species has been recorded in the Yass Valley, Tumut, Upper Lachlan, Snowy River and Galong. The species is known from the South Eastern Highlands, Australian Alps and Sydney Basin bioregions. Herbarium records indicate that the taxa once occurred more widely in inland NSW, near Cobar, Dubbo, Lithgow, Moss Vale and Delegate.	Low – grassland areas are highly disturbed. No records within 10 km of subject site.
Pelargonium sp. Striatellum	Omeo's Stork's-bill	E	E	Flowering occurs from October to March. Occurs in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds. The species is known to form clonal colonies by rhizomatous propagation. Known from only three locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. A population at a fourth known site on the Monaro has not been seen in recent years.	None – no known records. No habitat present.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
				The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang, Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas.	
Phyllota humifusa		V	V	Occurs in dry sclerophyll forest, sometimes near swamps, in deep sandy soils or gravely loams over a sandstone substrate. Accompanying trees are often Brittle Gum *Eucalyptus mannifera*, Narrow-leafed Peppermint *E. radiata* or Sydney Peppermint *E. piperita*.	Low – closest record over 6 km to the north-east. Lack of sandstone present. Habitat very marginal.
Pimelea axiflora subsp. *pubescens*	Bungonia Rice-flower	E	-	Endemic to NSW and currently only known to occur in the Bungonia State Conservation Area, south east of Goulburn. Occurs in a single population which is estimated to contain a total of 50 to 500 plants within an area of less than 4 square kilometres. Occurs on limestone cliff edges and outcrops.	Low - This species was not recorded within the Study Area during the field surveys or in any previous survey of the Study Area. The species is currently only known to occur in the Bungonia State Conservation Area, south-east of Goulburn, in a single population which is estimated to contain a total of 50 to 500 plants within an area of less than four square kilometres. The species occurs along limestone cliff edges and outcrops. Within the Study Area such habitat features are limited and occur sparsely to the far east of the existing Mine. These features will not be impacted by the Project as they do not occur within the Study Area. As such, given the species was not recorded during the current or previous survey, and potential habitat is unlikely to be disturbed as a result of the Project, the species has not been considered further in this assessment.
Pomaderris cotoneaster	Cotoneaster	E	E	Cotoneaster Pomaderris has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock	Low - This species was not recorded within the Study Area

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
	Pomaderris			beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs. Habitat notes from specimens include: 'base of cliff, tall open forest (*E. fastigata*)'; 'alluvial terrace with tall open forest (*E. cypellocarpa*)'; 'alluvial terrace with tall open forest (*E. muelleriana*)'; 'rocky riparian site amongst tall open eucalypt forest (*E. viminalis*)'; 'rocky river bed'; 'Growing on dry south-westerly facing slope above river. Associated with *Westringia* sp. aff. Longifolia, *Grevillea lanigera, Prostanthera* sp. nov., *Eucalyptus radiata, Olearia sp., Kunzea ericoides* and *Acacia pravissima'*; 'Growing in shrubby woodland of *Eucalyptus maidenii* & *E. elata*. South-facing slope with loamy soil on metasiltstone'	during the field surveys or in any previous survey of the Study Area. The closest record is within 1 kilometre to the south in Bungonia gorge. The species has been recorded from five reserves: South East Forests National Park (three populations); Morton National Park (two populations); Kosciuszko National Park (one population), Bungonia State Conservation Area (two populations); Coopracambra National Park (one population). The species has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs. The species was given a moderate likelihood of occurrence given it can occur within a wide variety of habitat. However, the species was not recorded during targeted survey. Furthermore, the records of *Pomaderris cotoneaster* in Bungonia State Conservation Area has been associated with the following species: *Eucalyptus dives* and *E. macrorhyncha, E. agglomerata / E. punctata* forest. These species were only occasionally recorded during the survey, however were recorded outside of the Study Area.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat[3]	Likelihood of Occurrence
Pomaderris delicata	Delicate Pomaderris	CE	CE	Delicate Pomaderris is known from only two sites; between Goulburn and Bungonia and south of Windellama (Cullula). At both known sites the Delicate Pomaderris grows in dry open forest dominated by *Eucalyptus sieberi* with a dense she-oak understorey. Soils are shallow and derived from sandstone and siltstone. Nothing is known about the response of the species to fire and other disturbance.	Low – Not detected during the field survey. Associate species Eucalyptus seiberi is present, however after traverses throughout the Study Area is unlikley to remain undetected given it is a relatively conspicuous species.
Pomaderris pallida	Pale Pomaderris	V	V	This species usually grows in shrub communities surrounded by Brittle Gum (*Eucalyptus mannifera*) and Red Stringybark (*E. macrorhyncha*) or Callitris spp. woodland. The Pale Pomaderris is found at numerous small sites along the plateau edge and very steep upper slopes and cliffs of river valleys at 480-600 m above sea level. The ACT sites are only on the eastern banks of the rivers, with an aspect ranging from north-westerly through westerly to southerly. The soils are shallow, pale brown sandy loams over granite rock and large, exposed granite boulders may be present. The species grows in near-monospecific stands in shrubland, surrounded by Eucalyptus or Callitris woodland, or in open forest. The shrubland is commonly dominated by *Bursaria spinosa* (Blackthorn/Boxthorn), *Grevillea juniperina* (Juniper Grevillea), *Acacia rubida* (Red-stemmed Wattle) and *Kunzea ericoides* (formerly *Leptospermum phylicoides*).	Low - This species was not recorded within the Study Area during the field surveys or in any previous survey of the Study area. The species is found at numerous small sites along the plateau edge and very steep upper slopes and cliffs of river valleys. Within the Study Area the species has potential habitat toward the east as this area contains steeper slopes. However, there is a low potential for this species to occur within the Study Area given the Study Area is located approximately 100 metres away from the plateau edges. As such, the species is unlikely to be disturbed and has not been considered further in this assessment.
Pultenaea pedunculata	Matted Bush-pea	E	-	The Matted Bush-pea occurs in a range of habitats. NSW populations are generally among woodland vegetation but plants have also been found on road batters and coastal cliffs. It is largely confined to loamy soils in dry gullies in populations in the Windellama area. The ability of stems to creep and root from the nodes has made this species a very good coloniser of bare ground in many parts of its range. Matted Bush-pea is widespread in Victoria, Tasmania, and south-eastern South Australia. In NSW however, it is represented by just three disjunct populations, in the Cumberland Plain in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn (where it is locally abundant). The Cumberland Plain occurrences were more	Low – out of known range. Unlikely to be present.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat^3	Likelihood of Occurrence
				widespread (Yennora, Canley Vale and Cabramatta were lost to development) and is now found at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel number 2 (Upper Sydney Water Supply Canal).	
Rulingia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: snow gum woodland at Rose Lagoon; blue leaved stringybark open forest at Tallong; and in brittle gum low open woodland at Penrose; scribbly gum – swamp mahogany ecotonal forest at Tomago.	Low – habitat not suitable within disturbance area and unlikely to remain undetected during survey if present. .
Rutidosis heterogama	Buttone Wrinkewart	V	V	Recorded from near Cessnock to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides	Low – habitat not suitable within Study Area and unlikely to remain undetected during survey if present.
Rutidosis leptorrhynchoides	Button Wrinklewort	E	E	In the ACT and NSW, Button Wrinklewort occurs in box-gum woodland, secondary grassland derived from box-gum woodland or in natural temperate grassland; and often in the ecotone between the two communities.	Low – habitat not suitable within Study Area and unlikely to remain undetected during survey if present.
Solanum celatum		E	-	Grows on hills and slopes in eucalypt woodland; commonly found after fire or disturbance. Restricted to an area from Wollongong to a little south of Nowra and west to Bungonia Nature Reserve.	Known – recorded during current survey. Many records within the locality.
Swainsona sericea	Silky Swainson-pea	V	-	Silky Swainson-pea has been recorded from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. There is one isolated record from the far north-west of NSW. Its stronghold is on the Monaro. Also found in South Australia, Victoria and Queensland. Found in Natural Temperate Grassland and Snow Gum *Eucalyptus pauciflora* Woodland on the Monaro. Found in Box-Gum Woodland in the Southern Tablelands and South West Slopes.	Low – not detected during targeted flora survey which was completed during the recommended flowering period (November). Unlikely to remain undetected during the survey.
Thelymitra kangiloonica	Kangaloon Sun Orchid	CE	CE	Only known to occur on the southern tablelands of NSW in the Moss Vale – Kangaloon – Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. It is found in swamps in sedgelands over grey silty grey loam soils	None – no habitat present.
Thesium australe	Austral Toadflax	V	V	Grows in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland. Grows on kangaroo grass tussocks but has also been recorded within the exotic bullrush grass.	No records within 10 km of subject site. Habitat not suitable.

Threatened fauna likelihood of occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Amphibians							
Heleioporus australiacus	Giant Burrowing Frog	V	V	The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with more sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis. Some potential habitat is present within the gullies to the south and east of the emplacement areas, however the species was not recorded during field surveys and has not been recorded from the locality or the region.	Low	Unlikely	Species – excluded from further assessment
Litoria aurea	Green and Golden Bell Frog	E	V	Inhabits a very wide range of water bodies including marshes, dams and streams, particularly those containing emergent vegetation such as bulrushes or spikerushes. It also inhabits numerous types of man-made water bodies including quarries and sand extraction sites. Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow, have a grassy area nearby and diurnal sheltering sites available. A single record exists from the locality and region from 40 years ago. Species no longer deemed to be present in region. Some potential habitat is present particularly within Marulan Creek but it is highly unlikely that this is occupied due to the frogs absence from the region.	Low	Unlikely	Species – excluded from further assessment
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Occurs in wet and dry sclerophyll forests and heathland associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range from the Central Coast down into Victoria. Individuals have been collected from a wide range of water bodies that includes semi-permanent dams, permanent ponds, temporary pools and permanent streams, with calling occurring from fringing vegetation or on the banks. Individuals have been observed sheltering under rocks on high exposed ridges during summer and within deep leaf litter adjacent to the breeding site. Calling occurs in all months of the year, often in association with heavy rains. The tadpoles are distinctive, being large and very dark in colouration. Some potential habitat is present within the gullies to the south and east of the emplacement areas, however it was not recorded during field surveys; it has not been recorded from the locality and there are no records in the region.	Low	Unlikely	Species – excluded from further assessment
Birds							

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Actitis hypoleucos	Common Sandpiper	-	M, MA	Utilises a wide range of coastal wetlands and some inland wetlands, mostly found around muddy margins or rocky shores. Forages in shallow water and on soft mud, roosts on rocks or vegetation such as mangroves. Northern hemisphere breeding.	Low – transient visitor only.	Unlikely – negligible impacts.	N/A
Anthochaera phrygia	Regent Honeyeater	CE	E,M	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. This species has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. Three records from the locality centred around the Bungonia National Park area to the south. As the species is migratory it may occur as a transient visitor to the site, including to forage, but would use the site rarely. No breeding habitat present. Not recorded during targeted bird survey.	Low – transient visitor only.	Unlikely – negligible impacts.	Species – excluded from further assessment – not detected during survey.
Apus pacificus	Fork-tailed Swift	-	M	The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 m above ground and probably much higher.	Moderate	Unlikely – negligible impacts. May fly over site.	N/A
Ardea alba	Great Egret	-	M	Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. May occur intermittently within the Study area, particularly during flood around Marulan Creek.	Moderate	Potential – with minimal impacts.	N/A
Ardea ibis	Cattle Egret	-	M	The Cattle Egret is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. May occur intermittently within the Study area – species is common and widespread.	High	Unlikely	N/A
Botaurus poiciloptilus	Australasian Bittern	E	E	The Australasian Bittern is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes. Single record from Bungonia State Conservation Reserve. Potential habitat is very limited within the proposed disturbance areas with permanent wetlands very limited in extent.	Low	Unlikely	Species - excluded from further assessment

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Prefers muddy edges of shallow or brackish wetlands, with inundated or emergent sedges, saltmarsh or other low vegetation. Also found foraging in sewage ponds and flooded paddocks. Northern hemisphere breeding.	Low – transient visitor only.	Unlikely – negligible impacts.	N/A
Calidris ferruginea	Curlew Sandpiper	E	CE,M	It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland. Northern hemisphere breeding.	Low – transient visitor only.	Unlikely – negligible impacts.	Ecosystem
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine snow gum woodland and occasionally in temperate or regenerating forest. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. It requires tree hollows in which to breed. The species has been recorded to the south and north of the Study Area and is expected to use the site on occasion to forage. The species was not detected during survey however there is very limited breeding habitat.	Moderate. Recorded on Peppertree Quarry by ERM (2006)	Potential – with minimal impacts.	Ecosystem
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Inhabits forest with low nutrients, characteristically with key Allocasuarina spp. Tends to prefer drier forest types with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead. Endangered population in the Riverina. The species has been recorded to the south and north of the Study Area and is expected to use the site on occasion to forage. The species was not detected during survey however there is very limited breeding habitat.	Moderate	Potential – with minimal impacts.	Ecosystem
Chthonicola sagittata	Speckled Warbler	V	-	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. This species has been recorded from the locality within grassy woodland areas to the west of the Study Area. While the species was not recorded during field survey there is potential habitat that may be used. Three records exist for Speckled Warbler from the locality west of the Study Area. The species was not recorded during field survey.	Moderate	Potential – with minimal impacts.	Ecosystem
Climacteris picumnus victoriae	Brown Treecreeper	V	-	Found in eucalypt woodlands (including White Box Yellow Box Blakely's Red Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an	Low	Unlikely	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
				important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. Whilst this species has been recorded within the locality, there is limited potential habitat within the Study Area as mature trees with hollows and large logs are rare. Conspicuous species not recorded during field survey.			
Daphoenositta chrysoptera	Varied Sittella	V	-	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia. Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows. Four records exist from the locality to the west of the Study Area. A single observation of this species was made during the feasibility assessment from Grassy Woodland.	Known	Likely – non-significant impacts	Ecosystem
Gallinago hardwickii	Latham's Snipe	-	M	Latham's Snipe is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. No records from locality and not recorded during field survey.	Low	Unlikely	N/A
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes. Most records from the region are from lower elevation near coastal areas. Not recorded during survey.	Low	Unlikely	Ecosystem
Grantiella picta	Painted Honeyeater	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests.	Low	Unlikely	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	M	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna. Some potential habitat within the Study Area, though it would be infrequently used and for foraging only.	Low	Unlikely	Ecosystem
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees. Wide ranging species, not recorded during field surveys. One record exists from the north of the locality. Two records from Marulan area. No individuals or breeding nests were observed during field surveys.	Moderate – may fly over	Unlikely	Ecosystem
Hirundapus caudacutus	White-throated Needletail	-	M	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Potential overfly habitat only.	Low	Unlikely	N/A
Lathamus discolor	Swift Parrot	E	E	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability. No records within the locality and not recorded from surveys. Closest record is approximately 50 km east and most records in the region are coastal. As the species is migratory it may occur as a transient visitor to the site, including to forage, but would use the site rarely given the lack of records from the region.	Low	Unlikely	Ecosystem
Melanodryas cucullata cucullata	Hooded Robin	V	-	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. One recent and one dated record from locality to west of Study Area. Conspicuous bird that is primarily sedentary and was not recorded during survey.	Low	Unlikely	Ecosystem
Melithreptus gularis gularis	Black-chinned Honeyeater	V	-	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (E. *albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). Two records from 30 years ago exist for this species from near Marulan and towards Goulburn. No other records occur from the region and the species was not recorded during field survey.	Low	Unlikely	Ecosystem
Merops ornatus	Rainbow Bee-eater	-	M	Found throughout mainland Australia most often in open forests, woodlands and shrublands, and cleared areas, usually near water. It will be found on farmland with	Moderate	Potential – with minimal impacts.	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
				remnant vegetation and in orchards and vineyards. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels. Widespread migratory species that may move through Study Area occasionally.			
Monarcha melanopsis	Black-faced Monarch	-	M	Found along the coast of eastern Australia, becoming less common further south. Inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Predominant habitat within Study Area is in lower areas away from proposed impact areas. May move through other parts of the Study Area.	Moderate	Potential – with minimal impacts.	N/A
Myiagra cyanoleuca	Satin Flycatcher	-	M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Low	Unlikely	N/A
Motacilla flava	Yellow Wagtail	-	M	Breeds in temperate Europe and Asia. The Yellow Wagtail is a regular wet season visitor to northern Australia. Increasing records in NSW suggest this species is an occasional but regular summer visitor to the Hunter River region. The species is considered a vagrant to Victoria, South Australia and southern Western Australia. Habitat requirements for the Yellow Wagtail are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	Low	Unlikely	Ecosystem
Neophema pulchella	Turquoise Parrot	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust. Recorded within Shoalhaven Gorge, within Casuarina gully forest, possibly moving to the area to drink. There are no records from the locality and records from the region are very sparse. The species was recorded outside of the Study Area during the field survey and there are limited hollow resources available for breeding within the Study Area.	Recorded during field survey outside of the Study Area.	Unlikely	Ecosystem
Ninox strenua	Powerful Owl	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within red turpentine in tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large	Moderate. Recorded outside of the Study Area.	Potential – with minimal impacts.	Dual credit. Species Credit component (breeding habitat) not present in Study Area and therefore listed as an

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
				proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm.			Ecosystem credit.
Numenius madagascariensis	Eastern Curlew	-	CE, MA, M	A primarily coastal distribution. Found in all states, particularly the north, east, and south-east regions including Tasmania. Rarely recorded inland. Mainly forages on soft sheltered intertidal sand flats or mudflats, open and without vegetation or cover. Breeds in the northern hemisphere.	Low	Unlikely	Ecosystem
Pandion cristatus	Eastern Osprey	V	M	Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging. They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. They exhibit a preference for coastal cliffs and elevated islands in some parts of their range, but may also occur on low sandy, muddy or rocky shores and over coral cays. They may occur over atypical habitats such as heath, woodland or forest when travelling to and from foraging sites.	None	None	Ecosystem
Petroica boodang	Scarlet Robin	V	-	The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs	Known	Likely – with minimal impacts.	Ecosystem
Petroica phoenicea	Flame Robin	V	-	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January. Two records from the locality around Marulan, however not recorded during survey. As the species is somewhat migratory it may visit the site, particularly grassy woodlands during winter.	Moderate	Potential – with minimal impacts.	Ecosystem
Rhipidura rufifrons	Rufous Fantail	-	M	Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany (*E. resinifera*); usually with a dense shrubby understorey often including ferns.	High – recorded outside of the Study Area	Likely – with minimal impacts	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Rostratula australis	Australian Painted Snipe	E	E, M	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Low	Unlikely	Ecosystem
Sminthopsis leucopus	White-footed Dunnart	V	-	The White-footed Dunnart occurs in Tasmania and along the Victorian and southern NSW coast. The Shoalhaven area is the species' northern-most limit. It has not been recorded west of the coastal escarpment with the western-most record being from Coolangubra State Forest, approximately 10 km south-east of Bombala. The White-footed Dunnart is found in a range of different habitats across its distribution, including coastal dune vegetation, coastal forest, tussock grassland and sedgeland, heathland, woodland and forest. In NSW, the species seems to favour vegetation communities with an open understorey structure (contrasting with populations in Victoria which apparently prefer dense shrub and ground layers). It is patchily distributed across these habitats and, where present, typically occurs at low densities.	Low	Unlikely	Species
Stagonopleura guttata	Diamond Firetail	V	-	Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including White Box Yellow Box Blakely's Red Gum Woodlands and snow gum woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities.	Known	Likely – with minimal impacts	Ecosystem
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet.	Moderate	Potential – with minimal impacts	Dual credit. Species Credit component (breeding habitat) not present in Study Area and therefore listed as an Ecosystem credit.
Tyto tenebricosa	Sooty Owl	V	-	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude less than 500 metres. Nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 centimetres in diameter.	Moderate – recorded outside of Study Area in Bunongia Gorge	Potential – with minimal impacts	Dual credit. Species Credit component (breeding habitat) not present in Study Area and

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
				No local records. Nearest regional record near Bundanoon. Recorded during current surveys within the Bungonia gorge.			therefore listed as an Ecosystem credit.
Fish							
Macquaria australasica	Macquarie Perch	E (FM Act)	E	Macquarie perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments. The conservation status of the different populations is not well known, but there have been long-term declines in their abundance. Macquarie Perch are found in both river and lake habitats; especially the upper reaches of rivers and their tributaries. They are quiet, furtive fish that feed on aquatic insects, crustaceans and molluscs. Sexual maturity occurs at two years for males and three years for females. Macquarie perch spawn in spring or summer in shallow upland streams or flowing parts of rivers and females produce around 50,000-100,000 eggs which settle among stones and gravel of the stream or river bed. Populations from the eastward-flowing Shoalhaven and Hawkesbury rivers are genetically distinct and may represent an undescribed species (Allen et al., 2002). Potential habitat exists in the upper reaches and tributaries of Shoalhaven River where one specimen has been recorded in 2007 (3km upstream of Bungonia confluence. However such habitat is not present within Bungonia or Barbers Creek.	Low – there is no preferred habitat in Bungonia Creek or Barbers Creek and no records from extensive surveys in these systems.	Unlikely	N/A
Prototroctes maraena	Australian Grayling	-	V	Historically, this species occurred in coastal streams from the Grose River Valley, southwards through NSW, Vic. and Tas, With occurrences in the Shoalhaven catchment below Tallowa Dam. It also occasionally occurred high upstream in the Snowy R. A single juvenile specimen was collected from Lake Macquarie in 1974. This species spends only part of its lifecycle in freshwater. The Tambo River population inhabits a clear, gravel-bottomed stream with alternating pools and riffles, and granite outcrops. It has also been associated with clear, gravel-bottomed habitats in the Mitchell & Wonnangatta Rivers but was present in a muddy-bottomed, heavily silted habitat in the Tarwin River.	None –no records up stream of Tallowa Dam.	Unlikely	N/A
Mammals							
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals.	Known	Likely – with minimal impacts.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
				Recorded at all locations where bat recorders were placed within the Study area including south of the proposed disturbance areas and within both the Western Overburden Emplacement area and the Northern Overburden emplacement area.			
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Spotted-tailed Quoll are found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. One regional record only. Not recorded during field survey. Low abundance of preferred prey items (ground dwelling fauna), no denning habitat and widespread presence of foxes which is likely to prevent establishment of a population in the area. Quolls may occur on the site (more likely dispersing males) given proximity of conservation areas but are unlikely to use site with any frequency and there is limited value in regard to prey density.	Low	Unlikely	Ecosystem
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor. This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites. Three records from locality to the west of the Study area near Marulan. One possible call from current survey. Not recorded at Marulan South during echolocation surveys.	Moderate – recorded outside of the Study Area	Potential – with low level impacts.	Ecosystem
Kerivoula papuensis	Golden-tipped Bat	V	-	Distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to Bega in southern NSW. Found in rainforest and adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first- and second-order streams. No Atlas records in locality or region. May occur within proposed disturbance areas but is likely to rarely use such areas being confined mainly to gullies.	Moderate – recorded outside of the Study Area	Potential – with low level impacts.	Ecosystem
Miniopterus schreibersii oceanensis	Eastern Bent-wing-bat	V	-	Eastern Bent-wing bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Known maternity caves within Bungonia Gorge. Recorded at one harp trap location and from all sites where echolocation recording was performed.	Known	Likely – with minimal impacts.	Ecosystem and species. Species Credit component (breeding habitat) excluded from assessment

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits. One record from locality from Hume Highway near Marulan. Not recorded during field survey. Hollows/required breeding habitat is rare within the areas to be impacted by clearing.	Known	Unlikely	Ecosystem
Petaurus australis	Yellow-bellied Glider	V	-	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Recorded from Bungonia Gorge during current surveys. Not recorded during surveys of the disturbance areas and no obvious glider incisions found. Not recorded outside of protected area complex on tableland areas.	Low – recorded in Bungonia Gorge	Unlikely	Ecosystem
Myotis macropus	Southern Myotis	V	-	Found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, Mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Has been recorded from locality near Bungonia gorge on three occasions. Three possible recordings during current survey. Limited water resources and roost habitat (e.g. hollow trees, bridges and culverts) within disturbance areas.	Moderate – recored outside of the Study Area in Bungonia Gorge.	Unlikely	Species
Petauroides volans	Greater Glider	EP	V	The Greater Glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	Low	Unlikely	No listed
Petaurus norfolcensis	Squirrel Glider	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA. Not recorded during survey. No records from locality or region (one Atlas record from Marulan area with accuracy of 100 km).	Low	Unlikely	Species – Excluded from further assessment

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices. No potential habitat within the disturbance areas and no habitat to be impacted indirectly. Not recorded during field survey.	Low	Unlikely	Species – excluded from further assessment
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall. Seen within forest on the east edge of existing Mine area.	High	Likely – significant impact under EPBC Act	Species
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. No records locally or regionally and not recorded during survey.	Low	Unlikely	Ecosystem
Pseudomys novaehollandiae	New Holland Mouse	-	V	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. No local records. Single record regionally. Habitat on site is not preferred habitat.	Low	Unlikely	Ecosystem
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km. Recorded from Bungonia Gorge during field survey and expected to occur throughout area.	High – recorded outside of the Study Area	Likely – non significant impacts.	Ecosystem and species. Species Credit component (breeding habitat) excluded from further assessment.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. No Bionet Atlas records in locality or within the wider region.	Known	Potential	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species Credit or Ecosystem Species and whether predicted
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches. Two records from the region with the nearest being approximately 12 km to the north of the Study Area. Recorded as possible within disturbance areas and probable outside.	Known – possible recording	Potential	Ecosystem
Reptiles							
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by kangaroo grass. Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. No records locally or regionally. Preferred habitat not present.	Low	Unlikely	Species - excluded from further assessment
Delma impar	Striped Legless Lizard	V	V	Found mainly in natural temperate grassland but has also been captured in grasslands that have a high exotic component. Also found in secondary grassland near natural temperate grassland and occasionally in open White Box Yellow Box Blakely's Red Gum Woodland. Sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter. No records locally, single record from Goulburn area regionally. Not recorded during survey and preferred sheltering habitat not present.	Low	Unlikely	Species – excluded from further assessment
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Occurs almost exclusively in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they spend most of the year sheltering in and under rock crevices and exfoliating rock. However, some individuals will migrate to tree hollows to find shelter during hotter parts of summer. Required habitat not present.	Low	Unlikely	Species – excluded from further assessment
Suta flagellum	Little Whip Snake	V	-	The Little Whip Snake is found within an area bounded by Crookwell in the north, Bombala in the south, Tumbarumba to the west and Braidwood to the east. Occurs in natural temperate grasslands and grassy woodlands, including those dominated by snow gum or yellow box. Also occurs in secondary grasslands derived from clearing of woodlands. It is commonly found under rocks in more open areas of habitat. Outside of known distribution with nearest records from ACT area – 50 – 100 km away. Limited habitat within Study Area.	Low	Unlikely	Ecosystem
Varanus rosenbergi	Rosenberg's Goanna	V	-	This species is a Hawkesbury-Narrabeen sandstone outcrop specialist. Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests. No local records. No termite mounds in Study Area, not recorded during survey and preferred habitat not present in areas to be impacted.	Low	Unlikely	Species – excluded from further assessment

Threatened Ecological Community (TEC) Likelihood of occurrence

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Illawarra and South Coast Lowland Forest and Woodland	This community comprises vegetation types that occupy the Illawarra coastal plain and escarpment foothills. Characteristic tree species include Forest Red Gum *Eucalyptus tereticornis*, Thin-leaved Stringybark *Eucalyptus eugenioides*, Woollybutt *Eucalyptus longifolia*, Coast Grey Box *Eucalyptus bosistoana* and White Feather Honey-myrtle *Melaleuca decora*. The understorey is not necessarily grassy as moist forest vegetation types are also included within this broad community. Common shrub species include *Acacia mearnsii* and *Dodonaea viscosa* subsp. *angustifolia*. Floodplain vegetation dominated by Casuarina species or rainforests on latite soils are not part of this community.	Endangered	Critically Endangered	None – occurs more toward the coast. Was not recorded during the vegetation survey.
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	Montane Peatlands and Swamps comprises a dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. It is the only type of wetland that may contain more than trace amounts of Sphagnum spp., the hummock peat-forming mosses. Small trees may be present as scattered emergents or absent. The community typically has an open to very sparse layer of shrubs, 1-5 m tall, (eg. *Baeckea gunniana*, *B. utilis, Callistemon pityoides, Leptospermum juniperinum, L. lanigerum, L. myrtifolium, L. obovatum, L. polygalifolium).* Species of *Epacris (*eg. *E. breviflora, E. microphylla, E. paludosa)* and *Hakea microcarpa* are also common shrubs. In some peatlands and swamps, particularly those with a history of disturbance to vegetation, soils or hydrology, the shrub layer comprises dense thickets of Leptospermum species. In other peatlands and swamps with a history of grazing by domestic livestock, the shrub layer may be very sparse or absent.	Endangered	Endangered	None – not recorded during vegetation survey, Project Area out of known range and not previously mapped within the Project Area.
Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory	In the Southern Tablelands of NSW and the ACT, dominant grasses include Kangaroo Grass *Themeda triandra*, wallaby grasses *Austrodanthonia* spp., spear grasses *Austrostipa* spp., Red Grass *Bothriochloa macra* and tussock grasses *Poa* spp.. *Themeda triandra* and Snow Grass *Poa sieberiana* are co-dominant in a variety of landscape positions and soil types. In wetter areas, such as moist flats, *Themeda* dominates the grassland with Pinrush *Juncus filicaulis*, while River Tussock *Poa labillardieri* is dominant along drainage lines, seepage areas, creeks and river flats. *Poa sieberiana* is dominant on the undulating basalt plains of the Monaro. The upper slopes, hill crests and ridges with well drained soils are generally dominated by Corkscrew *Austrostipa scabra* subsp. *falcata* and Tall Speargrass *A. bigeniculata*, while species of *Austrodanthonia* and *Bothriochloa macra* dominate gentle slopes, ridges and flats with well drained, shallow to skeletal soils. Present grass species dominance is thought to have changed significantly since European settlement because of past land uses. Other grasses such as Common Wheat Grass *Elymus scaber* and Nineawn Grass *Enneapogon nigricans* may also be present frequently, in the inter-tussock spaces.	Endangered	Endangered	None – out of range. Not recorded during field survey.

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions	Tableland Basalt Forest is dominated by an open eucalypt canopy of variable composition. *Eucalyptus viminalis, E. radiata, E. dalrympleana subsp. dalrympleana* and *E. pauciflora* may occur in the community in pure stands or in varying combinations. The community typically has an open canopy of eucalypts with sparse mid-story shrubs (e.g. *Acacia melanoxylon* and *A. dealbata*) and understory shrubs (e.g. *Rubus parvifolius*) and a dense groundcover of herbs and grasses, although disturbed stands may lack either or both of the woody strata. The structure of the community varies depending on past and current disturbances, particularly fire history, clearing and grazing. Contemporary tree-dominated stands of the community are largely relics or regrowth of originally taller forests and woodlands, which are likely to have had scattered shrubs and a largely continuous grassy groundcover. At some sites, mature trees may exceed 30 m tall, although regrowth stands may be shorter than 10 m tall. Tableland Basalt Forest is currently found in the Eastern Highlands and Southern and Central Tablelands, covering the local government areas of Bathurst Regional, Goulburn Mulwaree, Oberon, Palerang, Shoalhaven, Upper Lachlan and Wingecarribee. The community, however, may be found elsewhere within the designated bioregions.	Endangered	-	Low – not recorded during vegetation survey, or previously mapped by Tozer et al. (2006) within the Project Area.
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions	This community, commonly referred to as Tablelands Snow Gum Grassy Woodland, occurs as an open-forest, woodland or open woodland. This community may also occur as a secondary grassland where the trees have been removed, but the groundlayer remains. The main tree species are *Eucalyptus pauciflora* (Snow Gum), *E. rubida* (Candlebark), *E. stellulata* (Back Sallee) and *E. viminalis* (Ribbon Gum), either alone or in various combinations. Other eucalypt species may occur. A shrub layer may be present and sub-shrubs are common. The most common shrubs include Melicytus sp. 'Snowfileds' (Gruggly-bush) and *Melichrus urceolatus* (Urn Heath). The ground layer is grassy, with the most common species including *Themeda australis* (Kangaroo Grass), Poa spp. (snow-grasses), Austrostipa spp. (spear-grasses) and Rytidosperma spp. (wallaby-grasses). Sites in high condition have a range of forb (wildlfower) species, including *Leptorhynchos squamatus* (Scaly-buttons), *Chrysocephalum apiculatum* (Common Everlastings) and *Asperula conferta* (Native Woodlruff). Many threatened flora and fauna species have been recorded in this community.	Endangered	Critically Endangered	None – out of distribution range for this community.
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	The ecological community typically occurs as an open to tall open forest with a sparse to dense layer of shrubs and vines, and a diverse understorey of native grasses, forbs, twiners and ferns. However, the structure of the ecological community may vary from tall open forest with trees up to and above 30 m tall with a projected foliage cover of 30–70% (e.g. *Eucalyptus fastigata* forest on basalt near Sassafras in and around Morton National Park) to woodland with trees 10–30 m tall, with a projected foliage cover of 10–30% (e.g. exposed woodland on rocky microsyenite at Mt Jellore) depending on aspect, slope, soil conditions, soil depth, and previous clearing and disturbance.	Endangered	Endangered	Low – not recorded during vegetation survey, or previously mapped by Tozer et al. (2006) within the Project Area.

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
White Box, Yellow Box, Blakely’s Red Gum Derived Native Grassland	White Box Yellow Box Blakely’s Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: White Box *Eucalyptus albens*, Yellow Box *E. melliodora* and Blakely's Red Gum *E. blakelyi*. Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs. The community also includes a range of mammal, bird, reptile, frog and invertebrate fauna species. Intact stands that contain diverse upper and mid-storeys and groundlayers are rare. Modified sites include the following: •Areas where the main tree species are present ranging from an open woodland formation to a forest structure, and the groundlayer is predominantly composed of exotic species; and •Sites where the trees have been removed and only the grassy groundlayer and some herbs remain. The Australian Government listing of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland is slightly different to the NSW listing. Areas that are part of the Australian Government listed ecological community must have either: •An intact tree layer and predominately native ground layer; or •An intact native ground layer with a high diversity of native plant species but no remaining tree layer.	Endangered	Critically Endangered	Yes – recorded within the Study Area and will be impacted by the Project.

Appendix 2. Plant Community Type Descriptions

PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)

Habitat: PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland occupies the flat terrain and gentle slopes located to the north of the Study Area.

Structure/Characteristics: three different condition classes of the community were recorded in the Study Area. Typically, the best condition of the community consisted of a tree layer ranging in height from 15 - 25 m consisting of *Eucalyptus blakelyi,* and *Eucalyptus melliodora* with the occasional *E. eugenioides* and *E. bosistoana.* A midstorey contained *Acacia mearnsii*, was sparse. The sparse 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 filiform*is subsp. coriacea, Thysanotus patersonii, Anisopogon avenaceus, Poa sieberiana, Austrostipa scabra, and *Aristida ramosa*.

Nassella trichotoma (Serrated Tussock) was in relatively high cover and abundance throughout portions of this PCT within the Study Area.

Condition classes:

Three condition classes were assigned to 1334 Yellow Box - Blakely's Red Gum grassy woodland within the Study Area:

1. Moderate condition: this condition class was the best condition within the Study Area. It consisting of clumps of scattered trees (mainly *E. melliodora* with *E. blakelyiX*) with a mix of native and introduced ground cover. The native ground cover generally comprised of native grasses, including *Bothriochloa macra, Austrodanthonia racemosa, Dichelachne micrantha.* Forbs and shrubs were relatively sparse. Cover of Nassella trichotoma (Serrated Tussock) was relatively high across much of the vegetation zone. The zone had a vegetation integrity score of 40.4
2. Poor condition: consisting of very few scattered *Eucalyptus melliodora, E. bosistoana,* and *E. blakelyi*. Canopy cover was low when compared to benchmark. Acacia parramattensis was scattered in clumps throughout the vegetation zone. Forbs and shrubs were relatively sparse and typically were concentrated under the canopy. Much of this condition class has been used historically for grazing. Portions toward the west at the site of the Western Overburden Emplacement are still grazed. Cover of Nassella trichotoma (Serrated Tussock) was relatively high across much of the vegetation zone. The zone had a vegetation integrity score of 23.7.
3. Acacia/assisted regeneration: consisting of planted and regenerating Acacias and occasional eucalypts (not a CEEC under the EPBC Act). This vegetation zone had a ground cover similar to that of the 'poor condition' class, however tubestock has been planted in areas. The zone had a vegetation integrity score of 26.1.

Conservation Status: This vegetation community in a moderate and poor condition class aligns to the NSW BC Act - White Box Yellow Box Blakely's Red Gum Woodland TEC (EEC) due to the following listing criteria (Scientific Committee 2002) being satisfied within the Study Area:

- Characterised by the presence or prior occurrence of Yellow Box and/or Blakely's Red Gum
- The understorey in intact sites is characterised by native grasses and a high diversity of herbs
- Shrubs are generally sparse or absent, though they may be locally common

- Characteristic species are present as identified in the Scientific Committee (2012)
- Occurs within the known range of the TEC.

In regards to the EPBC Act listing, an analysis of the Determination and Flow Chart Diagram within the EPBC Act Policy Statement (DoE undated) was undertaken. The two different condition classes occurring in the Study Area meet the criteria in different ways. The alignment of each condition class to the CEEC criteria is provided in Table 15.

Resilience and ability to regenerate:

The historic clearing coupled with the existing and historic grazing within the Study Area has resulted in most of the Study Area having a low to moderate resilience. Serrated tussock was a dominant grass within much of the Study Area. It is likely that this species would continue to expand throughout the patches and would outcompete native groundcover. Extensive weed management would need to be undertaken in order to assist natural regeneration.

Table 15. Alignment to TEC determinations

Condition	Description	Comparison to the TSC Act Determination	Comparison EPBC Act Determination
Moderate	▪ The presence of diagnostic mature trees including *Eucalyptus blakelyi, E. melliodora* and *E. eugenioides* in an open woodland formation. ▪ Presence of diagnostic groundcover plant species including some important species (excluding grasses). ▪ Presence of regenerating over-storey species. ▪ Moderate occurrence of exotic plant species. ▪ The patch has a high resilience.	▪ Characterised by the presence or prior occurrence of *Eucalyptus albens, E. melliodora* and/or *E. blakelyi*. ▪ The understorey is characterised by native grasses and a high diversity of herbs. ▪ Shrubs are generally sparse or absent, though they may be locally common. ▪ Characteristic species are present as identified in the Scientific Determination. ▪ Occurs within the known range of the TEC.	▪ Diagnostic species present. ▪ Predominantly native understorey. ▪ Whilst the plots undertaken did not contain greater than 12 native understorey species (excluding grasses), the size of the patch when adjacent grassland areas are included is greater than 2 ha. ▪ Mature trees and natural regeneration of eucalypts is present.
Poor	▪ Reduced diversity of characteristic canopy dominants in the overstorey stratum with diagnostic tree species confined to *Eucalyptus blakelyi* and *E. melliodora.* ▪ Low to very low diversity of White Box Yellow Box Blakely's Red Gum Woodland CEEC groundcover plant species (excluding grasses). Rare occurrences of important species of which there were 0 to 2 of in floristic plots conducted within the degraded condition class. ▪ Regenerating over storey species. ▪ Moderate to high occurrence of exotic plant species. ▪ A long history of grazing.	▪ Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum. ▪ The understorey in intact sites is characterised by native grasses and some diversity of herbs. ▪ Shrubs are generally sparse or absent. ▪ Characteristic species are present as identified in the Scientific Determination. ▪ Occurs within the known range of the TEC.	▪ Whilst in a disturbed condition, diagnostic species such as overstorey eucalypts are present. ▪ Whilst the plots undertaken did not contain greater than 12 native understorey species (excluding grasses), the size of the patch when adjacent grassland areas are included is greater than 2 ha. ▪ Mature trees and natural regeneration of eucalypts are present.
Acacia	▪ Reduced diversity of characteristic canopy dominants in the overstorey stratum with diagnostic tree species confined to *Eucalyptus blakelyi* and *E. melliodora.* ▪ Low to very low diversity of White Box Yellow Box Blakely's Red Gum Woodland CEEC groundcover plant species	▪ Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum. ▪ The understorey in intact sites is characterised by native grasses and some diversity of herbs. ▪ Shrubs are generally sparse or absent.	▪ The plots did not contain greater than 12 native understorey species. ▪ The plots did not contain on average greater than 20 mature eucalypts or natural regeneration amongst mature eucalypts.

Condition	Description	Comparison to the TSC Act Determination	Comparison EPBC Act Determination
	(excluding grasses). Rare occurrences of important species of which there were 0 to 2 of in floristic plots conducted within the degraded condition class. ▪ High occurrence of exotic plant species. ▪ A long history of grazing. ▪ Assisted regeneration dominated by the planting on Acacia tubestock (mainly Acacia parramattensis)	▪ Characteristic species are present as identified in the Scientific Determination. ▪ Occurs within the known range of the TEC.	

Photo 4. PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands moderate condition

Photo 5. PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands poor condition

Photo 6. PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Acacia regrowth/assisted plantings

PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin

Habitat: PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin is equivalent to Tozer et al (2006) mapping unit p.27 Bungonia Slates Woodland. The PCT is found in the study are on the slopes where it comprise of a woodland to forest formation particularly toward the south-east of the Study Area. The vegetation community transitions into PCT 1334 on the gentle slopes and flat terrain. A degree of difficulty in determining the transition zone between the two communities was attributed due to the presence of Eucalyptus bosistoana which intergraded with E. melliodora. As discussed with OEH botanist John Briggs whilst on-site on the 16th June 2015, landscape position plays an important part in separating PCT 778 from PCT 778. As such, the steeper slopes have been attributed to the PCT 778 community.

Structure/Characteristics: Two different condition classes of the community were recorded in the Study Area. The best condition of the community consisted of a tree layer ranging in height from 15 - 25 m consisting of *Eucalyptus bosistiana,* and *E. blakelyi/E. tereticornis* with *E. eugenioides.* The sparse shrub layer consisted of *Cassinia aculeata, Lissanthe strigosa* and *Olearia viscidula.* The ground layer consisted of *Austrodanthonia racemosa, Microlaena stipoides, Bothriochloa macra, Acaena novae-zelandiae, Lomandra filiform*is subsp. coriacea, Anisopogon avenaceus, Poa sieberiana and *Aristida ramosa*.

Like that of PCT 1334, *Nassella trichotoma* (Serrated Tussock) was in relatively high cover and abundance throughout portions of this PCT within the Study Area.

Condition classes:

Two condition classes were assigned to PCT1334 within the Study Area:

Moderate: Consisting of a canopy dominated by *Eucalyptus bosistoana* and E. blakelyi/E.tereticornis with a mixture of native and introduced ground cover.

Poor: Typically lacked a canopy and shrub layer. Consisted predominantly of a native and introduced ground cover. This condition class typically occurred within the transmission line easement on steep slopes.

Conservation Status: This PCT does not align to a TEC under State or Commonwealth legislation.

Photo 7. PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin – Moderate Condition

Photo 8. PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin – Poor Condition

PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion

Habitat: PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion is equivalent to Tozer et al (2006) mapping unit P10. Eastern Tablelands Dry Forest.

The PCT is found in the study are on the upper slopes where it is of a forest formation with an open understorey of sclerophyll shrubs, sedges and forbs. It occurs only as relatively small patches toward the south and middle of the Study Area.

Structure/Characteristics: Two different condition classes of the community were recorded in the Study Area:

The best condition of the community consisted of a tree layer ranging in height from 10 - 25 m consisting of *Eucalyptus seiberi,* E. agglomerata and E. eugeniodes. The sparse shrub layer consisted of Persoonia linearis, Allocasuarina littoralis, Hibbertia obtusifolia, Stypandra glauca. *Cassinia aculeata, Lissanthe strigosa* and *Olearia viscidula.* The ground layer consisted of *Lepidosperma laterale, Lomandra filiform*is, and Austrodanthonia spp..

Condition classes:

Two condition classes were assigned to PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest within the Study Area:

Moderate: Consisting of a canopy dominated by *Eucalyptus seiberi,* E. agglomerata and E. eugeniodes with a mixture of native and introduced ground cover.

Poor: this condition class lacked a canopy and shrub layer leaving only a native and introduced ground cover.

Conservation Status: This PCT does not align to a TEC under State or Commonwealth legislation.

Photo 9. PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion – Moderate Condition

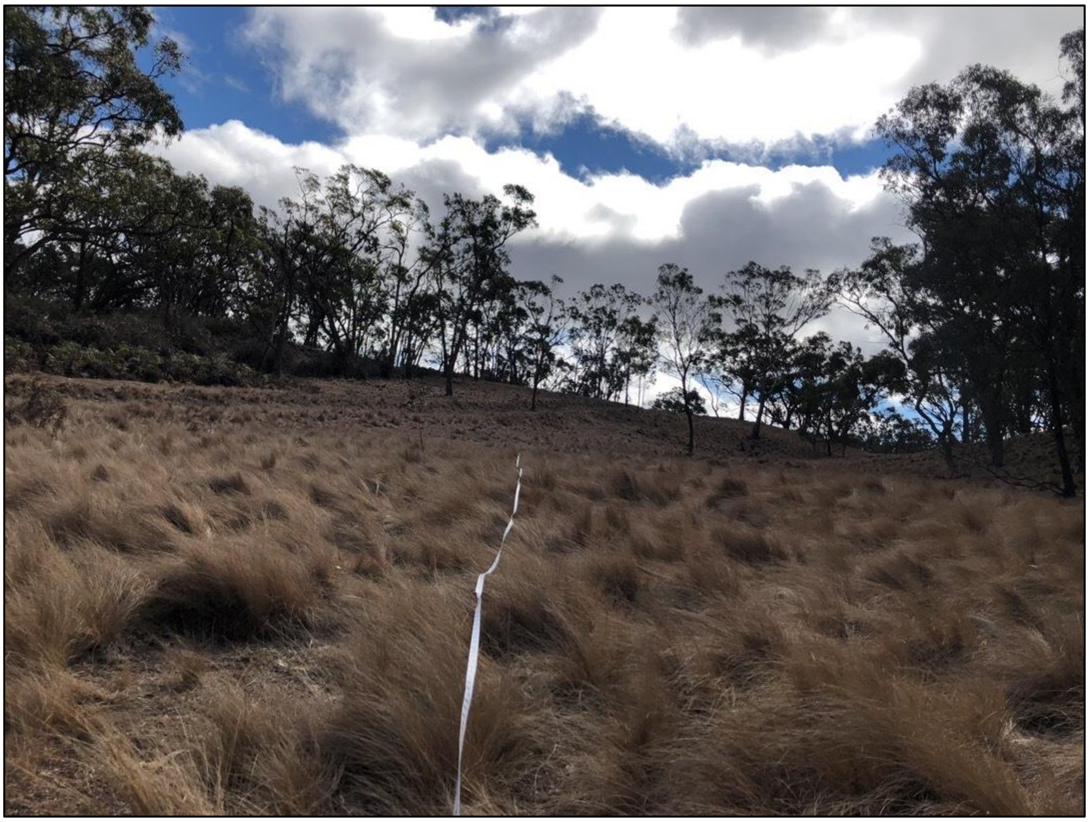


Photo 10. PCT 1150 - Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion – Poor Condition

PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion

Habitat: PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion is equivalent to Tozer et al (2006) mapping unit P23. Tableland Hills Grassy Woodland. The PCT is found in the study are on the slopes where it comprise of a woodland to forest formation particularly toward the south-east of the Study Area. The vegetation community transitions into PCT 1334 on the gentle slopes and flat terrain. A degree of difficulty in determining the transition zone between the two communities was attributed due to the presence of similar overstorey species. However, the presence of Eucalyptus goniocalyx is listed as an associate species with P23. Tableland Hills Grassy Woodland and not P24.Tableland Grassy Box-Gum Woodland.

Structure/Characteristics: One condition class was assigned to PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest within the Study Area: Moderate condition which consisting of a canopy dominated by *Eucalyptus goniocalyx, E. bosistoana E. eugenoides, E. cinerea, E. dives* and E. blakelyi/E.tereticornis with a mixture of native and introduced ground cover. The sparse shrub layer consisted of *Cassinia aculeata, Lissanthe strigosa* and *Olearia viscidula.* The ground layer consisted of *Austrodanthonia racemosa, Microlaena stipoides, Bothriochloa macra, Acaena novae-zelandiae, Lomandra filiform*is subsp. coriacea, T Anisopogon avenaceus, Poa sieberiana and *Aristida ramosa*.

Like that of PCT 1334, *Nassella trichotoma* (Serrated Tussock) was in relatively high cover and abundance throughout portions of this PCT within the Study Area.

Conservation Status: This PCT does not align to a TEC under State or Commonwealth legislation.

Photo 11. PCT 731 - Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion

PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin – BEST FIT

Habitat: occurs as small intermittent strips of native sedges and rushes along Marulan Creek generally in areas which receive semi-permanent pooling.

Structure/Characteristics: Cleared vegetation comprising of introduced pasture on the banks and within the proposed Marulan Creek Dam Inundation Area a mix of exotic grasses and native water dependent species.

No PCT matches the description of the vegetation observed on-site. Given the highly degraded condition the native vegetation integrity score was 8.9. This is below the amount required (>17 score) that triggers the requirement to offset.

Distribution within Project site: Occurs sporadically along Marulan Creek where there are patches of permanent to semi-permanent pools. Occurs at the northern end of the Project site within the proposed Marulan Creek Dam proposed Marulan Creek Dam Inundation Area.

Condition and Presence of Weeds: the vegetation has been cleared and grazed. As a result, no trees occur along the banks. Exotic pasture grasses surround the proposed Marulan Creek Dam proposed Marulan Creek Dam Inundation Area and occur within the areas that receive less water. In the deeper channel of the proposed Marulan Creek Dam proposed Marulan Creek Dam Inundation Area where water holds for a long period, native species occur including: *Plantago lanceolata, Anagallis arvensis, Juncus usitatus,* and *Paspalum dilatumdilatatum*.

Conservation Status: This PCT does not align to a TEC under State or Commonwealth legislation.

Photo 12. Water-dependent native vegetation along portions of Marulan Creek.

Non-native vegetation

Portions of the Study Area have been extensively cleared, and have a soil profile which offers very little resilience to regenerate to a native vegetation community. These areas have been attributed to non-native vegetation type given the historic disturbance. These areas are dominated by introduced grasses and herbaceous weeds, including: *Plantago lanceolata, Hypochaeris radicata, Pennisetum clandestina, Setaria gracilis, Nassella trichotoma and Paspalum dilatatum.*

Photo 13. Example of Non-native vegetation

Appendix 3. Floristic plot data

Plot Data extracted from Fulcrum digital data collection – Evidence of the raw Fulcrum data files can be provided upon request as handwritten datasheets are no longer used. The below species lists can be provided in excel format upon request.

Species	1139b		1143		1144b		1384		1386b		1389b		1393b		1424		l1429b		l1432b		lb02		lb03		lb04		lb05		lb06		lb07		lb08		lb09		lb10		2498l1410b		2498l1412b		2498l1414b		2498l1415b		2498L1416b		2498lp01	
	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C
Acacia falcata													0	0.5	0	10													0	2			0	1																
Acacia floribunda																									0	5																								
Acacia mearnsii			0	10	0	0.5			0	15			0	10	0	5	0	1	0	5	0	1			0	40			0	15	0	15	0	5	0	15	0	15												
Acacia parramattensis																																							0	1	0	1			0	5				
Acaena novae-zelandiae	0	0.1	0	0.1					0	0.1											0	0.1					0	0.1	0	1	0	0.5	0	0.1			0	0.1			0	0.1	0	0.1	0	0.5			0	0.2
Allocasuarina littoralis																											0	2																						
Anagallis arvensis																							3	0.1											0	0.1	0	0.1												
Aristida ramosa													0	5																					0	5	0	1												
Asperula conferta																																															0	0.2		
Austrostipa ramosissima																	0	1																							0	5								
Austrostipa scabra											0	10															0	0.1																						
Bothriochloa macra	0	20	0	20	0	10	0	5	0	40	0	25											0	10	0	1					0	35	0	5	0	15	0	5					0	5	0	10	0	10	0	20
Cassinia longifolia																																							0	20	0	5								
Cassinia spp.																													0	0.5																				
Cassinia uncata					0	0.1									0	2	0	20	0	15	0	5											0	30																
Centella asiatica																																					0	0.1												
Cheilanthes sieberi	0	0.1																																																
Chloris gayana									0	2																																								
Cirsium vulgare											0	0.1									0	0.1					0	0.1							0	0.1			0	0.1	0	0.1	0	0.1			0	0.2		
Clematis aristata																			0	0.5																			0	0.1										
Clematis microphylla																	0	0.1																																
Conyza bonariensis																																															0	0.1		
Cotoneaster glaucophyllus																																							0	0.5										
Cotula australis																																							0	0.5										
Cynodon dactylon																																															0	3		
Desmodium varians																																											0	0.2						
Dianella revoluta																					0	0.1																												
Dichelachne micrantha																									0	0.2															0	5	0	10	0	5			0	5
Dichondra repens			0	0.1	0	0.1					0	0.1	0	0.1			0	0.1	0	0.1	0	0.1							0	0.1			0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.5	0	0.5	0	1	0	0.5
Einadia nutans	0	0.1	0	0.1	0	0.2					0	0.1	0	0.1																			0	0.1																
Entolasia stricta					0	0.1																																	0	1			0	0.5						
Eucalyptus agglomerata															0	15																																		
Eucalyptus amplifolia																	0	5																							0	5								
Eucalyptus blakelyi					0	15	0	10			0	20					0	5							0	1	0	3																						
Eucalyptus bosistoana			0	10													0	20	0	15	0	30							0	5									0	20			0	5	0	5			0	10
Eucalyptus bridgesiana																																	0	20																
Eucalyptus cinerea																											0	3																						
Eucalyptus eugenioides																	0	1	0	5					0	0.5			0	2															0	5	0	10		
Eucalyptus globoidea													0	15							0	1																												
Eucalyptus goniocalyx															0	15																																		
Eucalyptus mannifera													0	5													0	5	0	10																				
Eucalyptus melliodora	0	10			0	15	0	5	0	5											0	5			0	5	0	15									0	0.1									0	4		

Species	1139b		1143		1144b		1384		1386b		1389b		1393b		1424		l1429b		l1432b		lb02		lb03		lb04		lb05		lb06		lb07		lb08		lb09		lb10		2498l1410b		2498l1412b		2498l1414b		2498l1415b		2498L1416b		2498lp01	
	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C
Eucalyptus sieberi													0	5																																				
Eucalyptus tereticornis																																							0	5	0	2								
Eucalyptus viminalis																																							0	5			0	2						
Galium divaricatum																																					0	0.1												
Galium propinquum																																											0	0.1	0	0.5	0	2		
Gamochaeta calviceps																																			0	0.1	0	0.5												
Geranium homeanum					0	0.1							0	0.1	3	0.2	0	0.1			0	0.1					0	0.1	0	0.2			0	0.1			0	0.1	0	0.2			0	0.2	0	0.2				
Geranium solanderi			0	0.1															0	0.1																			0	0.1	0	0.5	0	0.2	0	0.2	0	0.2	0	0.1
Glycine tabacina															3	0.1																											0	0.1	0	0.1				
Gonocarpus tetragynus			0	0.1									0	0.2															0	0.1																				
Goodenia bellidifolia													0	0.1															0	0.1																				
Hardenbergia violacea													0	0.1							0	0.1																												
Hibbertia spp.																																	0	0.1																
Hypericum gramineum	0	0.1									0	0.1																	0	0.1																				
Hypericum perforatum	0	0.1																																																
Hypochaeris radicata									0	5			0	0.1									2	0.1			0	0.1	0	0.1	0	2					0	1	0	0.1			0	0.5	0	1	0	5		
Indigofera australis																													0	0.1																				
Juncus spp.									0	0.1	0	0.1															0	0.1																						
Lagenophora spp.																																													0	0.5				
Lepidosperma gunnii																					0	0.1																												
Lepidosperma laterale															3	0.2	0	0.1	0	0.1													0	0.1					0	0.1										
Lissanthe strigosa	0	0.1	0	1	0	1									0	3	0	1	0	0.2	0	2											0	3	0	0.1									0	0.5				
Lomandra filiformis			0	0.1	0	0.2							0	0.5	5	1	0	2									0	0.1	0	0.5			0	0.1					0	0.5					0	0.5			0	0.1
Lomandra longifolia																			0	0.1	0	0.1																												
Lomandra multiflora subsp. multiflora			0	0.1	0	0.1							0	0.1			0	0.1																																
Lycium ferocissimum																																													0	0.1				
Microlaena stipoides											0	5															0	0.2	0	1					0	1			0	5	0	5								
Monotoca scoparia	0	0.1																																																
Myoporum spp.																					0	0.1																												
Nassella trichotoma			0	40	0	30	0	0.5	0	5	0	10	0	20			0	10	0	3			0	5	0	1			0	0.5	0	10	0	5	0	40	0	40			0	55	0	50	0	20	0	40	0	55
Olearia viscidula																																									0	0.5								
Oxalis perennans																	0	0.1	0	0.1									0	0.1					0	0.1	0	0.1			0	0.1	0	0.1						
Ozothamnus diosmifolius																											0	0.1																						
Paspalum dilatatum																																							0	2	0	15								
Patersonia sericea	0	0.1																																																
Phyllanthus hirtellus													0	0.1																																				
Pittosporum undulatum																			0	1																														
Plantago debilis																	0	0.1																																
Plantago lanceolata							0	0.5	0	5	0	0.5	0	0.1																			0	0.5	0	0.1	0	0.1	0	0.1			0	3	0	1	0	5	0	1
Poa sieberiana															0	5	0	5	0	4	0	3							0	0.5									0	1										
Polygonum aviculare											0	0.1																																						
Pomax umbellata													0	0.1																																				

Species	**1139b**		**1143**		**1144b**		**1384**		**1386b**		**1389b**		**1393b**		**1424**		**l1429b**		**l1432b**		**lb02**		**lb03**		**lb04**		**lb05**		**lb06**		**lb07**		**lb08**		**lb09**		**lb10**		**2498l1410b**		**2498l1412b**		**2498l1414b**		**2498l1415b**		**2498L1416b**		**2498lp01**	
	A	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**
Poranthera spp.																																																0	0.1		
Pteridium esculentum																															0	4																			
Rhytidosporum spp.	0	53	0	10	0	10					0	15			0	0.5			0	5	0	3	0	5	0	1	0	2	0	1	0	5	0	5	0	15					0	5	0	15			0	15	0	15
Rubus fruticosus											0	1																			0	1			0	5	0	0.1	0	0.1					0	0.1				
Rumex brownii																			0	0.1											0	0.1									0	0.1	0	0.1						
Senecio linearifolius																	0	0.1	0	1																					0	0.1								
Senecio madagascariensis																	0	0.1																							0	0.1								
Setaria gracilis																																															0	20		
Solanum celatum																					0	0.1																												
Solanum nigrum																																													0	0.1				
Sporobolus creber																																									0	5								
Urtica incisa																																									0	0.1								
Veronica plebeia	0	0.1									0	0.1																	0	0.1			0	0.1	0	0.1														
Vittadinia cuneata																											0	0.1																						

	24		**25**		**26**		**28**		**31**		**1410**		**1412**		**1413**		**1414**		**1415**		**1416**	
Species	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**
Acacia parramattensis											1	1	1	1						5		
Acaena novae-zelandiae									5	0.1												
Acaena zelandiae			5	0.1	2	0.1	10	0.1														
Acaena novae-zelandiae													5	0.1			5	0.1	10	0.5		
Asperula conferta			5	0.1	2	0.1																
Asperula conferta conferta																					5	0.2
Austrodanthonia racemosa		25		30		15		10		5						25						
Austrodanthonia tenuior tenuior																						15
Austrostipa scabra				5		5	100	3		5												
Austrostipa ramosissima														5								
Austrostipa scabra scabra																						5
Axonopus virginicus		5						15		5												
Bidens pilosa					3	0.1																
Bothriochloa macra				20		20		25		15												
Bothriochloa macra																		5		10		
Bromus cartharticus																5						
Bromus cartharticus cartharticus																						10
Carex inversa			5	0.1	1	0.1																
Carex inversa															1	0.1						
Cassinia uncata															4	2						
Cassinia longifolia												20		5								
Centella asiatica	5	0.1							10	0.2												
Cheilanthes seiberi	5	0.1	10	0.1	3	0.1	3	0.1														
Chrysophephalum apiculatum	2	0.1																				
Cirsium vulgare											1	0.1	2	0.1	10	0.5	5	0.1				

	24		25		26		28		31		1410		1412		1413		1414		1415		1416	
Species	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C
Cirsium vulgare vulgare																					4	0.5
Clematis aristata											1	0.1										
Convolulous graminetinus															1	0.1						
Conyza bonariensis									10	0.3												
Cotoneaster glaucophyllus											5	0.5										
Cotula australis												0.5										
Cyperus gracilis	1	0.1																				
Dactylis glomerata glomerata																					4	0.2
Desmodium varians															4	0.1	20	0.2				
Dichelachne micrantha		15																				
Dichelachne micrantha														5				10		5		
Dichondra repens			20	0.2	4	0.2									30	0.2						
Dichondra repens											50	0.1	1	0.1			100	0.5	50	0.5		
Dichondra repens repens																					5	0.3
Entolasia stricta											20	1					5	0.5				
Eucalyptus blakelyi																10						
Eucalyptus eugenioides		5																				
Eucalyptus melliodora		5																				
Eucalyptus amplifolia														5								
Eucalyptus bosistiana																15						
Eucalyptus bosistoana												20						5		5		
Eucalyptus eugenioides																				5		
Eucalyptus eugenioides eugeniodes																						5
Eucalyptus melliodora melliodora																						15
Eucalyptus tereticornis												5		2								
Eucalyptus viminalis												5					1	2				
Galium propinquum																	2	0.1	50	0.5		
Geranium solanderi															20	0.2						
Geranium homeanum											50	0.2					50	0.2	50	0.2		
Geranium solanderi											50	0.1	1	0.5			50	0.2	20	0.2		
Geranium solanderi solanderi																					10	0.1
Glycine tabacina									15	0.1												
Glycine tabacina															5	0.1	2	0.1	10	0.1		
Hymenanthera dentata															2	0.1						
Hypericum peforatum									5	0.1												
Hypericum perforatum							20	0.1														
Hypochaeris radicata			25	0.5	5	0.5																
Hypochaeris radicata											5	0.1					50	0.5	100	1		
Juncus spp.			2	0.1																		
Lagenophora spp.																			2	0.5		
Lepidosperma laterale											1	0.1										
Lissanthe strigosa	5	0.5					5	1							20	4						

	24		25		26		28		31		1410		1412		1413		1414		1415		1416	
Species	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**	**A**	**C**
Lissanthe strigosa																			5	0.5		
Lolium perenne perenne																						15
Lomandra filiformis							25	0.5							15	0.3						
Lomandra filiformis											30	0.5							10	0.5		
Lycium ferocissimum																			1	0.1		
Medicago arabica									10	0.1												
Microlaena stipoides												5		5								
Nassella tenuissima		40		45		25		45		45						30						
Nassella tenuissima tenuissima																						35
Nassella trichotoma														55				50		20		
Olearia viscidula													1	0.5								
Opuntia stricta							2	0.1														
Oxalis perennans	20	0.1							20	0.2												
Oxalis perennans													1	0.1			30	0.1				
Panicum effusum		15								5												
Paspalum dilatatum				10		5																
Paspalum dilatatum											50	2		15								
Passiflora spp.															1	0.1						
Pennisetum cladenstina						5																
Plantago debilis															9	0.1						
Plantago lanceolata	5	0.5	5	0.5	5	0.5			20	0.5												
Plantago lanceolata											5	0.1					200	3	100	1		
Plantago lanceolata lanceolata																					20	0.5
Poa annua							60	3		5												
Poa sieberiana																5						
Poa sieberiana											20	1										
Rhytidosporum spp.														5				15				
Rubus fruiticosus									2	1												
Rubus fruticosus			2	1			1	1														
Rubus fruticosus											5	0.1							5	0.1		
Rumex brownii													1	0.1			2	0.1				
Rumex brownii brownii																					1	0.1
Senecio linearifolius													1	0.1								
Senecio madagascariensis													3	0.1								
Setaria gracilis				5		5																
Solanum nigrum																			1	0.1		
Sporobolus creber														5								
Themeda australis								5		5												
Urtica incisa													3	0.1								
Vulpia myuros myuros																						5
Wahlenbergia gracilis					1	0.1																

Appendix 4. Plot transect scores

Location details									Composition						Structure						Function										
plot	pct	area	patchsize	conditionclass	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to10	funTreeStem10to20	funTreeStem20to30	funTreeStem30to50	funTreeStem50to80	funTreeRegen	funHighThreatExotic
2155s01	1150	2.6	2000	Poor	56	227478	6148587.0	15	1	2	6	2	0	0	1.0	1.0	35.0	0.2	0.0	0.0	0	0	66.0	0.0	1	0	0	1	0	1	45.0
2155lb088	731	12.0	2000	Medium	56	227097.7	6147556.9	10	3	3	4	6	0	3	20.0	12.0	40.0	1.3	0.0	0.5	0	0	64.0	30.0	1	1	1	0	0	1	30.0
2155lb14	731	12.0	2000	Medium	56	227241	6147585.9	187	2	3	4	7	0	2	15.0	13.0	35.0	1.0	0.0	0.4	0	0	7.5	58.0	0	1	1	0	0	0	40.0
2155lb16	731	12.0	2000	Medium	56	227134.6	6147615.5	170	2	2	4	5	0	4	15.0	11.0	21.0	0.7	0.0	0.2	0	0	18.0	21.0	1	1	1	1	1	0	35.0
2155l1429b	778	57.9	2000	Medium	56	227727.3	6147161.7	160	4	3	5	5	0	1	31.0	22.0	8.2	0.5	0.0	0.1	0	0	78.0	36.0	1	1	1	1	0	0	10.0
2155l1432b	778	57.9	2000	Medium	56	227382.4	6147088.4	200	2	5	3	5	0	1	20.0	26.2	4.2	1.4	0.0	0.5	1	0	76.0	42.0	1	1	1	1	1	1	3.0
2155lb02	778	57.9	2000	Medium	56	227623	6146929.0	120	3	6	3	4	0	1	36.0	11.2	3.2	0.4	0.0	0.1	0	1	54.0	35.0	1	1	1	1	0	1	0.0
2498l1410b	778	57.9	2000	Medium	56	228004.3	6148656.7	340	4	1	5	4	0	1	31.0	20.0	7.6	0.9	0.0	0.1	1	0	74.0	25.0		1	1	1	1	0	2.0
2498l1412b	778	57.9	2000	Medium	56	228045.7	6148768.3	0	3	3	4	7	0	0	8.0	10.5	20.0	1.1	0.0	0.0	1	1	62.0	30.0	0	1	1	1	1	0	70.0
28	778	7.5	2000	Poor	56	227725	6148828.0	56	0	1	4	2	0	2	0.0	0.5	16.0	0.1	0.0	0.2	0	0	55.0	0.0	0	0	0	0	0	0	45.0
31	778	7.5	2000	Poor	56	227935	6148957.0	88	0	2	6	2	0	3	0.0	1.5	12.0	0.5	0.0	0.6	0	0	65.0	0.0	0	0	0	0	0	0	55.0
2155c01	778	7.5	2000	Poor	56	227744	6148787.0	270	1	2	4	1	0	0	1.0	1.0	20.0	0.1	0.0	0.0	0	0	55.0	0.0	1	0	0	1	0	1	40.0
2155a1	778	0.1	2000	Waterdependent	56	227504	6151693.0	47	0	0	2	2	0	4	0.0	0.0	5.0	0.6	0.0	40.0	0	0	40.0	0.0	0	0	0	0	0	0	25.0
2155lb04	1334	7.9	2000	Acacia_plantings	56	226668.7	6148325.3	230	3	3	2	0	0	0	6.5	46.0	1.2	0.0	0.0	0.0	0	0	56.0	0.0	1	1	0	0	0	0	1.0
2155lb05	1134	7.9	2000	Acacia_plantings	56	226623.3	6148301.7	210	5	2	4	3	0	0	28.0	2.1	0.5	0.3	0.0	0.0	0	0	67.0	5.0	1	1	1	1	0	1	0.0
2155lb09	1334	7.9	2000	Acacia_plantings	56	226896.1	6147721.6	120	0	3	3	3	0	0	0.0	30.1	21.0	0.3	0.0	0.0	0	0	34.0	0.0	1	1	0	0	0	1	40.0
2155lb10	1334	7.9	2000	Acacia_plantings	56	226732.6	6147692.2	46	1	1	2	5	0	0	0.1	15.0	6.0	0.5	0.0	0.0	0	0	31.0	20.0	1	1	0	0	0	1	40.0
2155lb07	1334	7.9	2000	Acacia_plantings	56	226842.5	6148155.8	220	0	2	1	2	0	0	0.0	20.0	35.0	0.6	0.0	0.0	0	0	11.0	0.0	0	1	1	0	0	0	10.0
2155lb08	1334	7.9	2000	Acacia_plantings	56	226695.1	6148084.0	190	1	6	3	5	0	0	20.0	44.1	5.2	0.5	0.0	0.0	0	0	45.0	0.0	1	1	1	0	0	1	5.0
2498l1415b	1334	48.8	2000	Medium	56	228141.2	6149141.8	40	3	1	3	6	0	1	15.0	0.5	15.5	2.4	0.0	0.1	0	0	44.0	20.0	0	1	1	1	0	1	20.1
2498l1416b	1334	48.8	2000	Medium	56	228077.6	6149315.9	195	2	1	2	5	0	0	14.0	15.0	13.0	3.5	0.0	0.0	2	1	40.0	24.0	0	0	1	1	1	0	40.0
2498lb01	1334	48.8	2000	Medium	56	227783.4	6149329.4	130	1	1	3	3	0	0	10.0	15.0	25.1	0.8	0.0	0.0	1	0	54.0	0.0	0	0	0	1	1	1	55.0
2155l1139b	1334	48.8	2000	Medium	56	226917.2	6147894.6	60	1	3	1	5	1	0	10.0	53.2	20.0	0.5	0.1	0.0	0	0	48.0	0.0	1	1	0	0	0	1	0.1
2155l1143b	1334	48.8	2000	Medium	56	226975.1	6147765.4	210	1	3	3	5	0	0	10.0	21.0	20.2	0.5	0.0	0.0	0	0	62.0	10.0	1	1	1	1	0	1	40.0
2155l1144b	1334	48.8	2000	Medium	56	227029.1	6147661.5	200	2	4	4	3	0	0	30.0	11.6	10.4	0.4	0.0	0.0	0	0	66.0	15.0	1	1	1	0	0	1	30.0
2155l1389b	1334	48.8	2000	Medium	56	226848	6148034	70	1	1	4	4	0	0	20.0	15.0	40.1	0.4	0.0	0.0	1	0	73.0	30.0	1	1	1	1	1	1	10.0
2155Lb17	1334	48.8	2000	Medium	56	226806.2	6148603.9	190	1	0	6	3	0	3	5.0	0.0	35.0	0.5	0.0	0.2	1	1	47.0	1.5	1	0	1	1	1	1	15.0
02	1334	48.8	2000	Medium	56	227727	6149114	167	2	2	4	6	1	3	15	5	35	2.0	0.1	0.5	0	0	75	6.5	1	1	1	0	0	0	35.0
1414	1334	48.8	2000	Medium	56	227966	6149217	308	2	1	3	7	0	2.0	7	15.0	15.5	1.3	0.0	0.3	1	1	68.0	5.0	0	0	0	1	0	0	50.0
2155l1384b	1334	31.9	2000	Poor	56	226827	6148328.2	300	2	0	1	0	0	0	15.0	0.0	5.0	0.0	0.0	0.0	1	0	64.0	0.0	1	0	0	1	1	1	0.5
2155lb18	1334	31.9	2000	Poor	56	226881	6148375	119	1	1	6	2	0	1	1.0	0.5	45.0	0.8	0.0	0.1	0	0	76.0	0.0	0	0	0	0	0	1	5.0
24	1334	31.9	2000	Poor	56	228136	6149301	101	1	2	6	4	0	2	1.0	1.0	10.0	3.0	0.0	4.0	0	0	60.0	0.0	0	0	1	0	0	0	50.0
25	1334	31.9	2000	Poor	56	227875	6149491	100	2	3	4	2	0	2	1.0	1.0	15.0	5.0	0.0	3.0	0	0	65.0	0.0	0	0	1	0	0	0	55.0
26	1334	31.9	2000	Poor	56	228036	6149467	96	0	0	5	2	0	2	0.0	0.0	22.0	0.6	0.0	0.1	0	0	55.0	2.5	0	0	0	0	0	0	50.0
2155l1393b	1150	13.7	2000	Medium	56	227242.8	6147988.7	23	3	3	3	6	0	1	25.0	10.6	5.6	0.7	0.0	0.1	0	0	78.0	30.0	1	1	1	1	0	1	20.0
2155l1424b	1150	13.7	2000	Medium	56	227036	6147266.4	200	2	5	3	1	0	1	30.0	20.5	6.2	0.2	0.0	0.1	0	0	78.0	15.0	1	1	1	0	0	0	0.0
2155lb22	1150	13.7	2000	Medium	56	227218	6148075	15	3	4	3	3	0	1	25.0	5.0	4.2	0.5	0.0	0.1	0	0	66.0	22.5	1	1	1	1	0	1	5.0

Appendix 5. Fauna survey species list and survey weather details

Group	Scientific name	Common name	Status	Observation type	Observer
Amphibia	*Crinia parinsignifera*	Beeping froglet	P	H	Simon Tweed
Amphibia	*Crinia signifera*	clicking froglet	P	H	Simon Tweed
Amphibia	*Crinia signifera*	clicking froglet	P	H	Simon Tweed
Amphibia	*Crinia signifera*	clicking froglet	P	H O	Simon Tweed
Amphibia	*Crinia signifera*	clicking froglet	P	H	Simon Tweed
Amphibia	*Limnodynastes tasmaniensis*	Spotted marsh Frog	P	H	Simon Tweed
Amphibia	*Limnodynastes tasmaniensis*	Spotted marsh Frog	P	H	Simon Tweed
Amphibia	*Limnodynastes tasmaniensis*	Spotted marsh Frog	P	H	Simon Tweed
Amphibia	*Limnodynastes tasmaniensis*	Spotted marsh Frog	P	H	Simon Tweed
Amphibia	*Limnodynastes peronii*	striped marsh frog	P	H	Simon Tweed
Amphibia	*Limnodynastes peronii*	striped marsh frog	P	H	Simon Tweed
Amphibia	*Limnodynastes peronii*	striped marsh frog	P	H	Simon Tweed
Amphibia	*Litoria verreauxii*	whistling tree frog	P	H	Simon Tweed
Amphibia	*Litoria verreauxii*	whistling tree frog	P	H	Simon Tweed
Amphibia	*Uperoleia rugosa*		P	H	Simon Tweed
Amphibia	*Uperoleia rugosa*		P	H	Simon Tweed
Amphibia	*Litoria verreauxii*	whistling tree frog	P	O	Simon Tweed
Amphibia	*Litoria nudidigitus*	southern leaf green tree frog	P	O	Simon Tweed
Amphibia	*Litoria lesueurii*	stoney creek frog	P	O	Simon Tweed
Amphibia	*Litoria lesueurii*	stoney creek frog	P	O	Simon Tweed
Amphibia	*Litoria verreauxii*	whistling tree frog	P	O	Simon Tweed, Matthew Stanton
Amphibia	*Litoria nudidigitus*	southern leaf green tree frog	P	O	Simon Tweed, Matthew Stanton
Amphibia	*Litoria lesueurii*	stoney creek frog	P	O	Simon Tweed, Matthew Stanton
Amphibia	*Litoria lesueurii*	stoney creek frog	P	O	Simon Tweed, Matthew Stanton
Aves	*Cracticus tibicen*	Australian Magpie	P	H	Simon Tweed
Aves	*Cracticus tibicen*	Australian Magpie	P	H O	Simon Tweed
Aves	*Cracticus tibicen*	Australian Magpie	P		Simon Tweed
Aves	*Cracticus tibicen*	Australian Magpie	P	H	Simon Tweed
Aves	*Aegotheles cristatus*	Australian Owlet-nightjar	P	H	Simon Tweed
Aves	*Corvus coronoides*	Australian Raven	P	H	Simon Tweed

Group	Scientific name	Common name	Status	Observation type	Observer
Aves	*Corvus coronoides*	Australian Raven	P	O H	Simon Tweed
Aves	*Corvus coronoides*	Australian Raven	P	H	Simon Tweed
Aves	*Corvus coronoides*	Australian Raven	P	O H	Simon Tweed
Aves	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	P	H	Simon Tweed
Aves	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	P	O H	Simon Tweed
Aves	*Artamus cinereus*	Black-faced Woodswallow	P	O H	Simon Tweed
Aves	*Coturnix ypsilophora*	Brown Quail	P	O	Simon Tweed
Aves	*Coturnix ypsilophora*	Brown Quail	P	O H	Simon Tweed
Aves	*Acanthiza pusilla*	Brown Thornbill	P	O H	Simon Tweed
Aves	*Acanthiza reguloides*	Buff-rumped Thornbill	P	O H	Simon Tweed
Aves	*Coracina tenuirostris*	Cicadabird	P	O H	Simon Tweed
Aves	*Coracina tenuirostris*	Cicadabird	P	O H	Simon Tweed
Aves	*Platycercus elegans*	Crimson Rosella	P	O H	Simon Tweed
Aves	*Platycercus elegans*	Crimson Rosella	P	O H	Simon Tweed
Aves	*Stagonopleura guttata*	Diamond Firetail	V	H 50 m away	Simon Tweed
Aves	*Stagonopleura guttata*	Diamond Firetail	V	O H	Simon Tweed
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	H	Simon Tweed
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	O H	Simon Tweed
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	O H	Simon Tweed
Aves	*Psophodes olivaceus*	Eastern Whipbird	P	O H	Simon Tweed
Aves	*Psophodes olivaceus*	Eastern Whipbird	P	O H	Simon Tweed
Aves	*Eopsaltria australis*	Eastern Yellow Robin	P	O H	Simon Tweed
Aves	*Eopsaltria australis*	Eastern Yellow Robin	P	O H	Simon Tweed
Aves	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P	O H	Simon Tweed
Aves	*Rhipidura albiscapa*	Grey Fantail	P	H	Simon Tweed
Aves	*Rhipidura albiscapa*	Grey Fantail	P	O H	Simon Tweed
Aves	*Rhipidura albiscapa*	Grey Fantail	P	O	Simon Tweed
Aves	*Rhipidura albiscapa*	Grey Fantail	P	O H	Simon Tweed
Aves	*Colluricincla harmonica*	Grey Shrike-thrush	P	H	Simon Tweed
Aves	*Colluricincla harmonica*	Grey Shrike-thrush	P	O H	Simon Tweed
Aves	*Microeca fascinans*	Jacky Winter	P	O	Simon Tweed
Aves	*Dacelo novaeguineae*	Laughing Kookaburra	P	O	Simon Tweed
Aves	*Dacelo novaeguineae*	Laughing Kookaburra	P	O H	Simon Tweed
Aves	*Vanellus miles*	Masked Lapwing	P	O H	Simon Tweed

Group	Scientific name	Common name	Status	Observation type	Observer
Aves	*Dicaeum hirundinaceum*	Mistletoebird	P	O	Simon Tweed
Aves	*Dicaeum hirundinaceum*	Mistletoebird	P	O H	Simon Tweed
Aves	*Dicaeum hirundinaceum*	Mistletoebird	P	O H	Simon Tweed
Aves	*Phylidonyris novaehollandiae*	New Holland Honeyeater	P	O H	Simon Tweed
Aves	*Phylidonyris novaehollandiae*	New Holland Honeyeater	P	O H	Simon Tweed
Aves	*Philemon corniculatus*	Noisy Friarbird	P	O	Simon Tweed
Aves	*Philemon corniculatus*	Noisy Friarbird	P	O H	Simon Tweed
Aves	*Philemon corniculatus*	Noisy Friarbird	P	O H	Simon Tweed
Aves	*Manorina melanocephala*	Noisy Miner	P	O H	Simon Tweed
Aves	*Geopelia striata*	Peaceful Dove	P	O H	Simon Tweed
Aves	*Strepera graculina*	Pied Currawong	P	H	Simon Tweed
Aves	*Strepera graculina*	Pied Currawong	P	O H	Simon Tweed
Aves	*Strepera graculina*	Pied Currawong	P	O H	Simon Tweed
Aves	*Strepera graculina*	Pied Currawong	P	O H	Simon Tweed
Aves	*Strepera graculina*	Pied Currawong	P	O H	Simon Tweed
Aves	*Porphyrio porphyrio*	Purple Swamphen	P	O H	Simon Tweed
Aves	*Neochmia temporalis*	Red-browed Finch	P	O H	Simon Tweed
Aves	*Neochmia temporalis*	Red-browed Finch	P	O H	Simon Tweed
Aves	*Psephotus haematonotus*	Red-rumped Parrot	P	O H	Simon Tweed
Aves	*Rhipidura rufifrons*	Rufous Fantail	P	O H	Simon Tweed
Aves	*Pachycephala rufiventris*	Rufous Whistler	P	O H	Simon Tweed
Aves	*Ptilonorhynchus violaceus*	Satin Bowerbird	P	O H	Simon Tweed
Aves	*Ptilonorhynchus violaceus*	Satin Bowerbird	P	O H	Simon Tweed
Aves	*Petroica boodang*	Scarlet Robin	V	O H	Simon Tweed
Aves	*Petroica boodang*	Scarlet Robin	V	O H	Simon Tweed
Aves	*Zosterops lateralis*	Silvereye	P	O H	Simon Tweed
Aves	*Zosterops lateralis*	Silvereye	P	O	Simon Tweed
Aves	*Zosterops lateralis*	Silvereye	P	O H	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	H	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O H	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O H	Simon Tweed

Group	Scientific name	Common name	Status	Observation type	Observer
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O H	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O H	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O H	Simon Tweed
Aves	*Cacatua galerita*	Sulphur-crested Cockatoo	P	O H	Simon Tweed
Aves	*Cacatua galerita*	Sulphur-crested Cockatoo	P	O H	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	O H	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	O H	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	O	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	O H	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	H	Simon Tweed
Aves	*Menura novaehollandiae*	Superb Lyrebird	P	O H	Simon Tweed
Aves	*Menura novaehollandiae*	Superb Lyrebird	P	O H	Simon Tweed
Aves	*Menura novaehollandiae*	Superb Lyrebird	P	O H	Simon Tweed
Aves	*Podargus strigoides*	Tawny Frogmouth	P	O H	Simon Tweed
Aves	*Aquila audax*	Wedge-tailed Eagle	P	O H	Simon Tweed
Aves	*Sericornis frontalis*	White-browed Scrubwren	P	O H	Simon Tweed
Aves	*Sericornis frontalis*	White-browed Scrubwren	P	O H	Simon Tweed
Aves	*Sericornis frontalis*	White-browed Scrubwren	P	O H	Simon Tweed
Aves	*Sericornis frontalis*	White-browed Scrubwren	P	O H	Simon Tweed
Aves	*Phylidonyris niger*	White-cheeked Honeyeater	P	O H	Simon Tweed
Aves	*Lichenostomus leucotis*	White-eared Honeyeater	P	O H	Simon Tweed
Aves	*Lichenostomus penicillatus*	White-plumed Honeyeater	P	O H	Simon Tweed
Aves	*Gerygone albogularis*	White-throated Gerygone	P	O H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Corcorax melanorhamphos*	White-winged Chough	P	O H	Simon Tweed

Group	Scientific name	Common name	Status	Observation type	Observer
Aves	*Corcorax melanorhamphos*	White-winged Chough	P	O H	Simon Tweed
Aves	*Rhipidura leucophrys*	Willie Wagtail	P	O	Simon Tweed
Aves	*Rhipidura leucophrys*	Willie Wagtail	P	O H	Simon Tweed
Aves	*Rhipidura leucophrys*	Willie Wagtail	P	O H	Simon Tweed
Aves	*Leucosarcia picata*	Wonga Pigeon	P	O H	Simon Tweed
Aves	*Acanthiza nana*	Yellow Thornbill	P	O H	Simon Tweed
Aves	*Acanthiza nana*	Yellow Thornbill	P	O H	Simon Tweed
Aves	*Acanthiza nana*	Yellow Thornbill	P	O H	Simon Tweed
Aves	*Lichenostomus chrysops*	Yellow-faced Honeyeater	P	O H	Simon Tweed
Aves	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo	P	O H	Simon Tweed
Aves	*Aegotheles cristatus*	Australian Owlet-nightjar	P	O	Simon Tweed
Aves	*Myiagra inquieta*	Restless Flycatcher	P	o	Simon Tweed
Aves	*Daphoenositta chrysoptera*	Varied Sittella	V	O	Simon Tweed
Aves	*Corcorax melanorhamphos*	White-winged Chough	P	H distant	Simon Tweed
Aves	*Cracticus tibicen*	Australian Magpie	P	H distant	Simon Tweed
Aves	*Corvus coronoides*	Australian Raven	P	H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Rhipidura albiscapa*	Grey Fantail	P	O	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	H	Simon Tweed
Aves	*Gerygone albogularis*	White-throated Gerygone	P	O H	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O H	Simon Tweed
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	O H	Simon Tweed
Aves	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	P	O H	Simon Tweed
Aves	*Aegotheles cristatus*	Australian Owlet-nightjar	P	O	Simon Tweed, Matthew Stanton
Aves	*Myiagra inquieta*	Restless Flycatcher	P	h	Simon Tweed, Matthew Stanton
Aves	*Daphoenositta chrysoptera*	Varied Sittella	V	O	Simon Tweed, Matthew Stanton
Aves	*Tyto tenebricosa*	Sooty Owl	V	H	Simon Tweed, Matthew Stanton
Aves	*Corcorax melanorhamphos*	White-winged Chough	P	H distant	Simon Tweed

Group	Scientific name	Common name	Status	Observation type	Observer
Aves	*Cracticus tibicen*	Australian Magpie	P	H distant	Simon Tweed
Aves	*Corvus coronoides*	Australian Raven	P	H	Simon Tweed
Aves	*Cormobates leucophaea*	White-throated Treecreeper	P	O H	Simon Tweed
Aves	*Rhipidura albiscapa*	Grey Fantail	P	O	Simon Tweed
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	H	Simon Tweed
Aves	*Gerygone albogularis*	White-throated Gerygone	P	H s	Simon Tweed
Aves	*Pardalotus punctatus*	Spotted Pardalote	P	O s	Simon Tweed
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	H s	Simon Tweed
Aves	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	P	O s	Simon Tweed
Aves	*Ninox strenua*	Powerful Owl	P	Calling about 1 km to the south.	Matthew Stanton
Aves	*Neophema pulchella*	Turquoise Parrot	V	In River Oak but possibly coming in to drink	Matthew Stanton
Aves	*Tyto tenebricosa*	Sooty Owl	V	H - a couple of calls. Probably male bomb	Matthew Stanton
Aves	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V	H	Matthew Stanton
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	P	O	Simon Tweed
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	P	O	Simon Tweed
Mammalia	*Macropus robustus*	Common Wallaroo	P	O	Simon Tweed
Mammalia	*Vombatus ursinus*	Common Wombat	P	O	Simon Tweed
Mammalia	*Vombatus ursinus*	Common Wombat	P	O	Simon Tweed
Mammalia	*Macropus giganteus*	Eastern Grey Kangaroo	P	O	Simon Tweed
Mammalia	*Macropus giganteus*	Eastern Grey Kangaroo	P	O	Simon Tweed
Mammalia	*Macropus giganteus*	Eastern Grey Kangaroo	P	O	Simon Tweed
Mammalia	*Macropus giganteus*	Eastern Grey Kangaroo	P	O	Simon Tweed
Mammalia	*Vulpes vulpes*	Fox	U	O	Simon Tweed
Mammalia	*Vulpes vulpes*	Fox	U	O	Simon Tweed
Mammalia	*Vulpes vulpes*	Fox	U	O	Simon Tweed
Mammalia	*Oryctolagus cuniculus*	Rabbit	U	O	Simon Tweed
Mammalia	*Oryctolagus cuniculus*	Rabbit	U	O	Simon Tweed
Mammalia	*Oryctolagus cuniculus*	Rabbit	U	O	Simon Tweed
Mammalia	*Petaurus breviceps*	Sugar Glider	P	H and various incisions seen.	Simon Tweed

Group	Scientific name	Common name	Status	Observation type	Observer
Mammalia	*Petaurus breviceps*	Sugar Glider	P	H during spotlighting	Simon Tweed
Mammalia	*Wallabia bicolor*	Swamp Wallaby	P	O	Simon Tweed
Mammalia	*Wallabia bicolor*	Swamp Wallaby	P	O spotlighting	Simon Tweed
Mammalia	*Wallabia bicolor*	Swamp Wallaby	P	O	Simon Tweed
Mammalia	*Wallabia bicolor*	Swamp Wallaby	P	O	Simon Tweed
Mammalia	*Pteropus poliocephalus*	grey-headed flying-fox	V	O	Simon Tweed
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	P	O	Simon Tweed
Mammalia	*Wallabia bicolor*	Swamp Wallaby	P	O	Simon Tweed
Mammalia	*Vombatus ursinus*	Common Wombat	P	O	Simon Tweed
Mammalia	*Petaurus australis*	Yellow-bellied Glider	V	H distant faintly	Simon Tweed
Mammalia	*Myotis macropus*	large-footed myotis	V	O probable seen raking water.	Simon Tweed
Mammalia	*Vespadelus vulturnus*	little forest bat	P	Harp trap	Simon Tweed
Mammalia	*Miniopterus schreibersii*	common bent-winged bat	V	Harp trap.	Simon Tweed
Mammalia	*Pteropus poliocephalus*	grey-headed flying-fox	V	O	Simon Tweed, Matthew Stanton
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	P		Simon Tweed, Matthew Stanton
Mammalia	*Wallabia bicolor*	Swamp Wallaby	P	O	Simon Tweed, Matthew Stanton
Mammalia	*Vombatus ursinus*	Common Wombat	P	O	Simon Tweed, Matthew Stanton
Mammalia	*Petaurus australis*	Yellow-bellied Glider	V	H distant faintly	Simon Tweed, Matthew Stanton
Mammalia	*Myotis macropus*	large-footed myotis	V	O probable seen raking water.	Simon Tweed, Matthew Stanton
Mammalia	*Vespadelus vulturnus*	little forest bat	P	Harp trap	Simon Tweed
Mammalia	*Miniopterus schreibersii*	common bent-winged bat	V	Harp trap	Simon Tweed
Mammalia	*Phascolarctos cinereus*	Koala	V	H - male	Matthew Stanton
Mammalia	*Phascolarctos cinereus*	Koala	V	H - male	Matthew Stanton
Mammalia	*Phascolarctos cinereus*	Koala	V	H - male	Matthew Stanton
Mammalia	*Petaurus australis*	Yellow-bellied Glider	V	H	Matthew Stanton

Group	Scientific name	Common name	Status	Observation type	Observer
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Chalinolobus gouldii*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Chalinolobus morio*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Miniopterus australis*	Little Bent-wing Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Miniopterus schreibersii*	Eastern Bent-wing Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Miniopterus schreibersii*	Eastern Bent-wing Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Miniopterus schreibersii*	Eastern Bent-wing Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Miniopterus schreibersii*	Eastern Bent-wing Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Miniopterus schreibersii*	Eastern Bent-wing Bat	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Mormopterus ridei*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Myotis macropus*	Southern Myotis	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Nyctophilus spp.*		P	Anabat	
Mammalia	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Kerivoula papuensis*	Golden-tipped Bat	V	Anabat	Simon Tweed, Matthew Stanton

Group	Scientific name	Common name	Status	Observation type	Observer
Mammalia	*Scotorepens ruppellii*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Rhinolophus megaphyllus*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Tadarida australis*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Vespadelus darlingtoni*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Vespadelus regulus*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Vespadelus vulturnus*		P	Anabat	Simon Tweed, Matthew Stanton
Mammalia	*Saccolaimus flaviventris*		P	Anabat	Simon Tweed, Matthew Stanton
Reptilia	*Physignathus lesueurii*	eastern water dragon	P	O	Simon Tweed
Reptilia	*Pseudechis porphyriacus*	red-bellied black snake	P	O	Simon Tweed
Reptilia	*Eulamprus quoyii*	eastern water-skink	P	O	Simon Tweed
Reptilia	*Eulamprus quoyii*	eastern water-skink	P	O	Simon Tweed, Matthew Stanton

Key: P = Protected; V = Vulnerable; E = Endangered; - = not listed under act (exotic/introduced species); O = observed; H = Heard

Weather conditions during field survey

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Direction of maximum wind gust	Speed of maximum wind gust (km/h)
1/02/2015	7.5	23.6	0	SSW	43
2/02/2015	10	21.9	19.2	SE	46
3/02/2015	7.6	21.8	0	SE	24
4/02/2015	7.8	20.2	0	ESE	39
5/02/2015	12.3	21.8	0.2	ESE	35
6/02/2015	10.9	23.5	0	E	30
7/02/2015	8.8	28.8	0	NNE	24
8/02/2015	9.4	32.6	0	W	43
9/02/2015	14.5	22.2	0	E	43
10/02/2015	15.8	27.2	0.4	E	35
11/02/2015	14.9	28.3	0	W	56
12/02/2015	16.8	25.1	14	SSE	44
13/02/2015	15.4	24.6	0	ESE	43

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Direction of maximum wind gust	Speed of maximum wind gust (km/h)
14/02/2015	12.1	23.2	0	SSW	43
15/02/2015	10.6	27.2	17.4	W	39
16/02/2015	14.3	27.9	0.2	ENE	28
17/02/2015	13.5	28.1	0	NE	37
18/02/2015	13	26.7	0	E	39
19/02/2015	12.6	27.4	0	ENE	43
20/02/2015	12.1	27.4	0	SE	30
21/02/2015	13.7	23.8	0	ENE	30
22/02/2015	14	26.2	3.4	NE	35
23/02/2015	14.5	28.2	0	SSE	57
24/02/2015	16.3	22.3	0	SW	48
25/02/2015	13.9	18.8	0.4	SE	35
26/02/2015	14.3	26.9	0	SE	50
27/02/2015	10.9	27.2	0.6	NE	30
28/02/2015	13.2	31.3	0	W	31
1/03/2015	11.5	31.6	0	WNW	65
2/03/2015	5.6	23.3	0	E	39
3/03/2015	8.9	30.1	0	NW	41
4/03/2015	15.7	29.9	0	W	39
5/03/2015	11.2	23.8	0	W	57
6/03/2015	7.1	22.5	0	W	61
7/03/2015	3.6	26.7	0	W	37
8/03/2015	11.1	29.4	0	NW	35
9/03/2015	10.4	29	0	WSW	48
10/03/2015	8.5	25.4	0	N	43
11/03/2015	11.8	30.6	0	WSW	56
12/03/2015	13.2	29.6	0	SW	52
13/03/2015	12.3	19	0	SE	31
14/03/2015	5.1	26	0	WNW	44
15/03/2015	9.5	22.6	0	ESE	44
16/03/2015	4.3	21.9	0	SE	35
17/03/2015	4.3	25.3	0	W	28
18/03/2015	11.4	29.9	4.6	W	48
19/03/2015	7.5	30.9	5.6	WNW	33
20/03/2015	11.1	31.2	0	ENE	44
21/03/2015	9.6	19.3	0	SE	43
22/03/2015	10.9	22.4	0	NE	37
23/03/2015	8.3	28.8	0	WNW	48
24/03/2015	16.1	21	10.8	WSW	43
25/03/2015	9.1	21.1	9.8	ENE	30
26/03/2015	7.3	19.8	0	W	65
27/03/2015	5.2	18.7	0	WNW	57
28/03/2015	1.3	21.4	0	ENE	26

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Direction of maximum wind gust	Speed of maximum wind gust (km/h)
29/03/2015	2.9	21.6	0	W	35
30/03/2015	2.6	22.3	0	NNW	20
31/03/2015	7.6	23	0.4	ESE	35

Appendix 6. Serious and Irreversible Impact (SAII) Criteria

White Box Yellow Box Blakely's Red Gum Grassy Woodland SAII criteria

SAII criteria	Address of SAII criteria
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section 5.1 regarding avoidance.
(b) the area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone.	White Box Yellow Box Blakely's Red Gum Grassy Woodland aligns to PCT1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) as mapped on Figure 12. Threatened Ecological Community Mapping. All areas of the TEC have been significantly impacted by historic logging, grazing, weed invasion, and feral animal impacts, and as such, no portions of the TEC within the Study Area are in a benchmark condition. Based on the plot surveys within and surrounding the development envelope, three vegetation condition classes were attributed to the TEC: 1. Moderate condition: this condition class was the best condition within the Study Area. It consisting of clumps of scattered trees (mainly *E. melliodora* with *E. blakelyiX*) with a mix of native and introduced ground cover. The native ground cover generally comprised of native grasses, including *Bothriochloa macra, Austrodanthonia racemosa, Dichelachne micrantha.* Forbs and shrubs were relatively sparse. Cover of Nassella trichotoma (Serrated Tussock) was relatively high across much of the vegetation zone. The zone had a vegetation integrity score of 40.4 2. Poor condition: consisting of very few scattered *Eucalyptus melliodora, E. bosistoana,* and *E. blakelyi*. Canopy cover was low when compared to benchmark. Acacia parramattensis was scattered in clumps throughout the vegetation zone. Forbs and shrubs were relatively sparse and typically were concentrated under the canopy. Much of this condition class has been used historically for grazing. Portions toward the west at the site of the Western Overburden Emplacement are still grazed. Cover of Nassella trichotoma (Serrated Tussock) was relatively high across much of the vegetation zone. The zone had a vegetation integrity score of 23.7. 3. Acacia/assisted regeneration: consisting of planted and regenerating Acacias and occasional eucalypts (not a CEEC under the EPBC Act). This vegetation zone had a ground cover similar to that of the 'poor condition' class, however tubestock has been planted in areas. The zone had a vegetation integrity score of 26.1. In total, 88.6 ha of the TEC is listed under the BC Act, and 80.6 under the EPBC Act. None of the TEC to be impacted was intact, with approximately 39.8 ha being a highly degraded condition class and assisted regeneration area. All areas to be

SAII criteria	Address of SAII criteria
	impacted had relatively low vegetation integrity scores (<45 score) which is representative of the degraded condition and invasion by Nassella trichotoma (Serrated Tussock). Indirect impacts to the remaining White Box Yellow Box Blakely's Red Gum Woodland would be avoided by carrying out weed control, pest control, demarcating 'no go' areas, and contractor education. Details regarding these are provided in section 5.1.
(c) a description of the extent to which the impact exceeds the threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	No impact threshold has been attributed to this TEC.
(d) the extent and overall condition of the potential TEC within an area of 1000ha, and then 10,000ha, surrounding the proposed development footprint	In an attempt to determine the extent of White Box Yellow Box Blakely's Red Gum Woodland in the locality, mapping by Tozer et al. 2006 was examined as it covered the locality extent. A total of 3,304.6 ha of the best equivalent vegetation type (p24, Tableland Grassy Box Gum Woodland) has been mapped within a 10 km radius of the Study Area. It should be noted however, that the Tozer et al, 2006 mapping does not appear to account for areas of derived grassland areas which may also align to the TEC, and as such may underestimate the extend of the TEC. The mapped occurrence of White Box Yellow Box Blakely's Red Gum Woodland based on Tozer et al (2006) surrounding the development footprint is as follows: • 1,000 ha = < 230 hectare • 10,000 ha = 600.6 hectares. The condition of White Box Yellow Box Blakely's Red Gum Woodland within both the 1,000 ha and 10,000 hectares circles is likely to be predominately in a low to moderate condition, given the rural pressure and historic clearing of the area. It is highly likely that weeds would occupy portions of the lower stratums similar to that of the Study Area. The largest patches of White Box Yellow Box Blakely's Red Gum Woodland have been mapped (Figure 8) include: • A patch greater than 20 hectares which occurs to the north of Peppertree Quarry. This patch has been assessed by Niche to be in a relatively good condition. • Scattered patches ranging in size from 5 hectares to 10 hectares occurring within private property, approximately 2 kilometres to the west of the Study Area.
(e) an estimate of the extant area and overall condition of the potential TEC remaining in the IBRA subregion before and after the impact of the	Throughout its range the TEC has been reduced in area and is highly fragmented because of clearance for cropping, grazing and pasture improvement due to the ecological community's occurrence on fertile soils. Very few high quality remnants remain anywhere across its former range. The EPBC Policy Guidelines (DoE 2014) state that over 90% of the

SAII criteria	Address of SAII criteria
proposed development has been taken into consideration	original extent of this ecological community has been cleared. This is supported by OEH (2014b) who regarded the equivalent Biometric Vegetation Type to be 90% cleared, and Thomas et al. (2000) estimate that within South-Eastern NSW 59,468 ha remain from the pre-1750 extent of 1,012,052 ha (approximately 94% cleared). Within the Bungonia IBRA subregion, Niche estimates that greater than 5,000 ha of the TEC remains, which is within a derived condition or as sparsely scattered woodland patches. Based on this estimate, the Project would reduce the extent of the Bungonia IBRA region extent by approximately 0.5 percent of the IBRA Subregion range.
(f) an estimate of the area of the potential TEC that is in the reserve system within the IBRA region and the IBRA subregion	Niche estimate that less than 3 percent of White Box Yellow Box Blakely's Red Gum Woodland within the Bungonia Subregion, and similarly for the IBRA region, is formally protected within National Parks or Conservation Areas.
(g) the development, clearing or biodiversity certification proposal's impact on: (i) abiotic factors critical to the long-term survival of the potential TEC; for example, how much the impact will lead to a reduction of groundwater levels or the substantial alteration of surface water patterns (ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants (iii) the quality and integrity of an occurrence of the potential TEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the potential TEC	i. The Project will result in the loss to 88.6 ha of the TEC due to direct clearing. The position of the TEC to be impacted is already in a modified condition due to historic land clearing and the occurrence of Serrated Tussock and grazing by goats and rabbits. The patch to be removed is unlikely to result in changes to the flow regime or ground water levels that may impact upon other patches of the TEC within the locality. ii. The Project will not result in inappropriate fire and flooding regimes that would impact upon surrounding patches of TEC. The existing Bushfire Management Plan would be updated as part of the Project to minimise any potential fire ignition from the site, and to ensure that recommended fire management is carried out. iii. The removal of 88.6 ha of White Box Yellow Box Blakely's Red Gum Woodland opens the surrounding patches to edge effects. Edge effects include the invasion of weeds, erosion and sedimentation. Mitigation measures to be undertaken as part of the Project include: weed control, pest control, demarcating 'no go' areas, and contractor education. Details regarding these are provided in section 5.1.
(h) direct or indirect fragmentation and isolation of an important area of the potential TEC	The condition of the TEC within the Study Area is of a moderate to poor condition, typically containing a scattered canopy layer and mixture of native and introduced ground cover. It is likely that the patch would continue to decline without weed management, particularly targeting Serrated Tussock and Blackberry, and assisted tubestock or direct seeding regeneration.

SAII criteria	Address of SAII criteria
	The affected patches of White Box Yellow Box Blakely’s Red Gum Woodland in the Study Area are already fragmented by access roads, exotic pasture and infrastructure. This is a common theme for the TEC which is highly fragmented in the locality (Tozer et al. 2006 mapping of map unit p24). The Project will lead to increased fragmentation of the ecological community in the local context through the development of the Project however connectivity will be retained within contiguous habitat around the periphery of the Study Area.
(i) the measures proposed to contribute to the recovery of the potential TEC in the IBRA subregion.	The Project will require a like-for-like offset to satisfy the requirements of the BAM and EPBC Act. As such, this will result in the establishment of a conservation area that will protect and enhance White Box Yellow Box Blakely’s Red Gum Woodland. The proposed offset would achieve no net loss in extent and condition of the ecological community throughout its geographic distribution as per the requirement of the BAM.

Koala habitat

SAII criteria	Address of SAII criteria
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section 5 regarding avoidance.
(b) the size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification	Impacts from the Project largely relate to the removal of foraging and dispersal habitat that has been defined as being critical to the survival of the Koala under the EPBC Act (DoE 2014; Appendix 8). Habitat mapped as good and moderate habitat potential within the Study Area (Figure 16) contained either two or more known feed trees (listed as primary, secondary or tertiary species under the species Recovery Plan (DECC 2008)) or a single feed species that occupied more than 50% of a 400 m2 floristic quadrat. Such habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The Project would result in the removal of 132.4 ha of such habitat. Due to the apparent limited use of the Study Area (owing to lack of detection of Koala presence during the fieldwork) and its extremely small extent in relation to similar habitat for the Shoalhaven Gorge Koala population (7,500 ha), it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven gorge) such that a decline would occur or that the population is placed at risk of extinction. Active sites for this population are concentrated within protected areas and the Study Area is not thought to provide a link between active areas within the population’s distribution or to any other Koala population. Mitigation measures detailed in section 6.3 would be employed to reduce the indirect impact toward the Koala.
(c) the extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	No impact threshold has been attributed to the Koala.
(d) the likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to:	i. The Project would result in the removal of approximately 132.4 hectares of habitat. ii. Impacts from the Project largely relate to the removal of foraging and dispersal habitat. Due to the apparent limited use of the Study Area and its extremely small extent in relation to similar habitat for the Shoalhaven Gorge Koala population (7,500 ha), it is not considered that removal of this

SAII criteria	Address of SAII criteria
(i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven gorge) such that a decline would occur or that the population is placed at risk of extinction. Active sites for this population are concentrated within protected areas and the Study Area is not thought to provide a link between active areas within the population's distribution or to any other Koala population. iii. The proposed development would result in the removal of approximately 132.4 hectares of koala habitat. This is a reduction of less than 1 percent of the available occupiable habitat (8,713 ha of similar habitat for the Shoalhaven Gorge Koala population). The remaining habitat would not be impacted by the Project and therefore would not result in extinction of the population. The population is likely to utilise existing habitat within the surrounding area.
BioNet Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development (e) the likely impact on the ecology of the local population. At a minimum, address the following: (i) for fauna: breeding, foraging, roosting, and dispersal or movement pathways	As the area for removal is a small relative extent (less than 1percent) of habitat for the Shoalhaven population of Koala. It is not considered that the removal of this habitat alone would significantly adversely impact the Shoalhaven koala population which is centred within Bungonia Gorge and the Shoalhaven River. Active sites for this population are concentrated within protected areas and the Study Area is not thought to provide a link between active areas within the population's distribution or to any other koala population.
(f) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	No Koalas or evidence of Koalas were recorded within the Study Area, however the eucalypt species present in the Study Area are Koala feed trees. As discussed previously, the Study Area is not thought to provide a link between active areas within the population's distribution or to any other koala population. It is unlikely that the local koala population will become fragmented or isolated as a result of the Project, however fragmentation of foraging habitat would occur and be centred around the existing infrastructure.

SAII criteria	Address of SAII criteria
(g) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	It is unlikely that the Study Area provides an important linkage to Koala populations. The species was not detected during field surveys, nor have there been any sightings within the Study Area historically. However, it is recognised that given the presence of feed trees, the Koala has the potential to utilise the Study Area on occasion. The Study Area is unlikely to be import for breeding, dispersal and genetic viability given the Shoalhaven Koala population is already centred and protected within the Bungonia Gorge.
(h) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The Project is likely to result in edge effects in the form of weed invasion, sedimentation and erosion within habitat for Koala immediately adjacent to the areas being cleared. However, mitigation measures detailed in section 5.1 would be employed to reduce the impact of edge effects occurring on habitat for the remaining population.
(i) an estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion	Based on previous mapping (Tozer et al 2006), the area of potential habitat in the locality is approximately 7,500 hectares. The proposed development would result in the removal of less than 1 percent of potential habitat in the locality. As can be seen from Figure 16, the records for the Koala predominately occur to the south of the Study Area within Bungonia Gorge, away from the Study Area. The habitat features in this area, would not be impacted by the Project.
(j) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.	The Project will require a like-for-like offset to satisfy the requirements of the BAM and EPBC Act. As such, this will result in the establishment of a conservation area that will protect and enhance Koala habitat. The proposed offset would achieve no net loss in extent and condition of the Koala habitat as per the requirement of the BAM.

Large-eared Pied Bat foraging habitat

SAII criteria	Address of SAII criteria
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section 5.1 regarding avoidance.
(b) the size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification	Impacts from the Project largely relate to the removal of foraging habitat for the Large-eared Pied Bat. Habitat mapped as good habitat is provided in Figure 16. This habitat includes potential foraging habitat within proximity to known caves and overhangs and main watercourses. The Project would result in the removal of 140.3 ha of such foraging habitat. The Project will not impact roosting habitat given it is positioned away from known caves, and overhangs likely to occur along Bungonia Gorge. Known cave site (located approximately 900 m to the south) which may contain roosting habitat for the species would not be impacted by the Project. Mitigation measures detailed in section 6.3 would be employed to reduce the indirect impact toward the Large-eared Pied Bat habitat.
(c) the extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	Breeding habitat is identified as an SAII – however the Project would not impact upon breeding habitat for the Large-eared Pied Bat.
(d) the likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development	i. The Project would result in the removal of approximately 140.3 hectares of foraging habitat. No breeding habitat would be impacted. ii. Impacts from the Project largely relate to the removal of 140.3 ha of foraging habitat. The Large-eared Pied Bat is known to forage in a range of vegetation types, including dry and wet sclerophyll forest, grassy woodland, Callitris dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country (Hoye & Dwyer 1995; Pennay 2002; DECC 2007). Foraging habitat on fertile soils (or within fertile valleys) is also considered an important overall requirement for the Large-eared Pied Bat (Pennay 2008), however the species has been recorded extensively within sandstone associated vegetation, indicating that whilst foraging habitat on fertile soils is

SAII criteria	Address of SAII criteria
(ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	likely to be important, foraging would by no means be confined to such areas. Based on an analysis of existing native vegetation mapping by Tozer et al (2006) and aerial interpretation, approximately 8,713 ha of potential foraging habitat has been mapped within the locality. The impact to approximately 140.3 ha of foraging habitat associated with the Project is relatively small in relation to similar habitat in the locality. iii. The proposed development would result in an impact to foraging habitat which is relatively extensive in the locality. It is unlikely that the modification of the habitat is detrimental to a population of the large-eared Pied Bat given the availability of similar habitat types through the locality. Furthermore, no breeding habitat would be impacted by the Project.
BioNet Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development (e) the likely impact on the ecology of the local population. At a minimum, address the following: (i) for fauna: breeding, foraging, roosting, and dispersal or movement pathways	**Breeding and roosting habitat**: The Project would not result in any impact to known breeding habitat or roosting habitat for the Large-eared Pied Bat. One cave is known to occur within 900m of the Study Area, known as Main Gully Spring (Bauer and Bauer 1998). The cave is located beneath the Mine and in periods of high discharge this cave acts as an overflow. A number of chambers and tunnels are described as occurring in this cave by Baeuer and Bauer (1998) including a chamber 1 m x 2.7 m wide. Main Gully Spring is a potential bat roosting site. It could not be inspected during the current field survey due to safety and access issues. However, a site inspection by Boral representitives accompanied by an experienced caver was undertaken in August 2017 at the base of the cave, and approximately 10 meteres inside the entrance. During the site inspection, approximately 5 microbats were observed. It was not possible to determine the species from photographs that were provided. As such, it is not possible to state with certainty that a maternal roost could not be established for Large-eared Pied Bat. Whilst microbats were recorded it is unlikely that long-term maternity roosts would be established in Main Gully Spring due to its limited size and occasional inundation of most, if not all parts of the cave in times of high flow. Regardless of whether bat roosting or breeding occurs within the cave, it is highly unlikely that the Main Gully Spring Cave would would experience any impact associated with the Project. This is due to the distance of the subject cave from the Mine expansion activities that involve mining and blasting which is to occur over 900 metres to the north. There has been an ongoing history of mining within the existing south pit throughout which any roosting bats would have persisted if present. The Project is not forecast to increase noise or vibration to the subject cave or any other known caves in the locality.

SAII criteria	Address of SAII criteria
	Foraging: Impacts from the Project largely relate to the removal of 140.3 ha of foraging habitat. The Large-eared Pied Bat is known to forage in a range of vegetation types, including dry and wet sclerophyll forest, grassy woodland, Callitris dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country (Hoye & Dwyer 1995; Pennay 2002; DECC 2007). Foraging habitat on fertile soils (or within fertile valleys) is also considered an important overall requirement for the Large-eared Pied Bat (Pennay 2008), however the species has been recorded extensively within sandstone associated vegetation, indicating that whilst foraging habitat on fertile soils is likely to be important, foraging would by no means be confined to such areas. Based on an analysis of existing native vegetation mapping by Tozer et al (2006) and aerial interpretation, approximately 8,713 ha of potential foraging habitat has been mapped within the locality. The impact to approximately 140.3 ha of foraging habitat associated with the Project is relatively small in relation to similar habitat in the locality. **Movement pathways:** The Study Area is located adjacent to an operating Mine, and would essentially expand the footprint of the exiting Mine to the west. The foraging habitat to be impacted is unlikely to result in any disruption to flight paths and mobility given there will still be extensive unimpeded bushland is located throughout the locality and throughout Bungonia gorge. Patches of bushland will still exist on land surrounding the west of the Study Area. Given the mobility of the species, it is unlikely that the Project would disrupt the mobility of the species.
(f) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	It is highly unlikely that the local Large-eared Pied Bat population would be significantly impacted by the removal of 140.3 ha of foraging habitat given the extent available within the locality. Furthermore, the removal of such habitat is unlikely to result in a change to flight movements as discussed above. The Project would also not result in any impact to known breeding or roosting sites.
(g) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and	It is highly unlikely that the Project would impact upon any important local Large-eared Pied Bat population. No breeding habitat would be impact, nor would any limiting foraging habitat be impacted. Furthermore, the removal of such habitat is unlikely to result in a change to flight movements given the mobility of the species and habitat would still exist around the periphery of the Study Area.

SAII criteria	Address of SAII criteria
whether the local population is at the limit of the species' range	
(h) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The Project has the potential to result in edge effects in the form of weed invasion, sedimentation and erosion within foraging habitat for Large-eared Pied Bat immediately adjacent to the areas being cleared. However, mitigation measures detailed in section 5.1 would be employed to reduce the impact of edge effects occurring on foraging habitat for the remaining population.
(i) an estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion	Based on previous mapping (Tozer et al 2006), the area of potential habitat in the locality is approximately 7,500 hectares. The proposed development would result in the removal of less than 1 percent of potential habitat in the locality. As can be seen from Figure 8, a potential cave site occurs approximately 900 m to the south of the Study Area within Bungonia Gorge. This potential breeding site would not be impacted by the Project.
(j) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.	The Project will require a like-for-like offset to satisfy the requirements of the BAM and EPBC Act. As such, this will result in the establishment of a conservation area that will protect and enhance Large-eared Pied Bat habitat. The proposed offset would achieve no net loss in extent and condition of the Large-eared Pied Bat habitat as per the requirement of the BAM.

Eastern Bent-wing Bat foraging habitat

SAII criteria	**Address of SAII criteria (undertaken to satisfy the SEARs in replace of section 9.2 of the FBA). It should be noted that the Eastern Bent-wing Bat is regarded as an ecosystem credit species in regards to the current Project.**
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section section 5.1 regarding avoidance.
(b) the size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification	Impacts from the Project largely relate to the removal of foraging habitat for the Eastern Bent-wing Bat. Habitat mapped as good habitat is provided in Figure 10. This habitat includes potential foraging habitat within proximity to known caves and overhangs and main watercourses. The Project would result in the removal of 140.3 ha of such foraging habitat. The Project will not impact roosting habitat given it is positioned away from known caves, and overhangs likely to occur along Bungonia Gorge. Known cave sites (located approximately 900 metres to the south) which may contain roosting habitat for the species would not be impacted by the Project. Eastern Bent-wing Bats were recorded frequently during echolocation surveys within the area surveyed, occurring at all sites where recordings were made (Appendix 5). Nightly Eastern Bent-wing Bat recordings showed consistent arrival and departure times with bats typically recorded from around 8:20 pm in the evening until 5:50 am the following morning during the survey in early February 2015. It is expected that the majority of recorded bats arrived from the Drum Cave roost site where exit times for bats between the 10th and the 12th of February in 2004 were concentrated from 8:00 pm to 8:45 pm with a peak around 8:15 – 8:30 pm (Law and Chidel 2004). The Study Area is situated approximately 3.7 km north of a major breeding cave and maternity roost for the Eastern Bent-wing-bat known as Drum Cave. Drum cave is one of four known major maternity roosts for the species and is suspected contain between 10,000 and 15,000 individual bats (Law and Chidel 2004). Other caves in the vicinity are known to act as roost habitat for Eastern Bent-wing Bats, however maternity roosts have not been recorded in surrounding caves. As discussed previously in relation to the Large-eared Pied Bat, Main Gully Spring (Bauer and Bauer 1998) which occur within 900 m of the Study Area are unlikely to contain frequent bat roosting due to the water inundation within the caves. It is assumed unlikely that long-term maternity roosts would be established in Main Valley Spring due to its

SAII criteria	Address of SAII criteria (undertaken to satisfy the SEARs in replace of section 9.2 of the FBA). It should be noted that the Eastern Bent-wing Bat is regarded as an ecosystem credit species in regards to the current Project.
	limited size and occasional inundation of most if not all parts of the cave in times of high flow. However, given the lack of previous survey of this cave, it is not possible to state with certainty that a maternal roost could not be established for Eastern Bent-wing bat within Main Valley Spring. Regardless, as is the case with the Large-eared Pied Bat, the cave is located away from the Study Area and would not experience any impact associated with the Project. This is due to the distance of the subject caves from the Mine expansion activities that involve mining and blasting which is to occur over 900 metres to the north. Foraging habitat for Eastern Bent-wing Bat would be similar to that of the Large-eared Pied Bat, occupying 140.3 ha within the Study Area. Foraging habitat in the locality is considered important for the Eastern Bent-wing Bat due to the large population dependant on the roost site known from the area (Drum Cave). While foraging habitat of the type to be removed is considered important for both species, such habitat is considered locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. It is estimated that 8,713 ha of native vegetation exists within the locality of the Study Area (within a 10 km radius of the Project site). Regardless, the 'species credit' component associated with this species is only triggered with impacts to breeding features (such as caves, tunnels, mines, culverts or other structures known or suspected to be used for breeding). As such, Eastern Bent-wing Bat is regarded as an 'ecosystem credit' species for this assessment. Mitigation measures detailed in section 6.3 would be employed to reduce the indirect impact toward the Large-eared Pied Bat habitat.
(c) the extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	Breeding habitat is identified as an SAII – however the Project would not impact upon breeding habitat for the Eastern Bent-wing Bat.
(d) the likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to:	i. The Project would result in the removal of approximately 140.3 hectares of foraging habitat. No breeding habitat would be impacted. ii. Impacts from the Project largely relate to the removal of 140.3 ha of foraging habitat. Foraging habitat for Eastern Bent-wing Bat would be similar to that of the Large-eared Pied Bat, occupying 140.3 ha within the Study Area. Foraging habitat in the locality is considered important for the Eastern Bent-wing Bat due to the large population dependant on the roost site known from the area (Drum Cave). While foraging habitat of the type to be removed is considered important for both species, such habitat is

SAII criteria	Address of SAII criteria (undertaken to satisfy the SEARs in replace of section 9.2 of the FBA). It should be noted that the Eastern Bent-wing Bat is regarded as an ecosystem credit species in regards to the current Project.
(i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	considered locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. It is estimated that 8,713 ha of native vegetation exists within the locality of the Study Area (within a 10 km radius of the Project site). The proposed development would result in an impact to foraging habitat which is relatively extensive in the locality. It is unlikely that the modification of the habitat is detrimental to a population of the Eastern Bent-wing Bat given the availability of similar habitat types through the locality. Furthermore, no breeding habitat would be impacted by the Project.
BioNet Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development (e) the likely impact on the ecology of the local population. At a minimum, address the following: (i) for fauna: breeding, foraging, roosting, and dispersal or movement pathways	**Breeding and roosting habitat**: The Project would not result in any impact to known breeding habitat or roosting habitat for the Eastern Bent-wing Bat. The Study Area is situated approximately 3.7 km north of a major breeding cave and maternity roost for the Eastern Bent-wing-bat known as Drum Cave. Drum cave is one of four known major maternity roosts for the species and is suspected contain between 10,000 and 15,000 individual bats (Law and Chidel 2004). Other caves in the vicinity are known to act as roost habitat for Eastern Bent-wing Bats, however maternity roosts have not been recorded in surrounding caves. As discussed previously in relation to the Large-eared Pied Bat, Main Gully Spring which occurs over 900 m to the south of the Study Area is unlikely to contain frequent bat roosting due to the water inundation within the caves. It is assumed unlikely that long-term maternity roosts would be established in Main Valley Spring due to its limited size and occasional inundation of most if not all parts of the cave in times of high flow. However, given the lack of previous survey of this cave, it is not possible to state with certainty that a maternal roost could not be established for Eastern Bent-wing bat within Main Valley Spring. Regardless, as is the case with the Large-eared Pied Bat, the caves are located away from the Study Area and would not experience any impact associated with the Project. This is due to the distance of the subject caves from the Mine expansion activities that involve mining and blasting which is to occur over 900 metres to the north.

SAII criteria	Address of SAII criteria (undertaken to satisfy the SEARs in replace of section 9.2 of the FBA). It should be noted that the Eastern Bent-wing Bat is regarded as an ecosystem credit species in regards to the current Project.
	Foraging: Foraging habitat for Eastern Bent-wing Bat would be similar to that of the Large-eared Pied Bat, occupying 140.3 ha within the Study Area. Foraging habitat in the locality is considered important for the Eastern Bent-wing Bat due to the large population dependant on the roost site known from the area (Drum Cave). While foraging habitat of the type to be removed is considered important for both species, such habitat is considered locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. It is estimated that 8,713 ha of native vegetation exists within the locality of the Study Area (within a 10 km radius of the Project site). Regardless, the 'species credit' component associated with this species is only triggered with impacts to breeding features (such as caves, tunnels, mines, culverts or other structures known or suspected to be used for breeding). As such, Eastern Bent-wing Bat is regarded as an 'ecosystem credit' species for this assessment. **Movement pathways:** The Study Area is located adjacent to an operating Mine, and would essentially expand the footprint of the exiting Mine to the west. The foraging habitat to be impacted is unlikely to result in any disruption to flight paths and mobility given there will still be extensive unimpeded bushland located throughout the locality and throughout Bungonia gorge. Patches of bushland will still exist on land surrounding the west of the Study Area. Given the mobility of the species, it is unlikely that the Project would disrupt the mobility of the species.
(f) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	It is highly unlikely that the local Eastern Bentwing Bat population would be significantly impacted by the removal of 140.3 ha of foraging habitat given the extent available within the locality. Furthermore, the removal of such habitat is unlikely to result in a change to flight movements as discussed above. The Project would also not result in any impact to known breeding or roosting sites.
(g) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	It is highly unlikely that the Project would impact upon any important local Eastern Bentwing Bat population. No breeding habitat would be impacted, nor would any limiting foraging habitat be impacted. Furthermore, the removal of such habitat is unlikely to result in a change to flight movements given the mobility of the species and habitat would still existing around the periphery of the Study Area.
(h) the extent to which the proposed development will lead to an increase in threats and indirect	The Project has the potentialto result in edge effects in the form of weed invasion, sedimentation and erosion within foraging habitat for the Eastern Bentwing Bat immediately adjacent to the areas being cleared. However, mitigation

SAII criteria	Address of SAII criteria (undertaken to satisfy the SEARs in replace of section 9.2 of the FBA). It should be noted that the Eastern Bent-wing Bat is regarded as an ecosystem credit species in regards to the current Project.
impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	measures detailed in section 5.1 would be employed to reduce the impact of edge effects occurring on foraging habitat for the remaining population.
(i) an estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion	Based on previous mapping (Tozer et al 2006), the area of potential habitat in the locality is approximately 7,500 hectares. The proposed development would result in the removal of less than 1 percent of potential habitat in the locality. As can be seen from Figure 8, a potential cave site occurs approximately 900 m to the south of the Study Area within Bungonia Gorge. This potential breeding site would not be impacted by the Project.
(j) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.	The Project does not require an offset under the BAM for the Eastern Bentwing Bat given it is an ecosystem credit species. The Study Area however, will be rehabilitated following decommissioning which will re-establish foraging habitat for the species.

Appendix 7. Biodiversity Credit Calculator Report

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00011994/BAAS17066/19/00012596	2155 Marulan South Project October 2018	04/01/2019
Assessor Name	Report Created	BAM Data version *
Sian Griffiths	07/03/2019	6

Assessor Number

BAAS17066

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Candidate SAII	Ecosystem credits
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion								
4	731_Medium	54.1	12.0	0.25	High Sensitivity to Potential Gain	2.00		325
							Subtotal	**325**

Coast Grey Box - stringybark dry woodland on slopes of the Shoalhaven Gorges, southern Sydney Basin Bioregion								
2	778_Medium	45.6	57.9	0.25	High Sensitivity to Potential Gain	1.50		990
7	778_Poor	18.3	7.5	0.25	High Sensitivity to Potential Gain	1.50		52
9	778_Waterdependent	8.9	0.1	0.25	High Sensitivity to Potential Gain	1.50		0
							Subtotal	**1042**
Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion								
3	1150_Medium	45.4	13.7	0.25	High Sensitivity to Potential Gain	1.50		233
8	1150_Poor	27.2	2.6	0.25	High Sensitivity to Potential Gain	1.50		27
							Subtotal	**260**
Yellow Box grassy woodland of the northern Monaro and Upper Shoalhaven area, South Eastern Highlands Bioregion								
1	1334_Medium	40.4	48.8	0.25	High Sensitivity to Potential Gain	2.00	TRUE	985
5	1334_Poor	23.7	31.9	0.25	High Sensitivity to Potential Gain	2.00	TRUE	378
6	1334_Acacia_plantings	26.1	7.9	0.25	High Sensitivity to Potential Gain	2.00	TRUE	103
							Subtotal	**1466**
							Total	**3093**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Candidate SAII	Species credits
Chalinolobus dwyeri / Large-eared Pied Bat (Fauna)						
1334_Medium	40.4	48.8	0.25	3	True	1478
778_Medium	45.6	57.9	0.25	3	True	1980
1150_Medium	45.4	13.7	0.25	3	True	467
731_Medium	54.1	12	0.25	3	True	487
1334_Poor	23.7	0	0.25	3	True	0
1334_Acacia_plantings	26.1	7.9	0.25	3	True	155
778_Poor	18.3	0	0.25	3	True	0
1150_Poor	27.2	0	0.25	3	True	0
					Subtotal	**4567**
Phascolarctos cinereus / Koala (Fauna)						
1334_Medium	40.4	48.8	0.25	2	N/A	985
778_Medium	45.6	57.9	0.25	2	N/A	1320
1150_Medium	45.4	13.7	0.25	2	N/A	311
731_Medium	54.1	12	0.25	2	N/A	325
					Subtotal	**2941**

Solanum celatum / Solanum celatum (Flora)						
778_Medium	45.6	0.1	0.25	2	False	2
					Subtotal	**2**

Appendix 8. Threatened species assessments of significance under the EPBC Act

Matters for Assessment

Assessments of Significance and supplementary information (where relevant) are presented for the following MNES in relation to the Project:

- Threatened Ecological Communities
  - Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- Threatened Fauna
  - Koala
  - Large-eared Pied Bat
  - Grey-headed Flying-fox
  - Regent Honeyeater
- Migratory Species
  - Fork-tailed Swift
  - Great Egret
  - Cattle Egret
  - Rainbow Bee-eater
  - Black-faced Monarch
  - Rufous Fantail

Yellow Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Likelihood
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will: reduce the extent of an ecological community	
A total maximum area of 80.7 hectares of Yellow Box Yellow Box Blakely's Red Gum Woodland (hereafter referred to as Box-Gum Woodland) will be removed by the Project. Much of the the TEC is of a highly degraded condition, and is only listed under the EPBC Act due to the patch size being greater than 2ha (DoE 2014). The Box-Gum Woodland CEEC has been heavily cleared across its range, with the remaining extent of the ecological community being highly fragmented, occurring in small isolated patches within a cleared environment, or within a landscape of other disturbed woodlands (DoE 2014). This is evident throughout the Study Area and within the wider Project area. The EPBC Policy Guidelines (DoE 2014) also state that over 90% of the original extent of this ecological community has been cleared. This is supported by OEH (2014b) who regarded the equivalent Biometric Vegetation Type to be 90% cleared, and Thomas et al. 2000 estimate that within South-Eastern NSW 59,468 ha remain from the pre-1750 extent of 1,012,052 ha (approximately 94% cleared). In an attempt to determine the extent of Box-Gum Woodland in the locality, mapping by Tozer et al 2006 was examined as it covered the locality extent. A total of 3,304.6 ha of the best equivalent vegetation type (p24, Tableland Grassy Box Gum Woodland) has been mapped within a 10 km radius of the Project area. The p24 mapping unit has been described by Tozer et al (2006) as "potentially aligning to the CEEC and the state listed EEC, however it would include some areas that do not meet the CEEC". As a precuatinoary measures, we have assumed in this assessment that half of the total p24 area would be an approximate representation of the remaining CEEC in the locality (i.e. 1,652.3 ha). The potential habitat removed by the Project is therefore estimated to represent only 4.8% of the community in the locality. It is unclear what the condition and security of the remaining CEEC is within the locality. It is likely that much of it is on private land and that it is similarly disturbed compared with the disturbance area.	Known
fragment or increase fragmentation of an ecological community	
All of the CEEC within the disturbance area has experienced weed invasion, grazing pressures and clearing, which has resulted in a predominantly degraded condition of this community. The CEEC within the disturbance area is currently fragmented, however the Project will increase fragmentation by expanding the existing Mine pit to the west and developing additional out of pit overburden emplacements.	Likely to increase fragmentation.
adversely affect habitat critical to the survival of an ecological community	
The CEEC to be disturbed by the Project consists of two condition classes as detailed in Appendix 2. Both of the condition classes meet the Commonwealth listing despite prior historic disturbance and clearing due to the patch size and the presence of regenerating eucalypts. The Box-Gum Woodland Recovery Plan regards all areas of Box-Gum Woodland which meet the minimum condition criteria to be considered critical to the survival of the ecological community. Based on this statement, it would mean that all patches of the CEEC within the disturbance area, no matter of condition or size, are critical to the survival of the community and similarly, this would extend to all areas of the community within the locality.	Likely – however an estimated 1,652.3 ha of the CEEC within the locality would remain.

Yellow Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland	Likelihood
As stated in the EPBC Act Policy Guidelines, the CEEC has been heavily cleared across most of its range with the remaining extent of the ecological community being highly fragmented, occurring in small isolated patches within a cleared environment, or within a landscape of other disturbed woodlands. With this in mind, any clearing of large patches of the CEEC may result in an adverse affect to critical habitat, however, given the Study Area only represents that 4.8 percent of the CEEC in the locality, the Project alone would not result in the removal of habitat critical to the CEEC survival as other areas of the CEEC would remain.	
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community’s survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	
The clearing of the CEEC will result in the destruction of abiotic factors within the disturbance area necessary for the CEEC survival given that the CEEC will be cleared. The clearing of the CEEC will modify soil and soil seed bank within the disturbance area. Outside of the disturbance area, the impacts associated with the proposal are not likely to significantly exacerbate currently operating edge-effects in areas of the CEEC (e.g. weed invasion, areas of erosion and grazing). Within remaining areas of the CEEC, the proposed surface water drainage follows natural drainage lines which are unlikely to be impacted such that water availability to the CEEC is altered.	Unlikely to be a factor outside of disturbance area– impacts restricted to clearing of the proposed disturbance area
cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	
The Project will result in the loss of the CEEC within the disturbance area. Within the immediate surrounds, patches of CEEC may experience an increase in introduced species via increased edge effects. However, these areas are already subject to weed invasion, and the risk would be decreased via weed control measures implemented in accordance withthe Biodiversity Management Plan. As such, it is unlikely that a substantial change to species composition would occur in the CEEC immediately adjacent to the disturbance area as a result of the Project. The Project has some potential to alter the fire frequency of the area, however fire is already discouraged from occurring around the Mine area due to the presence of Mine infrastructure. The Biodiversity Management Plan to be prepared for the site, will consider the potential to implement a fire frequency appropriate to the existing remaining vegetation communities.	Unlikely
cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established, or	
The Project will likely increase edge effects for remaining areas of the CEEC that are adjacent to the proposed disturbance areas. There is the potential that weed invasion may be exacerbated within adjacent patches of CEEC however establishment of new weed species is unlikely to occur particularly given control measures for weeds implemented through the Biodiversity Management Plan.	Potential
causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or	

Yellow Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland	Likelihood
The Project will not involve any spraying of fertilizers, herbicides or other chemicals of pollutants which will kill or inhibit the growth of the CEEC. Herbicides and fertilizers may be required for bushland restoration and rehabilitation purposes to reduce the spread of weeds and promote seed germination and growth of seedlings, however these will only be used in accordance within bushland restoration principles and best practise and will not result in any significant impacts to the CEEC.	Unlikely
interfere with the recovery of an ecological community.	
The National Recovery Plan for White Box–Yellow Box–Blakely’s Red Gum Grassy Woodland and Derived Native Grassland has been prepared under the provisions of the EPBC Act. The overall aim of the recovery plan is to promote the recovery and prevent the extinction of the CEEC. The specific objectives of the recovery plan is to minimise the risk of extinction of the ecological community through: achieving no net loss in extent and condition of the ecological community throughout its geographic distribution; increasing protection of sites in good condition; increasing landscape function of the community through management and restoration of degraded sites; increasing transitional areas around remnants and linkages between remnants; and bringing about enduring changes in participating land manager attitudes and behaviours towards environmental protection and sustainable land management practices to increase extent, integrity and function of Box-Gum Grassy Woodland. The Project will interfere with recovery of the CEEC given that 80.7 hectares of the community will be cleared. The Project would not be consistent with the first objective of the above stated recovery aims for the community unless offsetting arrangements for the Project secure and improve the condition of the community elsewhere within the region to the extent that a ‘no net loss’ outcome is achieved. The Project will satisfy the NSW Offsets Policy for Major Projects which will result in a no net loss (otherwise known as improve or maintain) outcome for the community at a regional level by securing patches of the CEEC and managing these in perpetuity. In the long-term the offset is expected to benefit the recovery of the community given that a larger area of CEEC will be protected and managed in perpetuity.	Likely however greater recovery benefits will be achieved through an offset.
Conclusion: The proposal is likely to result in a significant impact on Box-Gum Grassy Woodland, primarily through the removal of habitat considered critical to the survival of the community.	

Koala

In assessing the significance of the impact from the proposed action on the Koala the '*EPBC Act referral guidelines for the vulnerable koala*' were applied to the assessment. The following information is presented prior to the Assessment of Significance for the Koala to demonstrate application of the guidelines and to assist with understanding the assessment and its conclusion.

Koala Habitat Assessment Scoring (Department of the Environment (2014). EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory). Commonwealth of Australia, 2014.):

Attribute	Score	Habitat Appraisal
Koala occurrence	+2	Koalas have been encountered infrequently adjacent to the existing Mine (the most recent in December of 2017 along Marulan South Road approximately 1 km from the Mine) according to communications with site personnel; A number of Koala records exist from contiguous habitat approximately 1-2 km south of the proposed disturbance area.
Vegetation Structure and composition	+2	Habitat scoring was applied across the Project area using floristic data and Braun Blanquet cover values from 400m^2 quadrats. The mapping indicated that the majority of the Project area contained either 2 or more known feed trees or a single feed species that occupied more than 50% of the quadrat.
Habitat connectivity	+2	The area is part of a contiguous landscape of > than 1,000 hectares, however the existing Mine and perimeter roads (incorporating steep rocky embankments in places) form a significant barrier to accessing the Study Area from the south, where extensive vegetated areas occur (the most extensive of which are within the Morton and Bungonia National Parks). There are no major barriers to Koala movement to the Study Area from the immediate south and west which allows for connectivity between the Study Area and the Bungonia State Conservation Area (despite the presence of steep terrain) where the majority of the Koala records for the region occur.
Key existing threats	+2	There is no known documented or anecdotal evidence of Koala mortality from dog attack or vehicle collision within the Study Area or surrounds. Dogs, trucks, and train movements are all present within the Study Area however wild dogs are not common (not detected on infrared cameras or seen during

		survey) and vehicle movements within the Study Area are regulated at low speeds.
Recovery value	+1	Uncertain whether the habitat within the Study Areas will be important in achieving the interim recovery objectives. There is some relevance to the recovery objectives for inland areas (as per table 1 of the referral guidelines (DoE 2014) in regard to the development area representing habitat on fertile soil, however the habitat is not thought to specifically act as a habitat refuge. There is some relevance to the objective of maintaining habitat around refuges (i.e. the area within Bungonia State Conservation Area is a known refuge). However, connectivity to the known refuge area is somewhat limited though the existing Mine and gorge habitat. Additionally, given the extensive reserve network surrounding the existing refuge areas, the importance of the Project area is lessened.
Total	**9/10**	

Koala (vulnerable)	
Preamble There are 137 Koala records from the NSW Atlas of Wildlife within a 10 km radius of the Study Area, all but three of which are post 1980 records. The majority of these records (105) are from the Bungonia National Park (NP) and Bungonia State Conservation Area (SCA) which occur approximately 1 - 2 km south of the Project area and collectively are considered one of the primary known active sites for a Koala population centred along the Shoalhaven Gorge and extending approximately 30 km to the south of the Study Area (e.g. Allen 2002) encompassing large areas of Morton National Park. The Bungonia NP/SCA active Koala area includes popular walking areas and a camping site and therefore observations of Koalas from this area are relatively frequent. Other unknown active Koala areas may exist within the locality where access is limited. The Bungonia NP/SCA areas are separated from the Study Area by the Bungonia Gorge, a limestone gorge approximately 350 m deep. The steepness of the gorge would undoubtedly limit connectivity between the main known breeding area of Koalas in the locality (Bungonia NP/SCA) and the Project area, however there are records of the Koala from both sides of the gorge (albeit very limited from the northern side) and connectivity to the Study Area exists indirectly, west of the main gorge area. North and west of the protected areas around the Bungonia and Shoalhaven gorges Koala records within the NSW Atlas of Wildlife are very limited with sporadic observations from private land and along roadsides, one being from the Mine and two additional records (including road-kill) each from around the townships of Marulan and Tallong. These areas are more disturbed, predominantly private tenure. They generally consist of more fertile areas that have been developed traditionally for agriculture. It is clear that Koalas are able to travel through such areas and feed trees including primary feed trees are available to them throughout such areas. Targeted Koala survey in these areas (private land on the tablelands) is likely to have been minimal and therefore actual Koala distribution and abundance within such areas is poorly known. Despite the limits regarding Koala distribution and abundance, given previous disturbance resulting in fragmented vegetation and the lack of Koala records within the higher elevation areas away from the protected areas around the Bungonia and Shoalhaven gorges, it is considered unlikely that active Koala areas (with permanent and moderate to high densities of Koalas) such as those within the Bungonia NP/SCA would occur. Surveys and collection of anecdotal evidence of Koala sightings conducted within the Study Area as part of this assessment revealed that Koalas have been sighted sporadically within the south of the Study Area over the past decade, with Koalas observed every 2- 3 years around the Mine (pers. comm. Grant Thompson – Boral). However, no Koala observations are known from the Study Area. Scat surveys, spotlighting, call-playback and tree surveys did not identify repeated or on-going use of trees within any of the proposed disturbance areas. Therefore, whilst it is known that Koalas occur within these areas and that feed trees exist within them, it is likely that very low densities of Koalas occur or that Koalas use the areas whist moving through the landscape.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is considered unlikely that the Project would lead to a long-term decrease in the size of an important population of the Koala. It is considered that the population of Koalas occurring around the Shoalhaven and Bungonia gorges (as described in Allen - 2002) is an important population, however it has not been listed specifically as such within a recovery plan. The identified active Koala area within the Bungonia NP/SCA, which acts as a known breeding and regular feeding habitat is one of several active areas for this population. The Project is not considered to have impacts on the population such that it will lead to a long-term decline as records away from protected areas within the locality of the Project area are very sparse and use of the Study Area is thought to be transient only or support a very limited number of individuals.	Very unlikely

reduce the area of occupancy of a important population;	
The Project would not impact the area of occupancy of any population of the Koala as the areas to be cleared are not sufficient in extent to impact the area of occupancy of the Koala at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN). Koalas would still be expected to occur within the vicinity of the Project area (e.g. to the west of the proposed western and central emplacement areas).	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for the identified population. There may be some minor impacts on potential north-south migration routes west of the existing Mine, however such migration will still be able to persist. There are no known important areas for Koalas to the north of the existing Mine. Connectivity between the main active population areas would not be impacted.	Unlikely
adversely affect habitat critical to the survival of a species;	
Habitat within the Project area to be impacted constitutes habitat critical to Koala survival as determined through application of the Koala habitat assessment tool (DOE 2014), which is illustrated in the table above. The habitat within the disturbance area scores a 9/10.	Likely
disrupt the breeding cycle of an important population	
Habitat within the disturbance area is not thought to be a key breeding area due to the low number of records. Therefore removal of the habitat is unlikely to disrupt the breeding cycle of the population. The area constitutes a very small proportion of the overall habitat for the population, (considered to be the population centred on the Shoalhaven gorge (Allen 2002)), with active population areas, including the Bungonia NP/SCA site, being the prime candidate sites for breeding activity.	Unlikely
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The area to be removed is a patch supporting 132.4 ha of Koala habitat for the population and the species. Its removal may have a minor impact on patterns of Koala movement and no isolation between populations would occur from the Project.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
Invasive species such as foxes that may impact on the Koala are already established within the Project area. The Project is unlikely to further encourage these threats from occurring.	Unlikely
introduce disease that may cause the species to decline, or	
The main diseases affecting Koalas are chlamydial infections. The Project would not increase exposure to such infections as Koalas from the local population would not have increased contact with other Koala populations including infected populations.	Unlikely
interfere substantially with the recovery of the species.	
The following aspects are considered in relation to the possibility of the Project to interfere with the recovery of the Koala (from DOE 2014): *Increasing koala fatalities in habitat critical to the survival of the koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities.* There is no reason to suspect that dogs would become more prevalent within the Project area or surrounds as a result of the Project;	Unlikely

Increasing koala fatalities in habitat critical to the survival of the koala due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities.

There have been no reported Koala fatalities due to vehicle strike within the Mine site or along access roads. Additional vehicle movements are expected to occur as a result of the Project but would be negligible, with the Project mostly ensuring the continuation of the current regime of vehicle movements within the Project area. There are strict speed controls on the vehicles operating within the Mine (20 and 40 km/hr) and given the very low number of Koala sightings from this area and the absence of recorded fatalities it is considered that the risk of increased fatalities such that multiple ongoing fatalities occur is very low;

Facilitating the introduction or spread of disease or pathogens for example Chlamydia or Phytophthora cinnamomi, to habitat critical to the survival of the koala, that are likely to significantly reduce the reproductive output of koalas or reduce the carrying capacity of the habitat;

This is considered unlikely as there would be no new sources of contamination as a result of the Project. The Project would not lead to Koalas being transported to the site from other areas. If vehicles coming to and from the Mine are considered to be a potential agent of *Phytophthora cinnamomi,* the Project would not lead to a change in the source areas where vehicles travel from to arrive at the Mine and therefore it is not considered that the Project increases the risk of *Phytophthora cinnamomi* spread;

Creating a barrier to movement to, between or within habitat critical to the survival of the koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala.

The proposed disturbance footprint is an extremely small proportion of Koala habitat for the population and the species. Its removal would have a minor impact on patterns of Koala movement and no isolation between populations would occur from the Project; and

Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term.

The Project would strive to maintain, pre-development drainage regimes and water quality in areas outside the disturbance footprint. The Project is therefore unlikely to alter the hydrology to the extent that it would result in the degradation of remaining habitat critical to the survival of the Koala.

Conclusion: Impacts from the Project largely relate to the removal of habitat that has been defined as being critical to the survival of the Koala. Such habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The Project includes the removal of 132.4 hectares of critical habitat, which through application of the guidelines is considered a significant impact.

Due to the apparent limited use of the Study Area and its extremely small extent in relation to other habitat where Koala records occur, it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven gorge) such that a decline would occur, as active sites for this population are concentrated within protected areas and the Project area is not thought to provide a link between active areas within the population's distribution or to any other Koala population.

Large-eared Pied Bat (Vulnerable)	
Preamble The Large-eared Pied Bat has been recorded from a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. The species can also be found on the edges of rainforests and in wet sclerophyll forests. The Large-eared Pied Bat roosts in caves and mines in groups of between 3 and 37 individuals. During field survey the Large-eared Pied Bat was recorded in one location within the middle of the disturbance area by using an anabat recording device.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding habitat for the Large-eared Pied Bat would result from the Project as preferred breeding habitat comprises caves and mine shafts, neither of which will be impacted by the Project. Potential breeding habitat would likely be within the forges of Bungonia State Conservation Area and Morton National Park, both of which would not be impacted by the Project. Impacts from the Project constitute impacts to foraging habitat of which approximately 140.3 hectares would be cleared. The foraging habitat is considered to be of moderate to good quality for the species, being a mix of moderate condition woodland. Most of the foraging habitat to be removed associated with the current Project and the Marulan South project occurs on fertile soils that are connected indirectly to areas of sandstone outcrops within Morton National Park and Bungonia State Conservation Area via vegetated links, though, it should be noted that the linkages are relatively limited to the direct east of the Study Area given the Marulan South Mine. Foraging habitat on fertile soils has previously been recognised as being important for the species (e.g. Pennay 2008), but the species has also been recorded foraging within a wide range of habitats including dry and wet sclerophyll forest; Cyprus Pine (Callitris glauca) dominated forest; tall open eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country (DOE 2015). Within the locality of the Study Area 7,400 hectares of potential foraging habitat has been mapped, with most occurring within the reserve systems of Bungonia National Park, Bungonia State Conservation Area and Morton National Park hectares within the Project's locality. Given the occurrence of the Large-eared Pied Bat across the Study Area and the quality of the surrounding woodlands in the Study Area and adjacent lands, it is assumed that the species forages over a wide range of habitats within the Study Area and wider locality. It is noted however that survey concentrated on identification of presence/absence of target species rather than attempts to investigate habitat preferences within the locality and data capture was not sufficient to confidently explain patterns of distribution. Despite the loss of foraging land due to the clearing proposed, potential foraging habitat would remain abundant within the locality due to the conservation areas protecting foraging habitat. The currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species given the availability of habitat within the conservation areas and given the disturbance is not impacting roosting habitat. Furthermore, it appears that the species has wide habitat preferences of the species within 3 kilometres of the sandstone gullies of Bungonia and Barbers	Unlikely

Creek. It should be further noted that upon Project decommissioning, the Study Area would be rehabilitated to create a woodland structure, thus providing future Large-eared Pied Bat habitat.	
reduce the area of occupancy of an important population;	
The Project would not impact the area of occupancy of the Large-eared Pied Bat for the following reasons: – Large-eared Pied Bats would still be expected to forage surrounding the Study Area given that the species was recorded at all sites including close to mining activities. – Habitat within Morton National Park and Bungonia State Conservation Area is protected, and contains habitat immediately surrounding breeding sites. Such habitat would persist regardless of development. – The site would rehabilitated following decommissioning and re-establish foraging habitat for the species.	Unlikely
fragment an existing important population into two or more populations;	
The Study Area is already fragmented from cliffs lines and rock outcrops along Bungonia Gorge and Shoalhaven River where the species is likely to roost. In particular, the Study Area is obstructed to the immediate east by the Marulan South Quarry. However, despite such fragmentation, the species was recorded across the Study Area and surrounds which suggests that the species is relatively mobile being able to utilise thin vegetative corridors and open areas. The Project will reduce the amount of foraging habitat, however it is unlikely that the fragmentation would result in any significant disturbance to a population given the extent of habitat available within in Morton National Park and Bungonia State Conservation Area that provides formal protection of a Large-eared Pied Bat habitat including that of breeding and roosting habitat.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species has not been listed within guidelines or a recovery plan for the species. Such habitat is considered to include breeding caves and roost habitat. Such habitat would not be impacted from the Project. Foraging habitat within close proximity to cliff lines or rock outcrops of the type to be removed by the Project has been considered important for the species. Such habitat is formally protected within within Bungonia State Conservation Area and Morton Park. The habitat within these conservation reserves is relatively extensive and intact. As such, the habitat to be removed is not considered critical to the species survival given the species will still persist due to protection within the conservation reserves.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding events for this species primarily take place within caves or other suitable roost habitats, none of which are expected to be adversely impacted by the Project.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	

The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Biodiversity Management Plan. Potential invasive predators such as the fox are already present within the Project area and the Project is not expected to increase the level of predation threat for the Large-eared Pied Bat.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project is not expected to cause an increased risk of any bat diseases.	Unlikely
interfere substantially with the recovery of the species.	
The list of recovery actions for this species on its DOE profile page (DOE 2015) includes: “Management of the species should focus on the protection and enhancement of higher fertility soils”. Higher fertility soils do not occur within the Study Area, nor will the vegetation to be cleared occur in close proximity to breeding or maternity caves and constitute a very small proportion of similar habitat in the locality. As such, the Project is unlikely to interfere with the recovery of this species. Cleared areas will be rehabilitated and topsoil retained where possible or suitable growth media established.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Large-eared Pied Bat. Whilst foraging habitat on fertile soils (or within fertile valleys) is considered an important overall requirement for this species, impacts from the Project are not considered to be significant for the following reasons: - No roosting or breeding habitat would be impacted by the Project. - Better condition habitat types are protected within Morton National Park and Bungonia State Conservation Area which occur to the south and east of the Study Area. As such, the foraging habitat protected within these reserves would remain used by the Large-eared Pied Bat population. - The foraging habitat is not critical to the survival of the species given the habitat for the species in the conservation areas detailed above. - The Study Area would be rehabilitated to a woodland structure, thus providing future foraging habitat for the species.	

Grey-headed Flying-fox (Vulnerable)

Preamble

This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km.

Recorded from Bungonia Gorge during field survey and expected to occur throughout area.

Criteria (Vulnerable Species)	Likelihood
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding or roosting habitat for the Grey-headed Flying-fox would result from the Project as breeding/roosting camps will not be impacted and do not occur in the Study Area. Impacts from the Project constitute impacts to foraging habitat of which approximately 140.3 hectares would be cleared. The foraging habitat is considered to be of moderate quality for the species, being a mix of degraded and moderate-good condition woodland. There are a variety of different Eucalyptus species present within proposed disturbance areas, some of which may contribute to winter and spring food availability. The significance of this contribution is not expected to be high as the expanse of similar foraging habitat within the locality is high. Over time, foraging habitat would be at least partially restored through rehabilitation works and retention of the topsoil where possible or establishment of suitable growth media would occur as part of rehabilitation works, aiding in maintaining fertility of habitats. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of a important population;	
The Project would not impact the area of occupancy of the Grey-headed Flying-fox for the following reasons: The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and Grey-headed Flying-fox would still be expected to forage within the vicinity of the Project area given that it was recorded at all sites including close to mining activities.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Grey-headed Flying-fox is a mobile species and the Project would not impact on areas where the species is known to breed and roost.	None
adversely affect habitat critical to the survival of a species;	

Habitat critical to the survival of the species has been loosely nominated within the National Recovery Plan for this species (DECC 2009) guidelines or a recovery plan for the species, however "productive" areas are acknowledged as potentially being foraging habitat critical to the survival of the species. However no measure of productivity is given. There are no recognised 'prolific flowering or fruiting trees within the proposed disturbance areas. In addition, whilst the timing of productivity is considered to be important in determining whether habitat is critical to the survival of the species, the timing given as being important covers the entirety of the year (see DECC 2009). Foraging habitat of the type to be removed by the Project is considered important for the species, due to its capacity to add in some measure to locally available winter foraging resources. However, given that similar habitat is locally common, is well represented within adjacent conservation reserves, and that winter flowering pulses are not considered to be particularly high within the habitat to be cleared, the habitat to be removed is not considered critical to the species survival.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding events for this species primarily take place within camps, none of which would be adversely impacted by the Project.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Biodiversity Management Plan. Potential invasive predators such as the fox are already present within the Project area and the Project is not expected to increase the level of predation threat for the Grey-headed Flying-fox.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any bat diseases.	Unlikely
interfere substantially with the recovery of the species.	
The Project does not directly or substantially interfere with any of the specific recovery objectives under the National Recovery Plan (DECC 2009). A general objective is to lessen the currently operating threats to the species which includes the removal of foraging habitat. The Project is therefore not consistent with this general objective. However the level and type of foraging habitat removal is not considered to constitute substantial interference with the recovery of the species.	Unlikely

Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Grey-headed Flying-fox within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons:

The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size;

Similarly important foraging habitat occurs throughout the locality including within protected areas; and

Rehabilitation of areas to be cleared will occur which should mitigate the loss of foraging habitat to some extent.

Migratory Species Fork-tailed Swift, Great Egret, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail	
Preamble: The above species all have potential habitat within the Study Area that would be impacted from the proposed action. All of the species subject to this assessment are considered to occur within the Project area on an irregular basis and the habitat within the Project area is similar to widespread and common habitat within the locality for these species.	
Criteria (Vulnerable Species)	Likelihood
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species, or	
No important habitat for any of the potentially occurring migratory species is considered to occur within the Project area.	Unlikely
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	
No invasive species of particular significance to the identified migratory species are expected to be established as a result of the proposed action. The Project area is already affected by invasive plants including some noxious weeds and introduced fauna such as the Fox which have some potential to adversely impact most fauna occurring within the Project area and surrounds. New invasive species are unlikely to become established due to the proposed action.	Unlikely
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	
None of the potentially occurring migratory species would have a significant proportion of their population occurring within the Project area.	Unlikely
Conclusion: The Project would remove 140.3 hectares of native vegetation. None of the above species occur in significant numbers within the Project area and the Project area does not support significant breeding habitat such that it may be used by a significant number of individuals to conduct any aspect of their lifecycle including foraging, breeding, overwintering or sheltering.	

Regent Honeyeater	
Criteria (Critically Endangered Species)	Likelihood
An action is likely to have a significant impact on a Critical Endangered species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
Any population of the Regent Honeyeater should be regarded as an important population given the status of the species is Critically Endangered. Based on the results of the targeted field survey which met the survey hours/days suggested in the DoE (2017) Survey Guidelines for Australia's Threatened Birds EPBC Act survey guidelines, the Regent Honeyeater was not recorded within the Study Area, nor within better condition habitat surveyed surrounding the Study Area. However, like many threatened birds, given the species is mobile, its potential use of the Study Area on a very limited level cannot be ruled out, as the species may fly over or through the Study Area on occasion. It is possible that there is some degree of potential foraging habitat within the Study Area given the species is known to forage a range of habitats including dry open forest and woodland. However, the lack of detection during the targeted survey may suggest that the Regent Honeyeater is unlikely to utilise the Study Area and surrounds on a regular or permanent basis. This conclusion is further supported by the fact that three historical records have been made since 1983 within 12 km of the Study Area as per below: - Approximately 4.8 km south of the Study Area near Lockdown Road, Bungonia. This record was in made in 2005 within a gully environment near Bungonia Creek weir. - Approximately 5 km south of the Study Area near the Bungonia State Conservation Area office. This record was made in 1998. - Approximately 11.9 km south of the Study Area within private property. This record was made in 1983. Given Bungonia State Conservation Area and Morton National Park are relatively popular for bird watchers, if the Regent Honeyeater were to frequent the area, it seems reasonable to suggest that the records would be greater than three records within 36 years. As such, whilst it is noted that there is the possibility the Regent Honeyeater may move through the Bungonia region on occasion, the removal of 140.3 hectares of potential foraging habitat, is unlikely to reduce the size of an important population given the species is unlikely to utilise the Study Area on a regular or permanent basis.	Unlikely
reduce the area of occupancy of an important population;	
The Regent Honeyeater is not known to occupy the Study Area. As discussed above, the species was not detected during the field survey and three records with the Bungonia region over 36 year seems to indicate that the species does not have a regular movement through the Bungonia region, or provide significant or important habitat that supports regular population movements of the species. Given the species is not known to occupy the Study Area based on the meeting the survey guidelines, any impact to native vegetation within the Study Area is therefore not reducing habitat occupied by the species.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Regent Honeyeater is a mobile species and would still have movement within the Morton National Park and Bungonia State Conservation Area should the species were to move through the Bungonia area.	Unlikely
adversely affect habitat critical to the survival of a species;	

The National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia) states that any breeding or foraging areas where the species is likely to occur are all critical to the survival of the species. Breeding habitat within the Study Area is unlikely due to the absence of the species during field surveys, and due to the lack of recent records. In terms of foraging habitat, is it not possible to exclude any area of native vegetation with absolute certainty within the movement corridors of the species given the Regent Honeyeater can utilise a wide range of habitat types including that of orchards and urban gardens. However, the likelihood for the Regent Honeyeater to have foraging habitat with the Study Area and use it on a regular or intermittent basis seems relatively low given the species was not detected during field surveys, and the sparse records for the species with the locality over the past 30 years. Based on this, it is unlikely that the habitat within the Study Area is critical foraging habitat for the species. It should also be noted that foraging habitat is relatively well represented within adjacent conservation reserves with provide a well vegetated corridor throughout the locality.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding habitat was not detected during the field survey. As discussed above, habitat removal in the Study Area is not likely to result in changes to flight movements given the availability of habitat with the adjacent conservation reserves.	Unlikely
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The habitat within the Study Area has already been impacted by historic clearing events and high levels of weed and pest occurrence. As discussed above, the Study Area is only a marginal/low likelihood that foraging habitat existing for the Regent Honeyeater. The removal of such habitat is unlikely to reduce the availability of potential habitat for the species to an extent that the species is likely to decline. The clearing associated with the Marulan South Project (subject to separate approval) would contribute to vegetation clearing in the area, however the adjacent conservation reserves contain foraging habitat that would not be impacted by the Project.	Unlikely
result in invasive species that are harmful to a Critically Endangered species becoming established in the species' habitat;	
The Project is unlikely to increase the likelihood of invasive species being established in areas adjacent to Study Area that would result in die back of eucalypts and native vegetation. Mitigation measures have been proposed to minimise indirect impacts.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any bird diseases.	Unlikely
interfere substantially with the recovery of the species.	
The main objectives in the National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia) are: • 'Reverse the long-term population trend of decline and increase the numbers of Regent Honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years; and to	Unlikely

• Enhance the condition of habitat across the regent honeyeaters range to maximise survival and reproductive success, and provide refugia during periods of extreme environmental fluctuation.'

The Recovery Strategies to achieve the objectives include:

• 'Improve the extent and quality of regent honeyeater habitat.'

The removal of native vegetation within the Study Area is unlikely to substantially interfere with the recovery of the species given the following:

- No breeding habitat would be impacted.
- The Study Area does not occur within an area that has had extensive records.
- The Study Area is not a known refugia site.
- As discussed previously, the potential for the species to use the Study Area is relatively low.
- Rehabilitation of the site following decommissioning would provide foraging trees for the Regent Honeyeater (eg. Eucalyptus melliodora).

Conclusion: It is unlikely that a significant impact to the Regent Honeyeater would occur as a result of the Project due to the following:

- The species was not detected despite targeted survey
- Breeding habitat is unlikely to be present due to lack of mature hollow bearing eucalypts
- The species has only been detected three times in the past 36 years within the Bungonia region suggesting that the species potential usage of the Study Area is likely to be marginal/low.
- The adjacent conservation areas of Morton National Park and Bungonia State Conservation Area occur within the locality of the Study Area, and offer a range of habitat features for the Regent Honeyeater.

Niche Environment and Heritage

A specialist environmental and heritage consultancy.

Head Office

Niche Environment and Heritage
PO Box 2443 North Parramatta NSW 1750
Email: info@niche-eh.com

All mail correspondence should be through our Head Office

Appendix L

Aquatic ecology assessment

Marulan South Limestone Mine Continued Operations

Aquatic Assessment

Prepared for Boral Cement Ltd

November 2018

Document control

Project no.: 2155

Project client: Boral Cement Ltd

Project office: Sydney

Document description: Aquatic Assessment - Marulan South Limestone Mine Continued Operations

Project Director: Matthew Richardson

Project Manager: Matthew Richardson

Authors: Matthew Russell

Internal review: Radika Michniewicz

Document status: R0

Local Government Area: Marulan

Author	Revision number	Internal review	Date issued
Matthew Russell	D1	Radika Michniewicz	1/11/2018
Matthew Russell	D2		
Lucy Porter	R0		

Cover photograph: Barbers Creek

Niche Environment and Heritage

A specialist environmental and heritage consultancy.

Head Office

Niche Environment and Heritage
PO Box W36
Parramatta NSW 2150
Email: info@niche-eh.com
All mail correspondence should be through our Head Office.

Sydney
0488 224 888
Central Coast
0488 224 999
Illawarra
0488 224 777
Armidale
0488 224 094
Newcastle
0488 224 160
Mudgee
0488 224 025
Port Macquarie
0488 774 081
Brisbane
0488 224 036
Cairns
0488 284 743

Table of Contents

List of Figures

List of Tables

List of Graphs

List of Plates

Glossary

Term	Definition
Critical habitat	Areas of declared critical habitat as defined under the now repealed *Threatened Species Conservation Act 1995* (now Areas of Outstanding Biodiversity Value under the *Biodiversity Conservation Act 2016*) include, 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:	Impacts 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.
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 now repealed *Threatened Species Conservation Act 1994* (replaced by 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.
Local population:	The population that occurs in the project area. The assessment of the local population may be extended to include individuals beyond the project area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the project area, according to the following definitions. • The local population of a threatened plant species comprises those individuals occurring in the project area or the cluster of individuals that extend into habitat adjoining and contiguous with the project area that could reasonably be expected to be cross-pollinating with those in the project area. • The local population of resident fauna species comprises those individuals known or likely to occur in the project area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the project area. • The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the project area from time to time.
Project Area:	Is the subject site and any additional areas which are likely to be affected by the Project, either directly or indirectly.
Subject site:	Is the area directly affected by the Marulan South Limestone Mine Continued Operations.
Threatened ecological community (TEC)	An ecological community identified by the *Biodiversity Conservation Act 2016, Fisheries Management Act 1994* or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* as critically endangered, endangered or vulnerable.

Abbreviations

Acronym	Term/Definition
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AUSRIVAS	Australian Rivers Assessment
BC Act	*Biodiversity Conservation Act 2016*
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*
ha	Hectare/s
JAMBA	Japan-Australia Migratory Bird Agreement
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
OE50	Observed to Expected ratio. The ratio of the number of invertebrate families observed at a site (NTC50) to the number of families expected (NTE50) at that site.
OEH	Office of Environment and Heritage
PERMANOVA	Permutational Analysis of Variance
PSO	Planning Scheme Ordinance
REF	Review of Environmental Factors
RUKAMBA	Republic of Korea-Australia Migratory Bird Agreement

Acronym	Term/Definition
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy
SEPP 44	*State Environmental Planning Policy 44 – Koala Habitat Protection*
SIGNAL	Stream Invertebrate Grade Number Average Level
SIMPER	Similarity Percentage Analysis
SIS	Species Impact Statement
SSD	State Significant Development
TEC	Threatened Ecological Community
tpa	Tonnes per annum
TSC Act	*Threatened Species Conservation Act 1995* (NSW) (repealed)
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 aquatic ecology in support of the Environmental Impact Statement (EIS) for the proposed development. Specifically this report assesses whether the proposed development is likely to have a significant impact on aquatic ecological communities and specific threatened species listed on the NSW *Fisheries Management Act 1994* (FM Act), *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Results

Threatened species

Threatened species searches identified two threatened fish species in the Shoalhaven catchment, the Australian Grayling and Macquarie Perch. Australian Grayling do not occur above Tallowa Dam and therefore were not considered likely to occur within the study area. One record of Macquarie Perch in the Shoalhaven River occurs approximately 3 kilometres upstream of Bungonia Creek/Shoalhaven River confluence. No threatened species however were observed from the survey.

Marulan creek

Marulan Creek has a highly disturbed catchment with several farm dams and lengths of stream with poor riparian vegetation, however the assessment of macroinvertebrate communities did show similarity to reference conditions at one site on one occasion. Despite this, the stream is considered to be impaired, consisting generally of pollution tolerant macroinvertebrate fauna and a fish community predominately of introduced Mosquito fish.

Tangarang Creek

Surface water drains away from the centre of the resource area which is situated on a ridge of the plateau. Drainage lines within the property consist of ephemeral creeks which are either slightly eroded or lined with grass and likely to have similar aquatic fauna to Marulan Creek. A number of small farms dams are situated along these creek lines and appear to retain water with little seepage.

Bungonia Creek, Barbers Creek and Shoalhaven River

Bungonia and Barbers Creek, located downstream of the mine, are similar in gorge morphology, with bedrock, large boulders dominating pool substrate and little macrophyte growth. Shoalhaven River, a much larger system, has a variety of pool and riffle habitats, substrates and macrophytes. There was no statistical difference observed between macroinvertebrate communities and stream health of upstream and downstream sites in Marulan Creek, Shoalhaven River and Barbers Creek. However, there were faunal differences between up and downstream Bungonia Creek. This was considered to be due to changes in stream morphology and aquatic habitat downstream.

Fish communities in Barbers Creek and Bungonia Creek consisted of similar species including Cox's Gudgeon (*Gobiomorphus coxii*), Long-finned Eel (*Anguilla reinhardtii*), and Mountain Galaxias (*Galaxias olidus*). Additional species were recorded at Bungonia Creek, with the fish community including Australian Smelt (*Retropinna semoni*), Flathead Gudgeon (*Philypnodon grandiceps*), introduced Common Carp (*Cyprinus carpio*), as well as small Eel-tailed Catfish (*Tandanus tandanus*) observed near the confluence with the Shoalhaven River. Fish observed in the Shoalhaven River were Australian Smelt, Mosquito Fish (*Gambusia holbrooki*), Flathead Gudgeon, Cox's Gudgeon and Australian Bass (*Percalates novemaculeata*). The Shoalhaven River fish community upstream of the Tallowa Dam is also known to include Short-finned Eels (*Anguilla australis*). This community is known to be impacted by Tallowa Dam which has particularly affected migration/recruitment of diadromous fish species.

Impact assessment

Marulan creek

Marulan Creek is likely to experience some impact from the construction of the dam and the inundation area itself. While Marulan Creek does have aquatic ecological values (particularly where sampled upstream), the impact is likely to inundate areas within the catchment that are already disturbed. Mitigation measures will limit downstream impact during construction and it is expected that 10% of the average daily flow will be required to be released downstream to provide some temporal flow and aquatic habitat. While there will be unavoidable impacts from reduction of flow to this system, it is expected that the resilient characteristics of stream fauna of this ephemeral stream will occupy ephemeral habitats where available downstream and be similar to fauna downstream of Tangarang Dam.

Tangarang Creek

Tangarang Creek catchment will increase by approximately 50 ha, or about 8% of the existing catchment draining to the water supply dam for Peppertree Quarry. The change in the catchment runoff characteristics of the areas of overburden emplacement are predicted to lead to an increase of about 9% in the average annual flow into the dam. These changes in flow regime are not expected to have a significant adverse impact on Tangarang Creek. Considering this and the ephemeral nature of the stream there will be negligible impact to aquatic ecology.

Bungonia Creek, Barbers Creek and Shoalhaven River

The surface water assessment (Advisian 2018) and groundwater assessment (AGE 2018) indicated that there will be negligible impact to stream flow or ground/surface water quality from the Project. Therefore, it is unlikely that any downstream impact to aquatic ecology will occur in these systems.

Avoidance management and mitigation

Management of the waterways and its ecology is primarily implemented through the mitigation measures employed to manage stream flow and water quality. The surface water assessment (Advisian 2018) describes a conceptual water management system that is designed and proposed to be managed in accordance with the requirements for long term sites that discharge to 'sensitive' environments. This level of runoff retention and treatment is consistent with the principles of the Neutral or Beneficial Effect (NoBE) objectives, and as such will ensure minimum impact to the aquatic environment.

Avoidance of impact is likely for sensitive downstream environments of Bungonia Creek, Barbers Creek, Shoalhaven River as well as Tangarang Creek. Marulan Creek will require mitigation measures (provided within Advisian 2018) during construction to limit the impact to the local and downstream aquatic environment. Management of the Marulan Creek Dam during its operation will involve releasing a proportion of flow downstream to maintain some aquatic habitat immediately downstream of the dam. It is recommended that monitoring of aquatic biota is included in the Surface Water Management Plan to demonstrate management is not having impact on aquatic ecology and/or recovery/improvement from current conditions and to monitor potential impacts from the Project.

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 Aquatic Assessment Report is part of the EIS.

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

1.2 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 Limestone Mine Continued Operations 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). This document forms the aquatic assessment portion of the EIS.

1.2.1 Secretary's environmental assessment requirements

This aquatic assessment has been prepared to address specific requirements provided in the Secretary's environmental assessment requirements (SEARs) for the SSD application. Table 1 cross-references this report with the relevant SEARs.

Table 1 Relevant SEARs for this assessment

Requirement	Section addressed in report
Environment Protection Authority (EPA)	
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 aquatic assessment addresses this requirement throughout the report from an aquatic 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.	Addressed in Section 5.
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.	Addressed in Section 3.
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.	Addressed in Section 6.
Office of environment and Heritage OEH	
The EIS must assess the impact of the proposed project on hydrology, 'including: • Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems (GDE)s and stygofauna. • Impacts to natural processes and functions within rivers, wetlands, and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (eg river benches).	This report addresses aquatic ecological effects downstream of water-dependent flora and fauna and impacts to stream processes and function and stream health. GDEs and stygofauna are addressed in the Stygofauna and Groundwater Dependent Ecosystem Impact Assessment (Niche 2018).
Department of Planning and Environment	
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:	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 1, 3, 5 and 6 of this report.

▪ 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.	

1.3 Relevant Legislation

1.3.1 EP&A Act

The EP&A Act provides an assessment framework for the consideration of threatened species, populations, ecological communities and their habitats. Section 5A of the EP&A Act lists seven factors to be considered when projects are deemed to have an impact on the habitat of threatened biodiversity listed on the BC Act. The assessment of significance, or seven-part test, sets the criteria for determining whether a proposal is likely to have a significant impact on threatened biodiversity that, if this is identified, would necessitate the preparation of a species impact statement (SIS).

1.3.2 BC Act

The BC Act provides for legal protections of biodiversity and threatened species in NSW. It provides for:

- A process for declaring and protecting areas of outstanding biodiversity value.
- The listing of ‘threatened species, populations and ecological communities, with critically endangered, endangered and vulnerable species, listed under Schedule 1.
- The listing of critically endangered, endangered and vulnerable ecological communities listed under Schedule 2, and extinct species, species extinct in the wild and collapsed ecological communities of animals and plants listed under Schedule 3.
- Criteria for determining whether a proposal is likely to have a significant impact on threatened biodiversity, and direction for the preparation of a species impact statement (SIS) should significant impacts occur.
- Requirements for the content of a species impact statement (SIS).
- The NSW Biodiversity Offsets Scheme.

Threatened species, populations and ecological communities listed under the BC Act are relevant to this assessment.

1.3.3 EPBC Act

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on Matters of National Environmental Significance (MNES) undergo an assessment and approval process. Under the EPBC Act, an action includes a project, undertaking, development or activity. An action that ‘has, will have or is likely to have a significant impact on a Matter of National Environmental Significance’ is deemed to be a controlled action and may not be undertaken without prior approval from the Commonwealth Minister for Environment.

The EPBC Act identifies MNES as:

- World heritage properties
- National heritage places
- Wetlands of international importance (Ramsar wetlands)

- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining).

Listings deemed relevant to the Project have been assessed in accordance with relevant guidelines available at the time of writing the assessment.

1.3.4 FM Act

The main objectives of the FM Act are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations, and in particular:

- To conserve fish stocks and key fish habitats.
- To conserve threatened species, populations and ecological communities of fish and marine vegetation.
- To promote ecologically sustainable development, including the conservation of biological diversity and, consistently with these objectives.
- To promote viable commercial fishing and aquaculture industries.
- To promote quality recreational fishing opportunities.
- To appropriately share fisheries resources between the users of those resources.
- To provide social and economic benefits for the wider community of NSW.
- To recognise the spiritual, social and customary significance to Aboriginal persons of fisheries resources and to protect, and promote the continuation of, Aboriginal cultural fishing.

To meet the primary objectives, Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation. Part 7 commonly applies to “integrated development” proposals as defined by the EP&A Act.

The FM Act applies within the Project Area for state listed threatened species, populations and ecological communities. Impacts of the Project on threatened species, populations and ecological communities known or considered to have suitable habitat in the Project Area have been assessed to determine if significant impacts are likely to occur.

Key fish habitat policy

The waterways within the Project Area fall within the definition of, and are mapped as, ‘Key Fish Habitat’ (DPI 2013). NSW DPI recognises that certain types of activities have varying degrees of impact on Key Fish Habitat and, as such, require different levels of control and regulation. As a general principle, NSW DPI requires that proponents should, as a first priority, aim to avoid impacts on Key Fish Habitat. Where avoidance is impossible or impractical, proponents should then aim to minimise impacts. Any remaining impacts should then be offset with compensatory works.

1.4 Purpose of this Report

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to assess the aquatic ecological values and impacts associated with the Project. The primary objective of this report is to describe and assess the aquatic ecological values within the Project site and surrounds, and determine potential impacts of the Project on threatened aquatic biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act), *NSW Fisheries Management Act 1994* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). GDEs and stygofauna are addressed in the Stygofauna and Groundwater Dependent Ecosystem Impact Assessment (Niche 2018).

The assessment has been carried out in accordance with the SEARs and controlling provisions for the EPBC Act with reference to the following standards, guidelines and policies:

- Policy and Guidelines for fish habitat, conservation and management (DPI 2013)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DECC 2004)
- Threatened Species Assessment Guidelines: the Assessment of Significance (DPI 2008)
- DPI Key Fish Habitat Policy
- New South Wales Australian River Assessment System (AUSRIVAS): Sampling and Processing Manual, (Natural Heritage Trust, Department of Environment and Conservation NSW 2004)
- On Beyond BACI – sampling designs that might reliably detect environmental disturbances. Underwood, A.J. (1994) Ecological Applications 4, 3-15
- National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ)National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ 2000)
- Aquatic ecology in environmental impact assessment (Department of planning DOP 2002)

The specific objectives of this assessment are to:

- Describe the pre- development characteristics of stream ecology through quantitative and qualitative monitoring of macroinvertebrates as well as monitoring of fish, macrophytes, aquatic habitat in the Project Area.
- Identify or determine the likelihood of occurrence of aquatic threatened species, populations, habitat and/or communities with in the Project Area under the FM/BC and EPBC Act.
- Assess whether these impacts will cause significant adverse effects to stream ecology.
- Determine whether these impacts will significantly impact threatened species, populations, habitat or communities.
- Recommend mitigation measures to minimise potential impacts to stream ecology, in particular threatened aquatic species, populations and communities.

1.5 Site Description

1.5.1 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.

Table 2. Regional 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 and Morton National Park.
Surrounding land use	Mostly agricultural land to the west of the Project site. Peppertree Quarry occurs to the north, and Bungonia State Conservation Area and Morton National Park occur to the south and east.
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 stream) outside of the Project site to the east. Barbers Creek flows to the south-east into the Shoalhaven River (6th order stream). 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.

1.5.2 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 which forms Bungonia Gorge and is separated from the Shoalhaven River and Morton National Park to the east by Barbers Creek (Figure 2).

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.

1.5.3 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.

1.5.4 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).

1.5.5 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.

1.5.6 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.

1.6 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.

1.7 The Project

1.7.1 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.

1.7.2 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).

1.7.3 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.

2. Literature Review

A number of threatened species database searches were undertaken and previous reports relevant to the Marulan South Limestone Mine Continued Operations were reviewed.

2.1 Database Searches

- Bionet Atlas of NSW Wildlife and Atlas of Living Australia Database: A review of the documented records of the locations of threatened aquatic species within the Project Area has been undertaken using the Atlas of NSW Wildlife and Atlas of Living Australia. Searches of the database were undertaken in March 2018.
- DPI Fisheries data base searches and mapping: A review of the documented records of the locations of threatened aquatic species within the Shoalhaven Catchment was undertaken using the DPI Threatened Species Records Viewer (2015), and DPI Freshwater threatened species distribution maps (2018).
- EPBC Act Protected Matters Search: A Protected Matters Search was carried out within a 20 km^2 area buffer around the Project Area. A search was conducted in 2018.
- NSW AUSRIVAS data OEH: This data includes macroinvertebrates and AUSRIVAS score collected from Fossickers Flat collected approximately 17 km downstream of the Project Area.
- Sydney Catchment Authority (Water NSW) macroinvertebrate data: This data includes macroinvertebrate samples at two sites collected in upstream Bungonia Creek and upstream Barbers Creek, located 5-15 km upstream of the Project Area.

2.2 Review of Previous Ecological Surveys and Studies

Previous ecological assessments at Boral have not required aquatic ecology assessments for approval, as such there is no historical data specific to the Project. While there have been some ecological surveys in the Shoalhaven Catchment, particularly with regards to environmental flows and the impact of Tallowa Dam, there have been limited aquatic ecological surveys close to, or downstream of, the Project Area particularly in Bungonia Creek and Barbers Creek.

The following ecological survey and studies that contain ecological information potentially relevant to the Project Area were reviewed:

- Determining and managing environmental flows for the Shoalhaven River Report 1 - Environmental Flows Knowledge Review (Department of Natural Resources 2006).
- Changes in fish communities of the Shoalhaven River 20 years after construction of Tallowa Dam, Australia (Gehrke et al. 2002).
- OEH and WaterNSW data.

AUSRIVAS monitoring was conducted by OEH in the Shoalhaven River at Fossickers Flat approximately 17 km downstream of Marulan Limestone Quarry. The pool edge has been sampled on five occasions (the earliest 1997 and most recent 2009), showing mostly good stream health. The AUSRIVAS assessment scored pool edges in band A (close to reference) on three occasions and in band B and C (different from reference condition) on one occasion each. The spot water quality measurement conducted exhibited the following ranges:

- Temperature 7.3-27.3˚C
- Conductivity 91-300 uS/cm
- Turbidity 2-11.3 NTU
- Dissolved oxygen 6.7-11.7 mg/l
- pH 6.5-8.7

- Alkalinity 16-53.

The Sydney Catchment Authority have previously conducted macroinvertebrate surveys in Barbers Creek (2014) and Bungonia Creek (2001-2014) however these sites are located well upstream of the Project Area and are likely to be more similar to Marulan Creek than the gorge habitats associated with Bungonia and Barbers Creek downstream of the mine.

Fish surveys have not previously been conducted in Bungonia and Barbers Creek, with very few public records (Atlas of NSW Wildlife and Atlas of Living Australia) within 10 km of the Project Area. There is one record of Macquarie Perch (*Macquaria australasica*) upstream in the Shoalhaven Catchment from 2007 (Atlas of NSW Wildlife accessed 2018).

While limited fish surveys have been conducted in Bungonia and Barbers Creek, the Shoalhaven upstream (Talwong Mines) and downstream (Fossickers Flat) have been sampled as part of the Tallowa Dam fishway project, studying fish communities and migration in the Shoalhaven River prior to construction of a fishway (2001). They found Long-finned Eels (*Anguilla reinhardtii*), Short-finned Eels (*Anguilla australis*), Flathead Gudgeon (*Philypnodon grandiceps*), Australian Bass (*Percalates novemaculeata*), Australian Smelt (*Retropinna semoni*), Common Carp (*Cyprinus carpio*), Gambusia (*Gambusia holbrooki*) and Cox's Gudgeon (*Gobiomorphus coxii*).

The study found that the fish passage barrier posed by Tallowa Dam had resulted in a reduction in the biodiversity of the river system in the upper 75% of the Shoalhaven Catchment and had led to the extinction of ten migratory species upstream of Tallowa Dam, including Striped Mullet (*Mugil cephalus*), Freshwater Mullet (*Trachystoma petardi*), Common Galaxias (*Galaxias maculatus*), Striped Gudgeon (*Gobiomorphus australis*), Empire Gudgeon, Australian Bass, Bullrout (*Notesthes robusta*), Short-headed Lamprey (*Mordacia mordax*), Australian Grayling (*Prototroctes maraena*) and Freshwater Herring (*Potamalosa richmondia*). Cox's Gudgeon, Short-finned Eels and Long-finned Eels accumulate in large numbers below the dam and are significantly less abundant upstream of the dam.

3. Methodology

3.1 Sampling Locations and Study Design

Site locations were selected to address two main potential impacts from the development: changed surface water runoff/subsurface flow conditions into Barbers and Bungonia Creek; and the proposed construction of a dam on Marulan Creek. Sites were selected to capture the variability of aquatic biota within streams (up and downstream of the impact), and grouped according to stream type and impact (Figure 6, Table 3). To provide control and impact sites for any future monitoring, upstream (control) and downstream (potential impact) sites were selected. However, as the objective of the current surveys was to determine existing baseline conditions (prior to any potential impact), this report refers to the sites as upstream and downstream (*cf* control and impact). The aim was to assess current stream health and establish if a pre-existing difference between upstream and downstream sites exists and to establish current spatial variability with in the streams, their health and any existing impacts.

Barbers Creek and Bungonia Creek are geomorphically similar and, as such, downstream sites were compared to upstream sites in both Barbers and Bungonia Creeks. Shoalhaven River and Marulan Creek were analysed separately.

Sites were sampled in the autumn and spring of one year to capture temporal variability within a year. However, due to the lack of replication, time was not used as a factor in any statistical analysis.

Surveys were undertaken on the following dates:

- Spring 2014: 17th November -21st November
- Autumn 2015: 2nd March- 5th March

Table 3 Site locations and corresponding surface water sites

Stream Type	Site	Abbreviation	Type	Location	Easting	Northing
Gorge – Bungonia Creek and Barbers Creek	Bungonia Creek upstream Site 1	BungUp1	Gorge Upstream	Upper Bungonia Creek (furthest upstream)	227379	6145506
	Bungonia upstream Site 2	BungUp2	Gorge Upstream	Upper Bungonia Creek	227409	6145521
	Bungonia downstream Site 1	BungDown1	Gorge Downstream	Lower Bungonia Creek	228375	6145603
	Bungonia downstream Site 2	BungDown2	Gorge Downstream	Lower Bungonia (furthest downstream)	229086	6145713
	Barbers Creek upstream Site1	BarbUp1	Upstream gorge control	Upper Barbers Creek (furthest upstream)	229518	6148416
	Barbers Creek upstream Site 2	BarbUp2	Upstream gorge control	Upper Barbers Creek	229593	6148328
	Barbers Creek downstream Site 1	BarbDown1	Gorge treatment	Lower Barbers Creek	229461	6147514
	Barbers Creek downstream Site 2	BarbDown2	Gorge Treatment	Lower Barbers Creek (furthest downstream)	229542	6147306

Major coastal river - Shoalhaven River	Shoalhaven River upstream	SR1	Upstream control	Upper Shoalhaven River (above Bungonia confluence)	229183	6145620
	Shoalhaven River below Bungonia confluence	SR2	Treatment	Shoalhaven River (below Bungonia confluence)	229940	6146335
	Shoalhaven River below Barbers Creek	SR3	Treatment	Shoalhaven River (below Barbers confluence)	231172	6146891
Upstream tributary - Marulan Creek	Marulan Creek upstream	MC1	Upstream Control	Marulan Creek (above proposed dam)	225825	6151504
	Marulan Creek downstream	MC2	Treatment	Marulan Creek (below proposed dam)	228002	6151977

3.2 Aquatic Habitat Assessment

A visual assessment of aquatic habitat was conducted using the AUSRIVAS (Australian River Assessment System) proforma. The survey involves a rapid visual assessment based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

Photographs were taken at each site during both the autumn and spring surveys.

3.3 Water Quality

Physicochemical parameters could not be measured due to the difficult access (steep access which limited the amount of equipment that could be carried). However, alkalinity (mgCaCa$_3$/L) was measured for use in the AUSRIVAS models. The water quality portion of the aquatic ecology assessment will refer to the Surface Water Assessment (Advisian 2018) and Groundwater Impact Assessment (AGE 2018).

3.4 Fish

The fish survey was conducted in Marulan Creek, Bungonia Creek, Barbers Creek and Shoalhaven River. Sampling was conducted at opportunistic locations within proximity of macroinvertebrate sampling sites (Figure 6) to broadly represent upstream and downstream fish communities, and, where possible, targeted Macquarie Perch via nocturnal surveys. Survey effort was greater within the creek systems (*cf* Shoalhaven River) due to the greater likelihood of impact by the Project and because it was considered that, given the sampling methods, time and access available, the caught/observed fish species were more likely to be representative of the fish communities in the smaller tributaries. Fish surveys were undertaken at all sites using an array of visual, netting and trapping techniques including fyke netting, the use of baited fish traps, seine nets and visual observation, including nocturnal surveys. The nocturnal survey targeted the threatened Macquarie Perch in Barbers Creek, Bungonia Creek and Shoalhaven River. Fish were identified in the field using Field Guide to the Freshwater Fishes of Australia (Allen et al. 2002). Fish counts were tabulated and size noted. Fish surveys were limited as all techniques could not be used at all sites due to difficult/remote access, available habitat, large boulder substrate and time available to set traps. As such, the survey was opportunistic in nature and provides presence/absence of fauna rather than repeatable measures of abundance per unit effort.

Fish sampling was conducted in accordance with an Animal Research Authority (Fauna Surveys: Terrestrial and Aquatic) and a Scientific Collection Permit (No. P13/0008-2.0) issued by the NSW Department of Primary Industries.

3.5 Macrophytes

Macrophytes that occurred within a 100 m reach at each sample site were identified and recorded as part of the AUSRIVAS sampling protocol.

3.6 Aquatic Macroinvertebrates

Aquatic macroinvertebrates were collected using the AUSRIVAS protocol for NSW streams (Turak et al. 2004), the samples were used both for AUSRIVAS and quantitative analysis.

3.6.1 Field sampling

In accordance with AUSRIVAS, samples were collected from pool edges for a distance of 10 m, either as a continuous line or in disconnected segments. Sampling in segments was often undertaken to ensure the sampling of sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats. Segmented sampling was also employed where pool length was short and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted the suspended fauna. In many of the pools where it was difficult to scrape the substrate with the net (e.g. due to obstacles), the substrate was disturbed using a kicking motion and the net moved through the water column to collect specimens. The samples were sorted in the field according to AUSRIVAS protocol. The remaining unpicked samples were placed into a labelled jar containing 70% ethanol for quantitative laboratory processing.

Alkalinity, modal depth and width of the river, percentage bedrock, boulder or cobble and latitude and longitude of each site were recorded in the field, whilst distance from source, altitude, land-slope and rainfall were determined from desktop analysis.

3.6.2 Laboratory methods

After laboratory identification of AUSRIVAS samples the specimens were returned to the original sample for quantitative processing. Samples were subsampled in a 100 cell Marchant box (Marchant 1989). The subsampling method was based on the ACT AUSRIVAS laboratory procedures (Nichols et al. 2000). Samples were placed into a 100 cell Marchant box and agitated to ensure an even distribution of the sample among the 100 cells. A random number generator was used to randomly select cells. Cells were extracted until a minimum of 200 animals were counted or 50% of the sample had been extracted. All macroinvertebrates (except for segmented and unsegmented worms, Acarina and Chironomidae) were identified to family level. The segmented worms were identified to class (Oligochaeta) and unsegmented worms to phylum, except for flatworms which were identified to order (Tricladida). Acarina were identified to order and Chironomidae to subfamily. Small crustaceans Ostrocoda, Copapoda and Cladocera were not identified.

3.6.3 Data analysis

AUSRIVAS

Samples collected using AUSRIVAS protocol were analysed using the predictive spring and autumn models for NSW pool edge habitats. The AUSRIVAS model predicts the aquatic macroinvertebrate fauna expected to occur at a site in the absence of environmental stress, such as pollution or habitat degradation and generates the following indices:

- OE50
- SIGNAL
- Number of taxa

OE50

The Observed to Expected ratio is the ratio of the number of invertebrate families observed at a site (NTC50) to the number of families expected (NTE50) at that site. Only macroinvertebrate families with a greater than 50% predicted probability of occurrences are used by the model. OE50 provides a measure of biological impairment at the test site.

Bands derived from the OE50 indicate the level of impairment of the assemblage. The OE50 ratios are divided into bands representing different levels of impairment, indicated in Table 4.

Table 4: Interpretation of AUSRIVAS bands

Band	Interpretation	Comments
Band X	Richer than reference	• more families found than expected • potential biodiversity “hot spot” • possible mild organic enrichment
Band A	Reference condition	• index value within range of the central 80% of reference sites
Band B	Below reference	• fewer families than expected • potential mild impact on water quality, habitat or both, resulting in loss of families
Band C	Well below reference	• many fewer families than expected • loss of families due to moderate to severe impact on water and/or habitat quality
Band D	Impoverished	• very few families collected • highly degraded • very poor water and/or habitat quality

SIGNAL

SIGNAL (Stream Invertebrate Grade Number Average Level) is a simple biotic index for river macroinvertebrates, developed initially for application to eastern Australia (Chessman 1995). The SIGNAL method uses ecological patterns to measure water quality using waterbugs. The SIGNAL score of a site can be calculated to form an objective opinion about river health. Table 5 provides a broad guide for interpreting the health of the site according to the SIGNAL score of the site.

Table 5 Guide to interpreting SIGNAL scores

SIGNAL Score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution

Less than 4	Severe pollution

(Source: Gooderham J and Tsyrlin E 2002)

Number of taxa

The richness of macroinvertebrate families (or class/orders if not identified to family level) was calculated as an indicator of stream health.

3.6.4 Statistical analysis

OE50

An independent t-test was performed on OE50 ratios derived from the AUSRIVAS model for Marulan Creek, Shoalhaven River and gorge sites (Barbers Creek and Bungonia Creek) to test the null hypothesis that there was no significant difference between the means of upstream and downstream sites. It was assumed that upstream and downstream sites were independent for this analysis. The significance level was set at $p < 0.05$ for all statistical analyses.

Multivariate data

The sample size for each family was estimated by multiplying up the subsample (Number of individuals *100/No. cells subsampled). The quantitative data was 4th root transformed and examined using Bray-Curtis similarity measure. The statistical procedure, PERmutational Multivariate ANalysis Of VAriance (PERMANOVA), was used to examine the spatial changes (upstream and downstream) in macroinvertebrate data.

In order to examine the spatial upstream/downstream differences in macroinvertebrate communities, one factor (Location: upstream or downstream) was analysed. As previously mentioned, time was not included as a factor due to limited temporal replication. Location was considered as fixed and sites were treated as replicates within each location to provide replication at the location level where possible.

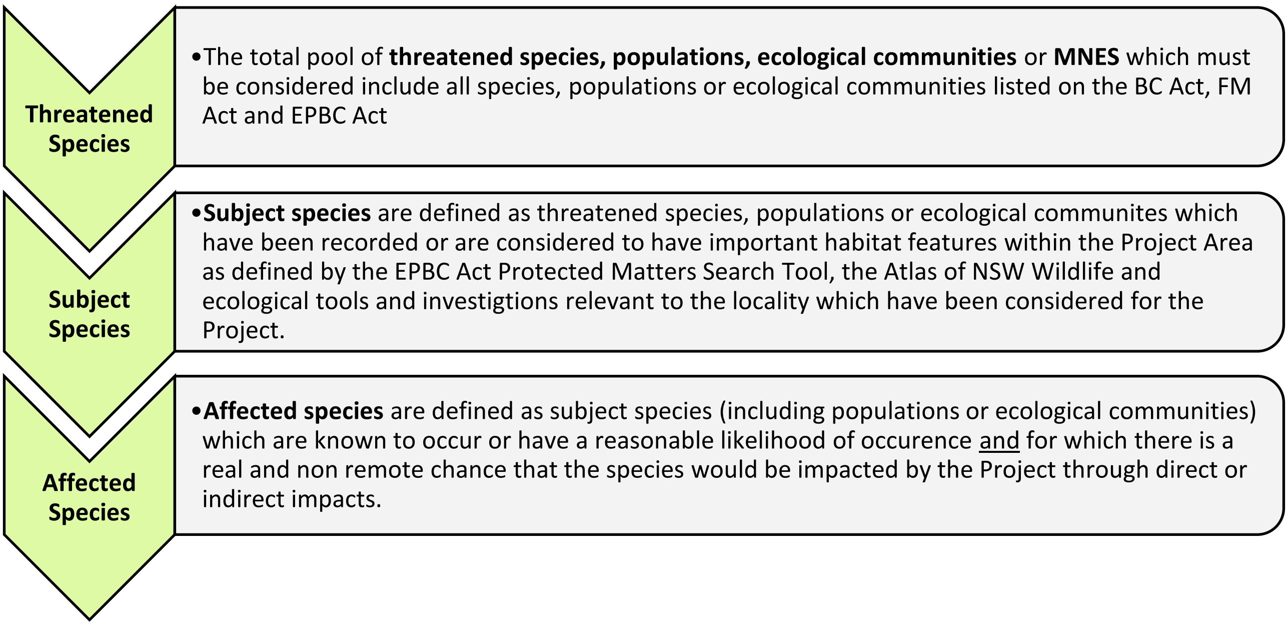
Where the number of unique permutations for a particular test was less than 100, Monte Carlo probability values were used to assess the significance of the test, as outlined in Anderson et al. (2008).

SIMPER routine was performed on tests where significant upstream/downstream differences were observed to investigate taxa that are likely to have contributed to these differences. Analyses were undertaken using the software package Primer v6 with the PERMANOVA+ add on.

3.7 Impact Assessment Approach

Not all threatened species that may occur, or for which potential habitat may occur, will be impacted by the Project. Database and literature searches were used to define the sub-set of threatened species potentially impacted by the Project (subject species). An analysis of likelihood of occurrence was then undertaken for the subject species to determine the affected species requiring consideration in the impact assessment. Diagram 1 provides a representation of the hierarchy of decision making employed to determine which species, populations, ecological communities or MNES should be considered further in the impact assessment of this report.

Diagram 1: The hierarchy of decision making to define the subject and affected species



- The total pool of **threatened species, populations, ecological communities** or **MNES** which must be considered include all species, populations or ecological communities listed on the BC Act, FM Act and EPBC Act
- **Subject species** are defined as threatened species, populations or ecological communites which have been recorded or are considered to have important habitat features within the Project Area as defined by the EPBC Act Protected Matters Search Tool, the Atlas of NSW Wildlife and ecological tools and investigtions relevant to the locality which have been considered for the Project.
- **Affected species** are defined as subject species (including populations or ecological communities) which are known to occur or have a reasonable likelihood of occurence and for which there is a real and non remote chance that the species would be impacted by the Project through direct or indirect impacts.

Five categories for ‘likelihood of occurrence’ (Table 6) were attributed to the subject species after consideration of criteria such as known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. This process was completed on an individual species basis.

Species considered further in formal assessments of significance pursuant to relevant legislation (affected species) were those in the ‘Known’ to ‘Moderate’ categories, and where impacts for the species could reasonably occur from the Project (refer to the outcomes of the affected species analysis in Section 4.1).

Table 6. Likelihood of occurrence criteria

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
Known	The species was observed within the Project Area	The species was observed within the Project Area
High	It is likely that a species inhabits or utilises habitat within the Project Area	It is likely that a species inhabits or utilises habitat within the Project Area
Moderate	Potential habitat for the species occurs on the site. Adequate field survey would determine if there is a ‘high’ or ‘low’	Potential habitat for the species occurs on the site and the species may occasionally utilise that

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
	likelihood of occurrence for the species within the Project Area	habitat. Species unlikely to be wholly dependent on the habitat present within the Project Area
Low	It is unlikely that the species inhabits the Project Area	It is unlikely that the species inhabits the Project Area. If present at the site the species would likely be a transient visitor. The site contains only common habitat for this species which the species would not rely on for its on-going local existence such as limited breeding habitat resources.
None	The species has not been recorded within the Project Area and habitat within the Project Area is unsuitable for the species	The species has not been recorded within the Project Area and habitat within the Project Area is unsuitable for the species.

3.8 Limitations

- Difficult access (steep terrain/remote) restricted sampling in areas (water quality sampling, fish sampling). It is however considered that the sampling undertaken is sufficient to adequately describe the existing ecology and provide a basis for impact assessment.
- Sampling was conducted in autumn and spring in one year.
- Fish surveys were limited as all techniques could not be used at all sites due to difficult/remote access, available habitat, large boulder substrate and time available to set traps. However the sampling effort and methods are considered sufficient to provide a representation of the fish communities present, particularly in the smaller creeks likely to be impacted, and to demonstrate the absence of Macquarie Perch from these systems.

4. Results

4.1 Threatened Species, Populations and Endangered Ecological Communities

Database and literature searches resulted in two subject species the Macquarie Perch and Australian Grayling. The assessment of likelihood of occurrence of these species is provided in Appendix 1 and discussed in section 5.1.7.

No threatened aquatic species, populations or communities were observed during surveys.

4.2 Aquatic Habitat

4.2.1 Bungonia Creek upstream

Upstream Bungonia Creek sites (BungUp1 and BungUp2) (Plate 1 and Plate 2) were located upstream of Main Gully (Figure 6). The riparian vegetation was in good condition, showed little disturbance and provided moderate shading of the river. The canopy was dominated by River Oak (*Casuarina cunninghamiana*), and included Sandpaper Fig (*Ficus coronata*), Pittosporum (*Pittosporum undulatum*), and Grey Myrtle (*Backhousia myrtifolia*). The midstorey consisted primarily of River Oak and Pittosporum, and included some Paperbark (*Melaleuca* sp.).

The stream pools had a modal width of 5 m and were approximately 0.5-1 m deep. The substrate was dominated by large boulders interspersed with cobbles and finer inorganics. The water clarity was high. Isolated occurrences of macrophytes included Water Plantain (*Alisma* sp.), Bullrush (*Typha* sp.), and sedges. Algae covered the entire pool substrate (Plate 1).

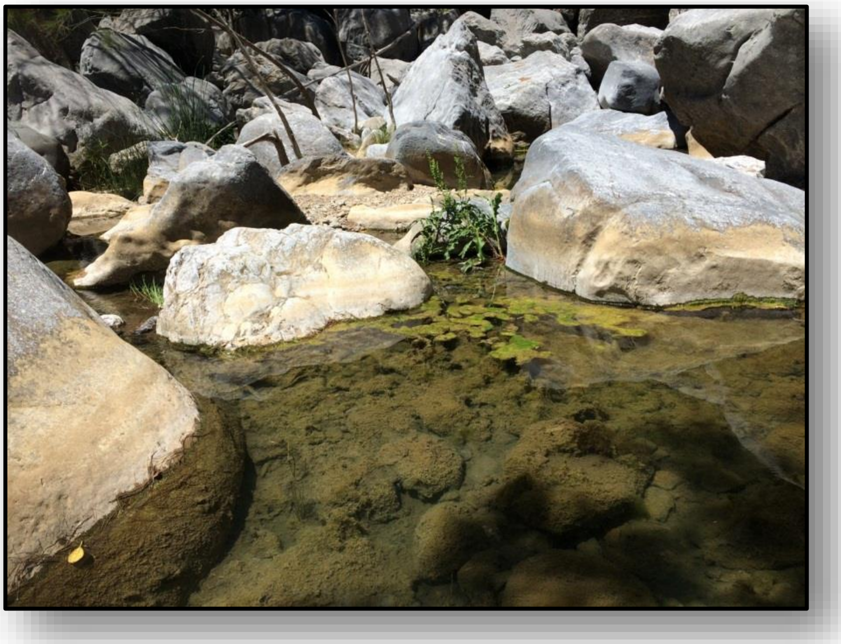


Plate 1 Bungonia Creek upstream Site 1.

Plate 2 Bungonia Creek upstream Site 2

4.2.2 Bungonia Creek downstream

Downstream Bungonia Creek sites (BungUp1 and BungUp2) (Plate 3 and Plate 4) were located downstream of Main Gully (Figure 6). The riparian vegetation was in good condition, provided moderate shading of the river and showed little disturbance, however isolated rubbish and exotic species (mostly Dock (*Rumex* sp.)) were observed. The canopy was dominated by River Oak and included Eucalypts (*Eucalyptus* spp.), Pittosporum, Sandpaper Fig, Acacia (*Acacia* spp.) and Grey Myrtle. Groundcover consisted predominantly of Lomandra (*Lomandra longifolia*) and Bracken (*Pteridium* sp.).

The stream pools had a modal width of 10 m and were approximately 0.5-3 m deep. The substrate included bedrock, boulder with significant deposition of sand and silt in the larger pools. The water clarity was high. Macrophytes were observed in approximately 5% of the reach. Common macrophytes included submerged Pondweed (*Potamogeton* sp.) and emergent Arrow Grass (*Triglochin* sp.). Algae covered most of the pool substrate (Plate 3).

Plate 3 Bungonia Creek downstream Site 1

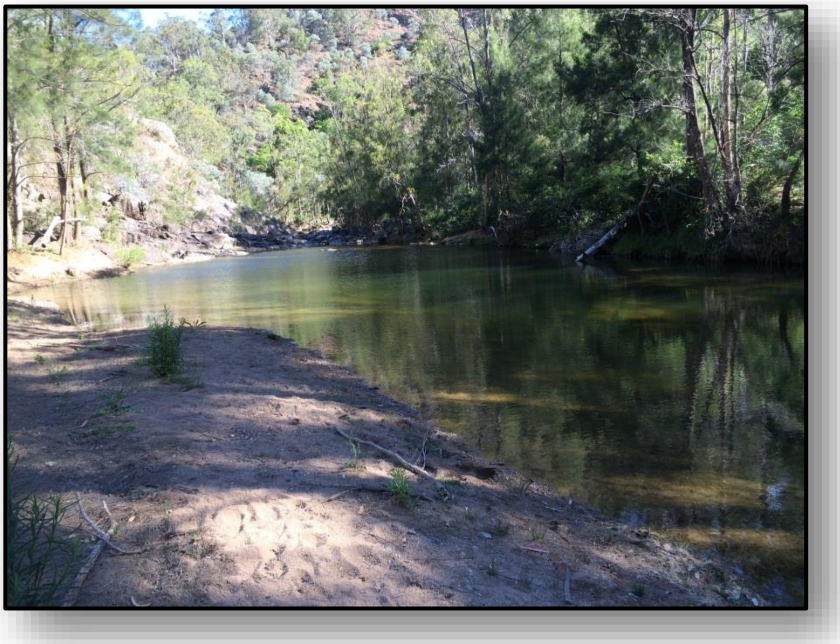


Plate 4 Bungonia Creek downstream site 2

4.2.3 Barber Creek upstream

Upstream Barbers Creek sites (BarbUp1 and BarbUp2) (Plate 5 and Plate 6) were located downstream of Bryces Overburden Emplacement (Eastern Batters) (Figure 6). The riparian vegetation was in good condition, showed little disturbance and provided moderate-high shading of the river. Dominant canopy species included River Oak and Pittosporum, with Sandpaper Fig and Grey Myrtle. Groundcover consisted predominantly of Lomandra, Wandering Jew (*Urtica* sp.), and Thistles (*Asteraceae* sp.).

The stream pools had a modal width of 7 m and were approximately 0.5-2 m deep. The substrate included predominately bedrock, boulder and some cobbles. However there was a significant deposition of sand in the large downstream pool (Plate 5). The water clarity was good. No macrophytes were present in the reach. No filamentous algae was observed in the pools, however patches were observed in higher flow sections of the reach.

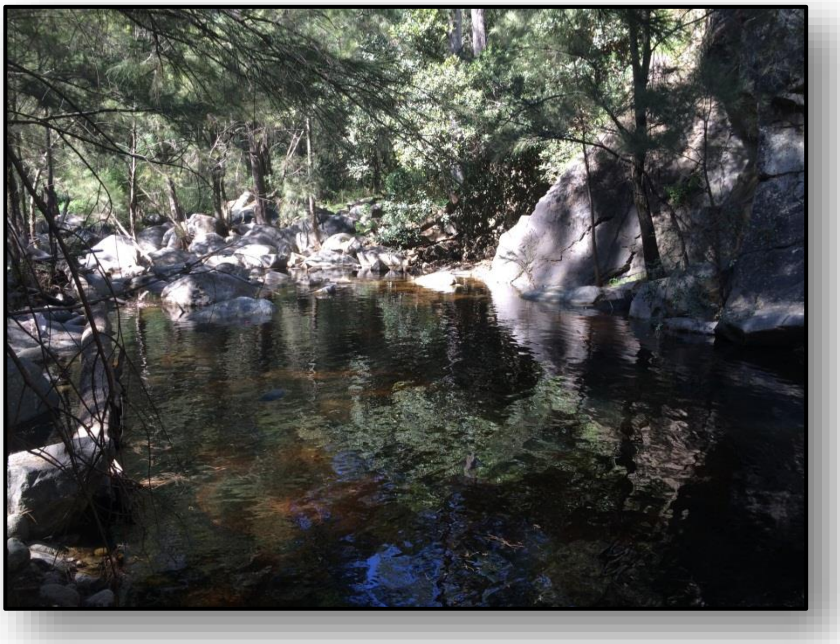


Plate 5 Barber Creek upstream site 1

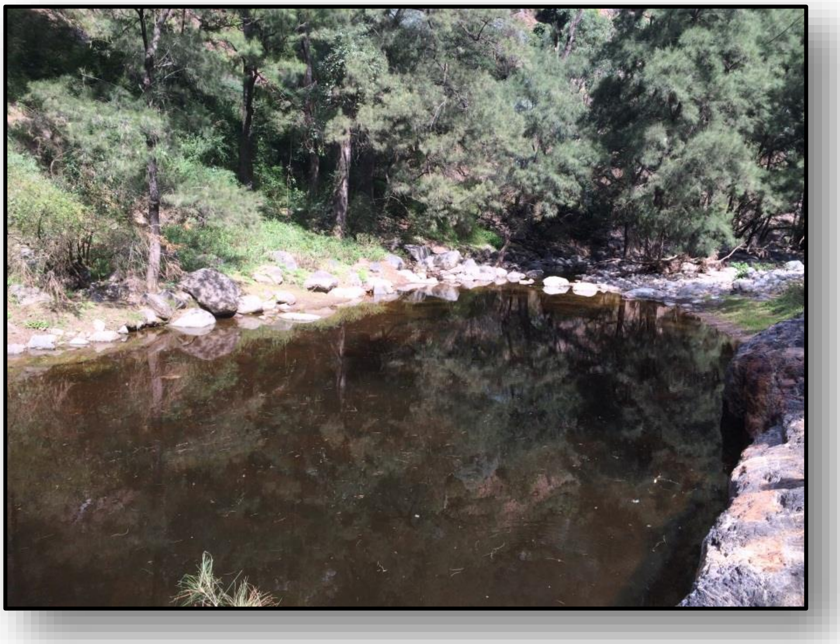


Plate 6 Barbers Creek upstream site 2

4.2.4 Barbers Creek downstream

Downstream Barbers Creek sites (BarbDown1 and Barbdown2) (Plate 7 and Plate 8) were located downstream of the mine (Figure 6). The riparian vegetation was in good condition, showed little disturbance and provided moderate-high shading of the river. Dominant canopy species included River Oak and Pittosporum, with Sandpaper Fig and Grey Myrtle.

The stream pools had a modal width of 3 m and were approximately 0.5-1 m deep. The substrate included predominately boulders as well as cobbles, pebbles and some sand lenses. The water clarity was good. No macrophytes were observed in the reach. No filamentous algae were observed, however patches were evident in higher flow sections.

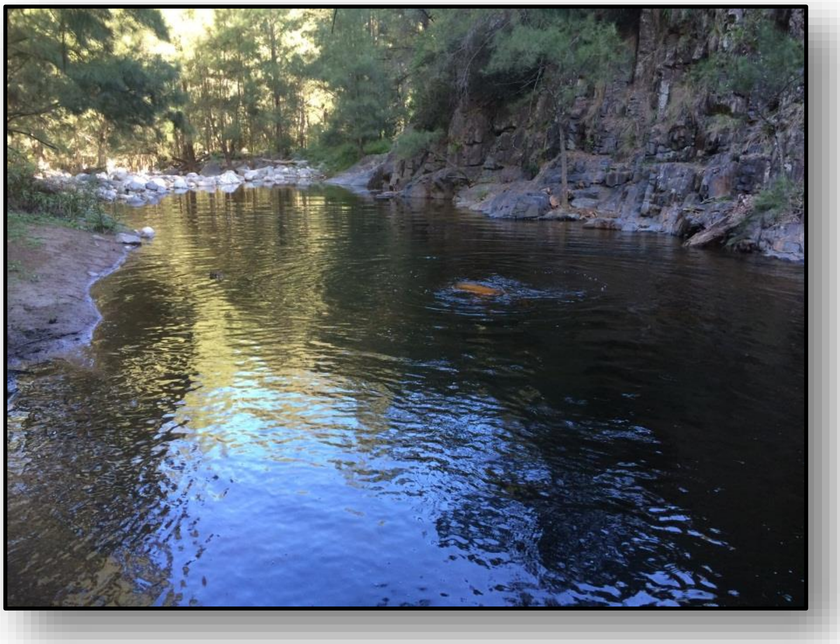


Plate 7 Barbers Creek downstream site 1

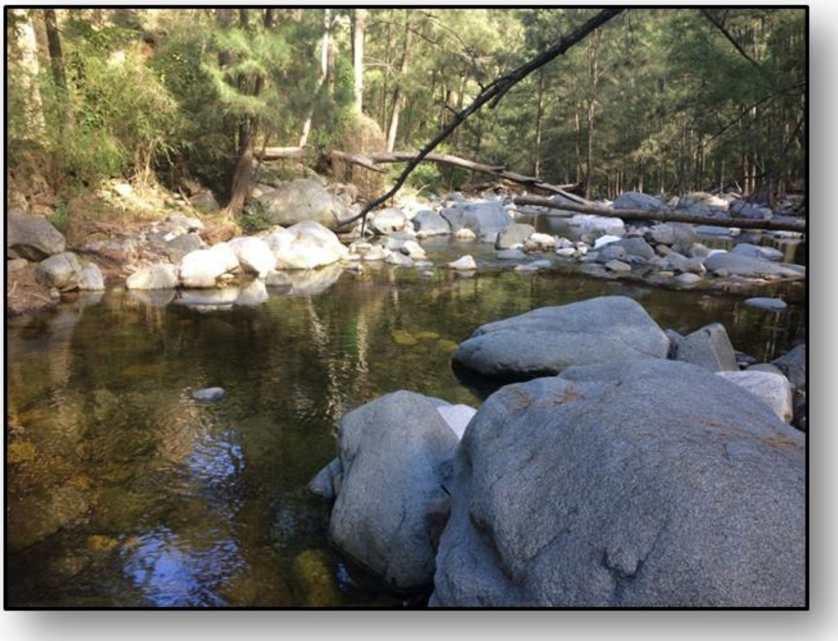


Plate 8 Barber Creek downstream site 2

4.2.5 Shoalhaven River

Shoalhaven River sites (SR1, SR2, SR3) (Plate 9, Plate 10, and Plate 11) were located upstream of Bungonia Creek confluence (SR1), downstream of Bungonia Creek confluence (SR2) and downstream of Barbers Creek confluence (SR3) (Figure 6). The riparian vegetation showed some disturbance, particularly the presence of weeds, and provided moderate-high shading of the river. The canopy was dominated by River Oak and Pittosporum, with Sandpaper Fig, Grey Myrtle and River Peppermint (*Eucalyptus elata*). Other species included Bottlebrush (*Callistemon* sp.), Water Cooch (*Paspalum distichum*), *Lomandra longifolia,* Snake vine (*Stephania japonica*)*,* Periwinkle (*Vinca major*)*,* Urtica, Farmers Friends (*Bidens pilosa*) and Dock.

The stream pools had a modal width of 50-80 m and were approximately 0.5->3 m deep. The substrate included predominately sands, gravels and cobbles, with a minor proportion of the pool substrate consisting of bed rock and boulders. The water clarity was poor. Macrophytes in the Shoalhaven River consisted of Watermilfoil (*Myriophyllum* sp.), Bullrush (*Typha* sp.), Slender Knot Weed (*Persicaria* sp.), Ribbon Weed (*Valsineria Americana*), Flat Sedge (*Cyperus* sp.) and other sedges. No filamentous algae were observed.

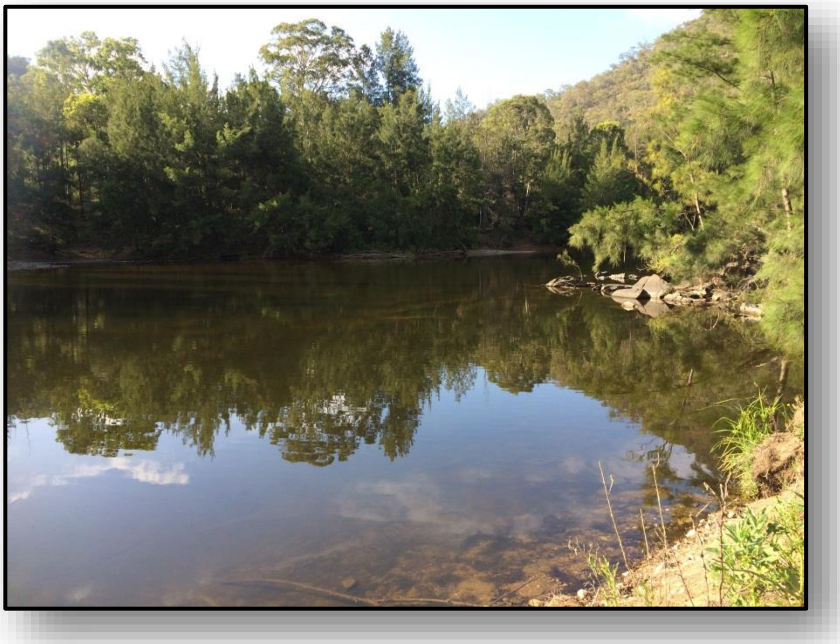


Plate 9 Shoalhaven River upstream (SR1)

Plate 10 Shoalhaven River downstream of Bungonia Creek confluence (SR2)

Plate 11 Shoalhaven River downstream of Barbers Creek confluence (SR3)

4.2.6 Marulan Creek upstream

Marulan Creek upstream site (MC1) (Plate 12) was located above the mine (Figure 6). The riparian vegetation provided moderate shading of the river and showed moderate disturbance due to the presence of exotic flora and a road crossing. The canopy was dominated by Black wattle (*Acacia* sp.), Green wattle (*Acacia decurrens*) and Cabbage Gum (*Eucalypus amplifolia*). Other species included Bracken, Plantain (*Plantago major*), Greater Quaking Grass (*Breeza maxima*), Yorkshire Fog (*Holcus lanatus*) and Wallaby Grass (*Austrodanthonia* sp.).

The stream had a modal width of 4 m and was approximately 0.5-1 m deep. The substrate included predominately cobbles, pebbles and gravel. Sand and silt was also present, as well as a small outcrop of bedrock. The water clarity was good, however there was a slight oily slick on the water surface. Macrophytes consisted of Flat Sedge, Slender Knot Weed, Arrow Grass and rushes. No filamentous algae were observed.

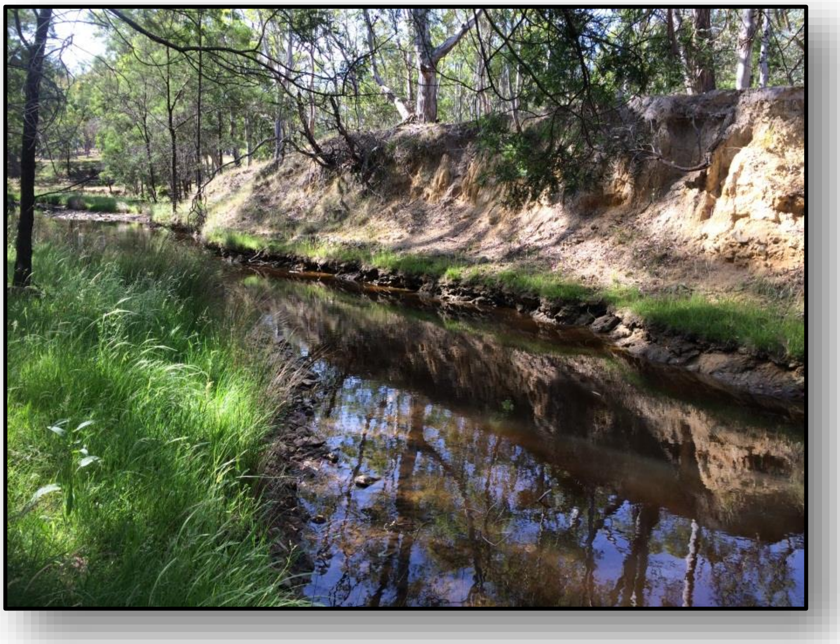


Plate 12 Marulan Creek upstream

4.2.7 Marulan Creek downstream

Marulan Creek downstream site (MC2) (Plate 12) was located downstream of the proposed Marulan Creek Dam (Figure 6). The riparian vegetation provided moderate shading of the river and showed moderate disturbance due to the presence of exotic flora. The canopy was dominated by River Oak. Other species included Blackberry (*Rubus* sp.), Lantana (*Lantana camara*) and *Acacia* sp.

The stream had a modal width of 2 m and was approximately 0.5-1 m deep. The substrate included predominately bedrock and boulders and sections of cobbles, pebbles, gravel, sand and silt. The water clarity was good. Macrophytes consisted of Bullrush and Common Reed, which covered a significant portion of the stream. Filamentous algae covered most of the substrate.

Plate 13 Marulan Creek downstream

4.3 Fish

4.3.1 General surveys

The 2014 spring and 2015 autumn surveys of Bungonia Creek , Barbers Creek, Shoalhaven River and Marulan Creek identified five native and two exotic fish species, as well as one reptile, the Eastern long-necked turtle (*Chelodina longicollis*) (Table 7 and Table 8). The fish collected were mostly small size-classed fish. No threatened fish were observed.

Barbers Creek and Bungonia Creek

The most commonly collected species in Barbers Creek and Bungonia Creek were the Australian Smelt and Cox's Gudgeon. Populations of Flathead Gudgeon and Mountain Galaxias (*Galaxias olidus*) were also recorded. Individual Long-finned Eels (*Anguilla reinhardtii*) were observed in both systems. The exotic Carp was observed in downstream Bungonia Creek, however was not observed in Barbers Creek. No Mosquito Fish were recorded in either stream. Nocturnal surveys recorded Eel-tailed Catfish (*Tandanus tandanus*) in Bungonia Creek near the confluence of the Shoalhaven River. Eastern long-necked turtles were observed in upper Barbers Creek.

Shoalhaven River

Surveys within Shoalhaven River recorded a high proportion of Australian Smelt, with only two observations of Cox's Gudgeon. Other native species included Flathead Gudgeon, one Australian Bass, and an Eel-tailed Catfish nest. The exotic Mosquito Fish was collected and visual observations of Carp were made.

Marulan Creek

Only one fish species, the introduced Mosquito fish, was recorded at Marulan Creek, which was common at both sites. The Common Yabby (*Cherax destructor*) was common at the Marulan upstream site.

4.3.1 Targeted nocturnal surveys for Macquarie Perch

The Macquarie Perch (*Macquaria australisica*) was not detected during any surveys.

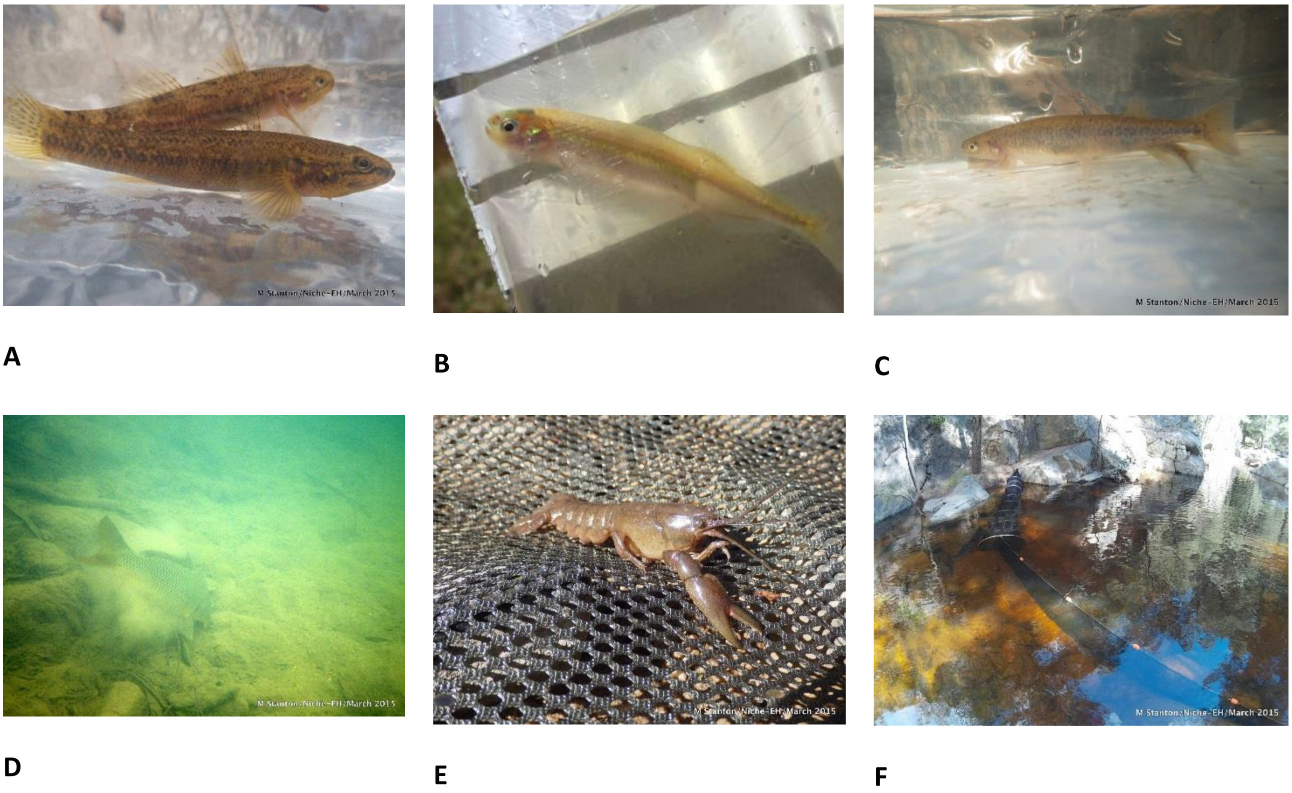


Plate 14 Images of fish captured or observed during aquatic surveys

A) Cox’s Gudgeon B) Australian Smelt C) Mountain Galaxias D) Common Carp E) Common Yabby F) Fyke net in Barbers Creek

Table 7: Fish survey results spring 2014

		Sites and number of individuals caught (observed)								
		Bungonia Creek upstream	**Bungonia Creek downstream**	**Barbers Creek upstream**	**Barbers Creek downstream**	**Shoalhaven River 1**	**Shoalhaven River 2**	**Shoalhaven River 3**	**Marulan Creek upstream**	**Marulan Creek downstream**
Fish species										
Native	***Retropinna semoni* (Australian Smelt)**	60	41			100	163	100		
	***Gobiomorphus coxii* (Cox's Gudgeon)**	9	11		2 (11)			(2)		
	***Galaxias olidus* (Mountain Galaxias)**	(5)			1 (7)					
	***Philypnodon grandiceps* (Flathead Gudgeon)**	22	6			3	16			
	***Anguilla reinhardtii.* (Long-finned Eel)**	1	1							
	***Macquaria novemaculeata* (Australian Bass)**					(1)				
Introduced	***Gambusia holbrooki* (Moquitofish)**					5			14	50+
	***Cyprinus carpio* (Common Carp)**		(5+)			1		(4)		
Reptile species										
	***Chelodina longicollis* (Eastern Long-necked Turtle)**			(4)						
Crustaceans										
	***Cherax destructor* (Common Yabby)**								4	
	***Macrobrachium australiens* (Long-armed Shrimp)**	1	2							
	***Paratya australiensis* (Freshwater Shrimp)**	1	10				2			

Table 8 Fish survey result autumn 2015

		Sites and number of individuals caught (observed)								
		Bungonia Creek upstream	**Bungonia Creek downstream**	**Barbers Creek upstream**	**Barbers Creek downstream**	**Shoalhaven River 1**	**Shoalhaven River 2**	**Shoalhaven River 3**	**Marulan Creek upstream**	**Marulan Creek downstream**
Fish species										
Native	***Retropinna semoni* (Australian Smelt)**	1	18			300	Observed			
	***Gobiomorphus coxii* (Cox's Gudgeon))**	25	11	10						
	***Galaxias olidus* (Mountain Galaxias)**			10						
	***Philypnodon grandiceps* (Flathead Gudgeon)**									
	***Anguilla reinhardtii.* (Long-finned Eel)**			1						
	***Macquaria novemaculeata* (Australian Bass)**									
Introduced	***Gambusia holbrooki* (Moquitofish)**					51	Observed		346	1 (50+)
	***Cyprinus carpio* (Common Carp)**						Observed			
Reptile species										
	***Chelodina longicollis* (Eastern Long-necked Turtle)**			1						
Crustaceans										
	***Cherax destructor* (Common Yabby)**								37	
	***Macrobrachium australiens* (Long-armed Shrimp)**		1							
	***Parataya australiensis* (Freshwater Shrimp)**			10						

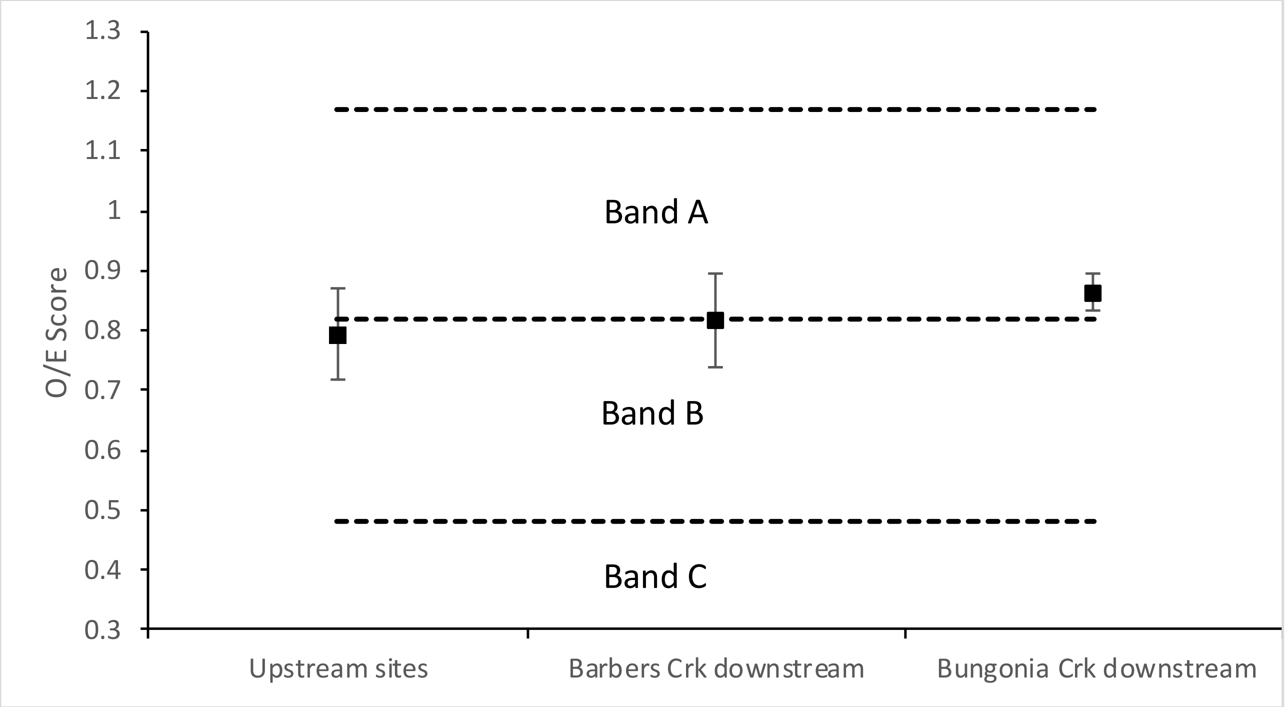
4.4 Macroinvertebrates

Macroinvertebrate data for AUSRIVAS and quantitative analysis is provided in Appendix 2 (Table 13, Table 14, Table 15, and Table 16).

4.4.1 Bungonia Creek and Barbers Creek

Bungonia and Barbers Creek scored in Band A and Band B (Table 9 and Table 10). While O/E 50 score average was higher in Bungonia Creek and Barbers Creeks downstream, t-tests indicated that these differences were not statistically significant (t ($_{10}$) = 0.99, p = 0.763 and t ($_{10}$) = 0.31, p = 0.341). SIGNAL scores ranged from 3.61-4.78, indicating a dominance of pollution tolerant taxa. Although some sites were below reference condition (Band B) and had low SIGNAL scores, they contained several sensitive taxa including: Leptophebiidae (SIGNAL 8), Leptoceridae (SIGNAL 6), Calocidae (SIGNAL 9), Gripoterygidae (SIGNAL 8), Calamoceridae (SIGNAL 7), Conoesucidae (SIGNAL 7), Helicopsychidae (SIGNAL 8), Polycentropodidae (SIGNAL 8), Tasmidae (SIGNAL 8), Telephlebiidae (SIGNAL 8), Philoreithidae (SIGNAL 8), Elmidae (SIGNAL 7) and Psphenidae (SIGNAL 6).

PERMANOVA analysis however showed a significant difference between Bungonia downstream sites and upstream sites (p = 0.0095, pseudo F = 2.823) in macroinvertebrate communities, however no significant difference was found between Barbers Creek downstream and upstream sites (p-= 0.307 pseudo F = 1.1545). SIMPER analysis indicated that differences in community composition (20% contribution), between Bungonia Creek downstream and gorge upstream sites are driven by differences in greater number of caddisflies, Hydroptilidae, gastropods, Hydrobiidae, true flies and Othocladiniidae at upstream sites, and an increase in caddisflies and Ecnomidae at Bungonia Creek downstream.

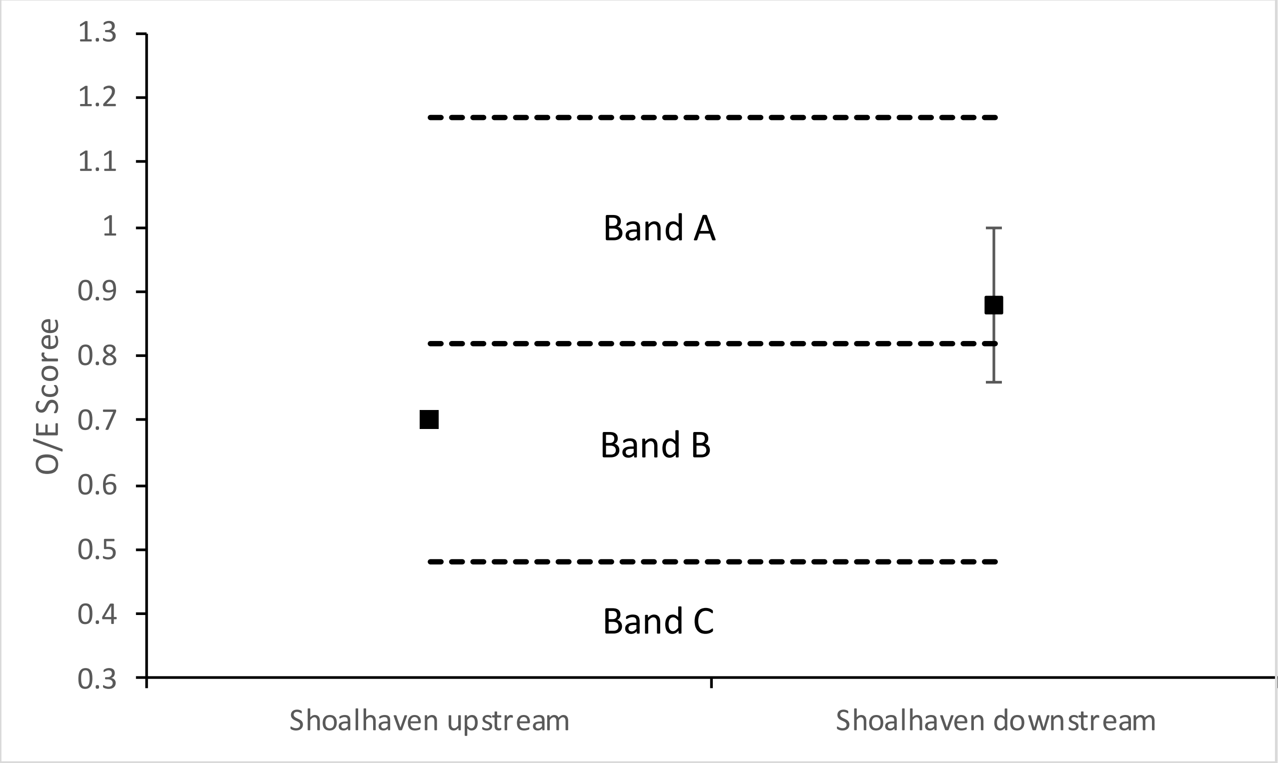


Graph 1. Average O/E 50 score ±SE at upstream sites and Barbers Crk downstream and Bungonia Crk downstream. (Dotted lined represent AUSRIVAS band limits).

4.4.2 Shoalhaven River

Shoalhaven upstream scored in Band B on two sampling occasions, indicating that the site was missing fauna expected in reference condition, while downstream sites scored in Band A and Band B (Table 9 and Table 10). O/E 50 score average was higher in downstream Shoalhaven River compared to upstream (Graph 2), however an independent t-test indicated that these differences were not statistically significant ($t_{(4)}$ = 1.26, p = 0.276). SIGNAL scores ranged from 3.78-4.33, indicating the dominance of pollution tolerant taxa. Although some sites at times were below reference condition (Band B) and had low SIGNAL scores (Table 9 and Table 10), they contained several sensitive taxa including: Leptophebiidae (SIGNAL 8), Leptoceridae (SIGNAL 6), Calamoceridae (SIGNAL 7), Telephlebiidae (SIGNAL 8), Elmidae (SIGNAL 7) and Psphenidae (SIGNAL 6). In light of the presence of good aquatic habitat, sensitive fauna, water quantity and quality, the river is considered to be in good stream health, despite moderate AUSRIVAS and SIGNAL results.

PERMANOVA analysis supported the AUSRIVAS results and also found no significant difference between Shoalhaven downstream and upstream sites (pseudo F = 1.5885 p = 0.1318).

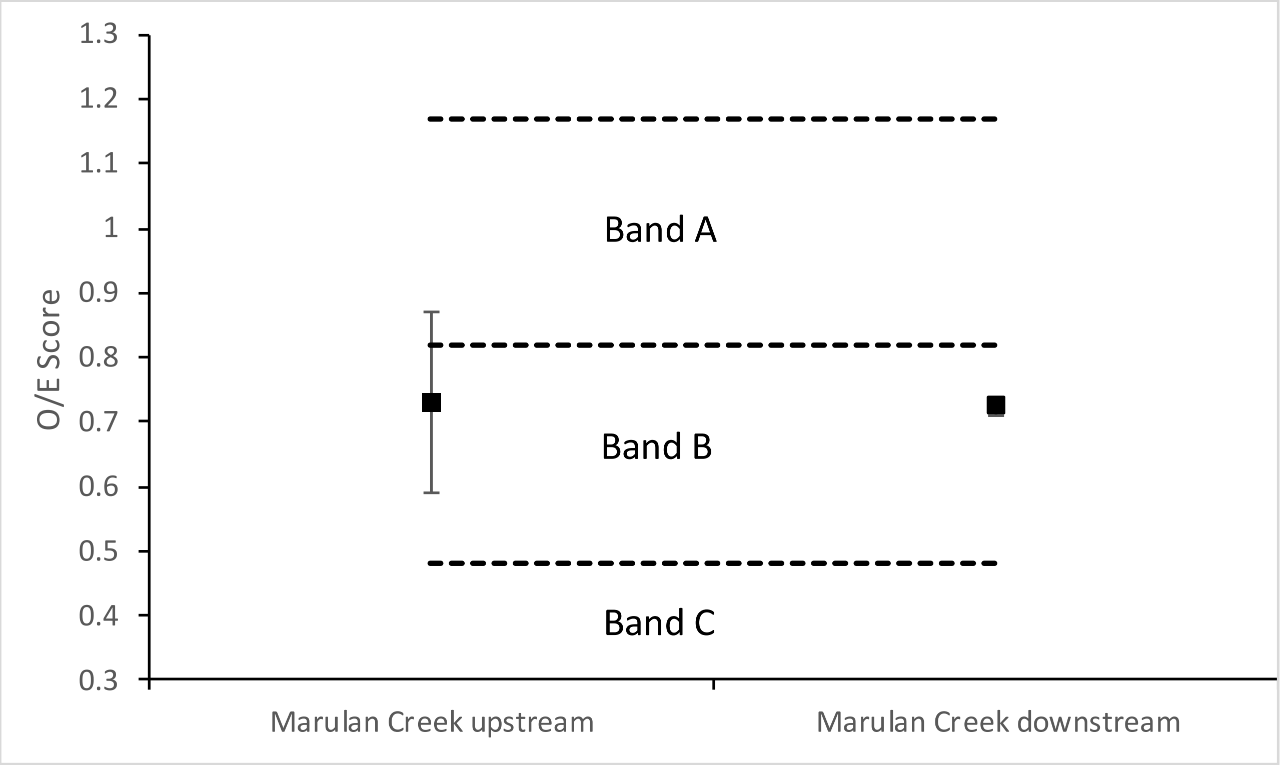


Graph 2. Average O/E 50 score ±SE at Shoalhaven River downstream and upstream sites. (Dotted lined represent AUSRIVAS band limits).

4.4.3 Marulan Creek

Marulan upstream scored in Band A and Band B over the two sampling occasions, indicating that the upstream site at times can be close to reference condition (Table 9 and Table 10). The downstream sites scored in Band B on both occasions. O/E 50 score average was slightly higher in upstream Marulan Creek compared to the downstream sites (Graph 3), however an independent t-test indicated that these differences were not statistically significant ($t_{(2)}$= 0.034, p = 0.97). Signal scores ranged from 3.56-3.81, indicating the dominance of pollution tolerant taxa. The sites contained sensitive taxa including: Leptophebiidae (SIGNAL 8), Leptoceridae (SIGNAL 6), Telephlebiidae (SIGNAL 8) and Elmidae (SIGNAL 7). Marulan Creek scored the lowest out of all sites and is considered likely to be affected by the agricultural land use and low flow, and is considered to have impaired stream health at both upstream and downstream sites.

PERMANOVA support the AUSRIVAS results and also indicated no significant difference in macroinvertebrate assemblages between Marulan downstream and upstream sites (pseudo F = 0.55, p = 1.0, p (MC) = 0.641).



Graph 3. Average O/E 50 score ±SE at Marulan Creek upstream and downstream sites. (Dotted lined represent AUSRIVAS band limits).

Table 9: Spring 2014 AUSRIVAS model results

Site	Watercourse	OE50 score	Band	SIGNAL 2	Number of taxa
BungUp1	Bungonia Creek	0.70	B	3.61	18
BungUp2	Bungonia Creek	0.77	B	4.48	23
BunDown1	Bungonia Creek	0.89	A	4.11	19
BunDown2	Bungonia Creek	0.79	B	4.21	24
BarbUp1	Barbers Creek	0.89	A	4.64	28
BarbUp2	Barbers Creek	0.77	B	3.90	21
BarbDown1	Barbers Creek	0.77	B	3.58	19
BarbDown2	Barbers Creek	0.87	A	4.2	25
SR1	Shoalhaven River	0.70	B	3.88	16
SR2	Shoalhaven River	1.00	A	4.29	21

SR3	Shoalhaven River	0.76	B	4.3	20
MC1	Marulan Creek	0.87	A	3.81	16
MC2	Marulan Creek	0.71	B	3.88	25

Table 10 Autumn 2015 AUSRIVAS model results

Site	Watercourse	OE50 score	Band	SIGNAL	Number of Taxa
BungUp1	Bungonia Creek	0.94	A	4.26	23
BungUp2	Bungonia Creek	0.75	B	4.06	16
BunDown1	Bungonia Creek	0.61	B	4.39	18
BunDown2	Bungonia Creek	0.97	A	4.2	20
BarbUp1	Barbers Creek	0.70	B	4.38	21
BarbUp2	Barbers Creek	0.83	A	4.55	22
BarbDown1	Barbers Creek	0.73	B	4.79	24
BarbDown2	Barbers Creek	1.08	A	4.68	28
SR1	Shoalhaven River	0.70	B	4.33	15
SR2	Shoalhaven River	0.68	B	4.29	17
SR3	Shoalhaven River	0.90	A	3.78	23
MC1	Marulan Creek	0.59	B	3.83	18
MC2	Marulan Creek	0.74	B	3.56	18

4.5 Discussion

4.5.1 Aquatic habitat

The surveyed waterways have distinctive geomorphology and aquatic habitats. Marulan Creek (catchment area 20 km^2) and Tangarang Creek (7.5 km^2) are ephemeral creek systems with flows only occurring during storm events or after prolonged periods of heavy rain. Tangarang Creek has a dam that supplies water to Peppertree Quarry. The stream morphology consists of a sequence of intermittent pools, with little riffle habitat. The pool habitat includes silts, sand, and cobble, with macrophytes common along the stream length. Downstream the creeks discharge into a gorge where it confluences with Barbers Creek.

Barbers Creek and Bungonia Creek have similar gorge morphology and aquatic habitat; being comprised of primarily bedrock, large boulders, and pools with little macrophyte growth. These systems have a strong base flow component to the overall flow, and often in lower flow periods will have no visible surface flow, however exhibit strong subsurface connectivity, particularly in areas surveyed downstream of the mine. Bungonia Creek, having a larger catchment (275 km^2), appeared to have more water in the system at the time of sampling compared to Barbers Creek (90 km^2), which ceases to flow more readily. Overall, Bungonia Creek's system downstream of the mine had a more diverse aquatic habitat than Barbers Creek, with large sandy pools prominent downstream and macrophytes near its confluence with Shoalhaven River. Bungonia Creek and Barbers Creek confluence with the Shoalhaven River, which is a much larger system (6th order stream).

The Shoalhaven has large areas of pool and riffle habitat, a variety of substrata (cobbles, rocks sand, silt), and macrophytes.

4.5.2 Macroinvertebrate communities

Upstream and downstream differences were recorded in Bungonia Creek, which are likely to be the result of habitat changes (increase in fine sediment and macrophytes) downstream. There were no upstream/downstream differences observed in other waterways. The results suggest that Barbers Creek and Bungonia Creek have good stream health, indicated by a downstream O/E 50 score comparable to upstream sites, modelled reference streams (AUSRIVAS score), and the presence of key sensitive fauna. Overall the stream health at the surveyed locations in the Shoalhaven River, Bungonia and Barbers Creek is considered to be moderate to good; being relatively close to reference condition. Barbers Creek in particular had several pollution sensitive species present, indicating good stream health. Marulan Creek upstream, despite scoring in AUSRIVAS Band A (Table 9) on one occasion, is considered as a whole to be in moderate health, as there are several land use impacts on aquatic habitat, water quality and stream flow along the length of the waterway (Advisian 2018), as opposed to specifically where sampling was conducted.

4.5.3 Fish communities

Fish communities differed between and within streams in the Project Area. The introduced Mosquito Fish was the only fish species observed in Marulan Creek. Barbers and Bungonia Creek both showed longitudinal distribution of fish species, with Mountain Galaxias observed in upstream sites only in both systems. The habitat is typical of this species, which are known to occur in small streams above water falls/cascades that can act as a barrier to fish predators. Carp and Eel-tailed Catfish Fish were recorded only in downstream sites. Flathead Gudgeon and Australian Smelt occurred sporadically throughout the survey. Cox's Gudgeon were commonly observed in both Bungonia and Barbers Creeks. Australian Smelt dominated the observed fish community in the Shoalhaven River. Previous surveys (Gerhke 2002) found upstream (upstream of

Tallowa Dam) Shoalhaven fish communities to include Long-finned and Short-finned Eel, Flathead Gudgeon, Cox's Gudgeon, Australian Bass, Carp, Mosquito Fish and Australian Smelt, most of which (with the exception of Short –finned Eel) were identified during the surveys.

4.5.4 Water quality

The water quality data (Advisian 2018) indicates that water quality in Marulan Creek improves gradually downstream. In addition, the water quality results for both Marulan Creek and Tangarang Creek indicate that the water is diluted once it enters Barbers Creek, as demonstrated by the comparably better water quality of Barbers Creek. It is unclear how water quality may be related to macroinvertebrate communities present in Marulan Creek, however it is likely that water quality changes associated with the wetting and drying of pools in the ephemeral system are a driving factor affecting the aquatic flora and fauna.

Barbers Creek and Bungonia Creek have similar water quality characteristics (Advisian 2018) and show a slight decline in water quality downstream. This difference however is not statistically significant, indicating that under existing operational practices, South Marulan Mine has a nil or negligible effect on surface water quality (Advisian 2018). It is unlikely that the small differences in water quality upstream and downstream are affecting fauna communities observed in these systems, and, as mentioned, Bungonia Creek upstream and downstream differences in macroinvertebrate communities are likely to be the result of gradational changes in stream habitat. Pollution sensitive taxa that were observed in Barbers Creek supports the surface water assessment of good water quality in Barbers Creek.

The Shoalhaven River also exhibited slight decreases consistently for all analytes between the upstream sampling point (SR1) and the furthest downstream point (SR3). These changes are unlikely to explain faunal communities.

5. Impact assessment

5.1 Potential impacts

5.1.1 Impacts of flow on creeks

The Project is expected to result in changes in catchment area for Barbers Creek and tributaries (including Tangarang Creek) and Bungonia Creek (via Main Gully) (Table 11). An increase of 50 ha in catchment area draining to Tangarang Creek and a change in catchment characteristics are likely to lead to a small overall increase in average annual flow of 9%, but have negligible impact on the daily flow regime and, as discussed by Advisian (2018), not expected to impact Tangarang Creek or tributaries. Mining is not expected to affect other minor tributaries into Barbers Creek as the sections proposed to be mined already flow into the South Pit. Bungonia Creek tributaries are unlikely to be changed from the existing catchment area, however there will be an increase in the catchment area of the Main Gully tributary (from the current catchment area), which will at closure be similar to the historical catchment size. The post mining flow regime in Main Gully is predicted to be comparable to pre-mining conditions, and to improve substantially from current operational conditions. Particularly as runoff, in which a large proportion of the catchment artificially drains subsurface into Main Gully through South Pit will be diverted into Main Gully tributary.

Ecological assessment

While there is expected to be some changes to flow in Tangarang Creek with the increase in catchment area the magnitude of change is considered unlikely to significantly impact aquatic ecology and may in fact provide more habitat with the increased flow. There are unlikely to be significant changes to Main Gully during mining however flow is expected to return to pre-mining conditions after mine closure. Drainage to the northeast of the mine (Eastern Batters) would not change. Given that the Surface Water Assessment (Advisian 2018) states that changes in flow regime are not expected to have any adverse impact on Tangarang Creek or Main Gully during or post-mining, it is expected that changes in flow regime will have minimal impact on aquatic habitat, flora, fauna or stream processes.

Table 11 Changes in catchment areas (Advisian 2018)

Catchment	Receiving Water	WSP Management Zone	Historic catchment area (ha)	Existing catchment area (ha)	Future catchment area (ha)
Northern Overburden Emplacement (north-west corner)	Tangarang Creek (north-eastern tributary)	Barbers Creek	40	40	73
Western Overburden Emplacement (northern section)	Tangarang Creek (eastern tributary)	Barbers Creek	99	99	116
Tangarang Creek upstream of Tangarang Creek Dam	Tangarang Creek Dam	Barbers Creek	614	614	664
Western Overburden Emplacement and adjoining areas	Main Gully	Bungonia Creek	232	38	186
Tributaries of Barber Creek	Barbers Creek	Barbers Creek	296	98	98

Tributaries of Bungonia Creek	Bungonia Creek	Bungonia Creek	128	45	45

5.1.2 Marulan Creek Dam

The existing Peppertree Quarry dam on Tangarang Creek (Tangarang Dam) maintains environmental flows to prevent any potential impacts on downstream ecology (Advisian 2018). Boral Resources (NSW) Pty Ltd who owns and operates Peppertree Quarry has committed to environmental flow releases equivalent to 10% of average daily flows, in addition to spills during flood events (ERM 2006). It is anticipated that the proposed dam on Marulan Creek would have similar conditions specified, in particular, requirements for environmental flows. The average annual flow downstream of the Marulan Creek Dam is expected to reduce from 1,023 ML/year under existing conditions to 829 ML/year during mine operation.

The following construction issues will be considered during detailed design and the preparation of a construction management plan for the dam:

- Temporary diversion – provision for a temporary diversion or bypass would need to be set in place prior to and during construction of the dam and spillway. A solution may comprise a temporary embankment upstream, and the provision and maintenance of a low flow channel around the construction site.
- Rock excavation in spillway – some rock excavation as well as dealing with large buried fresh grandiorite boulders may be required as part of the spillway excavation.
- Preparation of a site specific erosion and sediment control plan prior to construction. Erosion and sediment works would be in accordance with Managing Urban Stormwater: Soils & Construction (Landcom, 2004).

Ecological assessment

Marulan Creek is an ephemeral drainage line located within the Barbers Creek catchment and has several dams along its length and at times has limited aquatic habitat in dry conditions. The results showed fewer macroinvertebrate families than expected and low SIGNAL scores indicating an existing impairment to stream health.

There is expected to be some impact on aquatic ecology, particularly in close proximity to and immediately downstream of the proposed Marulan Creek Dam. This impact is likely to diminish with distance downstream as more water/aquatic habitat is available. The impacts are likely to be minimal given that:

- the system currently has an altered flow regime from farm dams,
- downstream will likely receive 10% of natural inflows as part of the dam management, and
- the ecology is modified and adapted to ephemeral/low flow environment.

However, locally (immediately downstream of the dam), these impacts may potentially lead to less aquatic habitat. Although the dam itself will provide some aquatic habitat for lentic invertebrates, macrophytes, birds, amphibians and fish.

There are also construction related impacts to be considered (such as sedimentation). Mitigation measures have been recommended in Section 6.1, however some impacts such as excavation of the dam leading to altered stream morphology, and local aquatic habitat during construction cannot be avoided.

Marulan Creek dam will pose a barrier to fish passage. However only introduced fish were observed in Marulan Creek, indicating poor fish communities. Given the poor condition of the waterway and limited fish habitat, it is expected that the impact on fish passage/recruitment would be low.

5.1.3 Water quality impacts

There would be two sources of water release from the mine:

- Occasional overflow from sediment dams in the event of rainfall in excess of the design requirements.
- “Clean” runoff from rehabilitated overburden emplacement areas following completion of mining.

The standard of treatment proposed would provide water that is better than, or comparable to, the water quality in the receiving environment (Advisian 2018). No adverse water quality impacts are expected on Tangarang Creek, Main Gully, Bungonia Creek, Barbers Creek, and Shoalhaven River and that no impacts are anticipated on downstream users or on aquatic fauna (Advisian 2018).

Ecological assessment

Advisian (2018) concluded that no adverse water quality impacts are expected to Tangarang Creek, Main Gully or Bungonia Creek. Furthermore groundwater quality is similarly unlikely to be impacted (AGE 2018). Considering this, it is unlikely that there will be any impacts to aquatic ecology due to surface or groundwater quality in these systems.

5.1.4 Impacts on springs

Springs and groundwater seeps have been observed at the base of the steep slopes of Bungonia Gorge. It is assumed that similar features are also present on the face of the gorge slopes elsewhere. The springs can either occur at the intersection of groundwater table with the steep slopes of Bungonia Gorge, or be fed by fracturing in limestone and karstic features or sandstone bedrock aquifers (AGE 2018).

AGE (2018) did not model the springs directly, with the exception of the karst conduit behind the Main Gully Spring Cave and Main Gully Spring, mostly because the exact location of minor springs is unknown. It was considered unlikely that springs would be impacted as the seepage through the pit floor would continue to recharge the limestone and the springs. The outflow from the mine pit to the geological environment would continue at a rate of 240 m^3/day.

Ecological assessment

AGE (2018) concluded that it was improbable that springs would be impacted as the recharge through the pit floor would continue to recharge the limestone and feed the springs. Springs form an important component of the river systems, they are the interface between the surface and groundwater system and there is often a unique fauna assemblage associated with these habitats. The assessment of springs and spring habitat (Niche 2018) concluded that there is unlikely to be significant impact to these communities.

5.1.5 Impacts on surface/groundwater flows

Previous modelling indicated change to bedrock flows into and out of the alluvium of Shoalhaven River is negligible. When the conservative nature of the modelling is considered, the impact is expected to be undetectable (AGE 2018).

Ecological assessment

AGE (2018) concluded that the impact to surface/groundwater flow is expected to be undetectable, and as such will have no impact on aquatic ecology.

5.1.6 Groundwater quality impacts

Significant impacts to groundwater quality are not expected. Currently, the limestone aquifer is recharged directly by rainfall, surface runoff and groundwater flow from adjacent geological units. AGE (2018) concluded that since the recharge mechanism remains unchanged as part of the Project, the groundwater quality of the limestone will not be significantly altered.

The base flow supporting the flow of Bungonia and Barbers Creeks receives a proportion of its recharge from the underlying bedrock. The potential impact of this volume on the base flow water quality of Bungonia and Barbers Creeks is likely to be negligible (AGE 2018).

The potential groundwater impacts of mined overburden and limestone ore were the subject of a geochemical investigation (AGE 2018). The outcome of this investigation indicated that the overburden and limestone mined at the site would have a minimal, if not negligible, impact on the downstream groundwater quality (AGE 2018).

Ecological assessment

The stygofauna and GDE assessment (Niche 2018) found that there will be negligible impact to groundwater ecology.

5.1.7 Likelihood of occurrence and assessment of threatened species, populations and communities

Two threatened species are known from the Shoalhaven Catchment: Australian Grayling and Macquarie Perch. The assessment of likelihood of occurrence is provided in Appendix 1. Australian Grayling were not observed during surveys and have previously only been reported downstream of Tallowa Dam. The dam is thought to be a barrier to migrating grayling (Gejhrke 2002), which are therefore considered unlikely to occur above the dam. Macquarie Perch was not observed during surveys, or mapped by DPI Fisheries in Freshwater threatened species distribution maps (accessed 2018), however a record exists from the Shoalhaven River from 2007 (Bionet Atlas accessed 2018), 2 km upstream of Bungonia Creek confluence with the Shoalhaven River. Survey of Bungonia and Barbers Creek concluded that the habitat in these systems was unsuitable for Macquarie Perch due to the number of barriers and lack of riffle substrate within which to reproduce. Furthermore, the Project is considered unlikely to significantly impact Bungonia Creek, Barbers Creek or the Shoalhaven River flow regimes or water quality. Considering these factors, the Project is considered unlikely to impact either of these species. Species Impact Statements were therefore not required for the Project.

5.2 Key Fish Habitat

Marulan Creek, Bungonia Creek, Barber Creek and Shoalhaven River are mapped as Key Fish Habitat. As discussed throughout Section 5, with the exception of Marulan Creek dam there is unlikely to be significant aquatic ecological impacts from the Project to these waterways. With regards to Marulan Creek Dam offsetting for habitat loss is not required considering that:

- The proposed mitigation measures will be implemented during construction, limiting disturbance.
- Maintenance flows will be implemented for downstream habitat post construction.
- The existing fish community within Marulan Creek is depauperate, consisting primarily of introduced invasive fish.
- Compensatory works will be completed to stabilise, and rehabilitate areas affected by the construction of the Marulan Creek Dam and areas immediately downstream and upstream as part of the maintenance and management of the waterway.

5.3 Key Threatening Processes

A list of Key Threatening Processes (KTPs) is maintained under the BC Act, the FM Act and under the EPBC Act. Key Threatening Processes relevant to the aquatic environment of the Project Area are listed and discussed in Table 12.

Table 12: Key Threatening Processes relevant to the Marulan South Project

Key Threatening Process (BC Act)	Increased by the Project
Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (BC ACT)	Unlikely. Flow regimes of Marulan Creek have historically been altered. No change to Bungonia creek, Barbers Creek or Shoalhaven River
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (EPBC Act)	Unlikely
Novel biota and their impact on biodiversity (EPBC Act)	Unlikely
Climate Change (BC, FM and EPBC Acts)	Unknown
The degradation of native riparian vegetation along New South Wales water courses (FM Act)	Unlikely
The removal of large woody debris from NSW rivers and streams (FM Act)	No
The introduction of fish to fresh waters within a river catchment outside their natural range (FM Act)	No

5.4 Cumulative Impacts

Cumulative impacts are the successive, incremental and combined impacts (both positive and negative) of an activity on society, the economy and the environment (Franks et al. 2010). They can arise from the compounding activities of a single operation given the interaction of that operation with past, current and future activities that may or may not be related to the existing development. Cumulative impacts may also arise through the interaction of one development with other types of activities and industries, such as grazing and broad scale agriculture.

In relation to the Marulan South Project, the cumulative impacts are considered to be the total impact on the environment that would result from incremental impacts (including both direct and indirect impacts) from the development added to other existing impacts and proposed developments in the locality and region.

Other developments locally include Peppertree Quarry and Lynwood Quarry located within Barbers Creek Catchment. Both been approved under recent major project planning processes and have strict water management requirements. These imposed conditions reduce the likelihood of cumulative impacts on water quality and flow regimes of receiving drainage systems.

Advisian (2018) conclude that the potential impacts from the Project listed in Section 5 are not expected to have any cumulative adverse impacts on surface water resources and water quality in Barbers Creek, Bungonia Creek or the Shoalhaven River. Therefore the Project would make a negligible contribution to any cumulative impacts associated with other projects in the local area, and as such is unlikely to measurably impact aquatic ecology.

6. Avoidance, Management and Mitigation

Mitigation of impacts to aquatic ecology in receiving waters downstream of the mine is primarily achieved through the management of flow and water quality of surface water. The surface water assessment (Advisian 2018) describes a conceptual water management system that is designed and proposed to be managed in accordance with the requirements for long term sites that discharge to 'sensitive' environments. This level of runoff retention and treatment is consistent with the principles of the Neutral or Beneficial Effect (NoBE) objectives and as such will ensure minimum impact to the aquatic environment.

6.1 Marulan Creek dam

Advisian (2018) advise that for the construction phase of the Marulan Creek Dam, a site specific Construction Management Plan would be prepared including an Erosion and Sediment Control Plan that complies with the requirements of Managing Urban Stormwater: Soils & Construction (Landcom 2004). In addition to the standard erosion and sediment control techniques, particular attention would be given to the diversion of Marulan Creek around the dam wall and spillway works during construction. This will limit sedimentation downstream of the proposed Marulan Creek Dam site and will maintain flow in the creek (when the creek is flowing) during construction. It is expected that 10% of average daily flows will be required to be released downstream. The dam will be designed and managed to meet stipulated environmental flow requirements. This will ensure a proportion of daily flow is transferred downstream, albeit at lower discharges than what would be considered natural. It is recommended that water quality monitoring be used as a proxy to interpreting any change in stream health and aquatic biota associated with the establishment of the Marulan Creek Dam.

6.2 Tangarang Creek

There is no significant impact expected for Tangarang Creek and no aquatic monitoring is proposed. However it is recommended that areas of the catchment and/or its tributaries, disturbed by mining activities, will be rehabilitated and maintained to minimise sedimentation and promote stream health.

6.3 Bungonia Creek, Barber Creek, and Shoalhaven River

The surface water impact assessment concluded that there will be negligible impact to these sensitive receiving waters under the proposed water management system. However monitoring of these environments is paramount to ensure the water management system and other water flow and quality management measures outlined by Advisian (2018) are working effectively and provide early identification of flow or water quality issues that may harm aquatic biota. Advisian (2018) have recommended continued quarterly monitoring and updating trigger values with the water quality data with baseline data. It is recommended that aquatic biota also be monitored within this sensitive environment, however the monitoring program must be designed to reflect the low level of potential impact expected and difficult access. It is therefore recommended that the monitoring program include 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 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.

7. Conclusions

This report provides an aquatic ecological assessment to address the potential impacts associated with the Marulan South Project. The assessment concluded that:

- There is a low likelihood of occurrence of the threatened Australian Grayling and Macquarie Perch in Barbers and Bungonia Creeks and that the level of aquatic impacts to these freshwater systems and the Shoalhaven River from the Project are low.
- The Project is unlikely to impact aquatic ecology in Barbers Creek, Bungonia Creek and the Shoalhaven River as there will not be a significant impact to surface water flow and quality.
- The Project is unlikely to impact aquatic ecology in Barbers Creek, Bungonia Creek and Shoalhaven River as there will not be a significant impact to groundwater flow and quality.
- Tangarang Creek will have some changes in catchment area, however associated small changes (increase) to the flow regime in this creek are not expected to impact aquatic ecology.
- Marulan Creek ecology will be impacted by the proposed dam. The construction and operation of the dam must be carefully managed to ensure that the impact is minimised. This would entail construction mitigation measures (specified in Advisian 2018) to limit sedimentation and erosion as well as the release of water from the dam to maintain ephemeral creek habitat downstream.
- Catchment management measures such as riparian rehabilitation and erosion/sedimentation controls should be implemented to improve stream health.
- Monitoring of biota is recommended as part of the Surface Water Management Plan/Biodiversity Management Plan, particularly in sensitive receiving environments in Marulan Creek, Barbers Creek and Bungonia Creek. This is required for two seasons prior to or at the commencement of the 30 year mine plan. Further monitoring would be required if water quality triggers are exceeded and determined as having the potential to harm aquatic biota.

8. References

Advisian (2018). *Marulan South Limestone Mine Continued Operations: Surface Water Assessment.* Prepared for Boral Resources Pty Ltd

AGE (2018). *Marulan South Limestone Mine Continued Operations - Groundwater*

Technical Study. Prepared for Boral Resources Pty Ltd

Allen G.R., Midgley S.H., and Allen M. (2003) *Field Guide to the Freshwater Fishes of Australia.* CSIRO Publishing.

Anderson M.J., Gorley R.N., Clarke K.R. (2008). *PERMANOVA for PRIMER: guide to software and statistical methods*. PRIMER–E Ltd., Plymouth, United Kingdom, 214.

Atlas of NSW Wildlife OEH (Accessed March 2018) http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx

Atlas of living Australia (Accessed March 2018) https://www.ala.org.au/

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). (2000). *National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality ANZECC/ARMCANZ.*

Boyes, B. (2006). *Determining and managing environmental flows for the Shoalhaven River, Report 1 - Environmental Flows Knowledge Review*. NSW Department of Natural Resources, May 2006.

Chessman, B. (1995). Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification, and a biotic index. *Australian Journal of Ecology*, *20*, 122-129

Chessman B., (2003). *SIGNAL 2 – A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31*, Commonwealth of Australia, Canberra DWR, 1992.

Clarke, K.R. (1993). Non-parametric multivariate analyses of changes in community structure. *Austral Ecology 18*,117–143.

Department of Environment (DOE). (Accessed 2015) *Macquaria australasica — Macquarie Perch SPRAT profile.* https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66632

Department of Environment. (Accessed 2015) *Prototroctes maraena — Australian Grayling Sprat profile.* http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26179

Department of Environment. (Accessed 2015) Protected matter search tool. http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf

Department of Environment (2011) *Survey guidelines for Australian Threatened Fish.*

Department of Environment and Conservation (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft*

Department of Environment and Climate Change. (2007). *Threatened Species assessment guidelines – the assessment of significance*. NSW Department of Environment and Climate Change.

Department of Planning (DoP). (2002). *Aquatic ecology in environmental impact assessment*.

Department of Primary Industries (DPI). (2008). *Threatened Species Assessment Guidelines: the Assessment of Significance.*

Department of Primary Industries (DPI). (2013). *Policy and guidelines for fish habitat, conservation and management*.

Department of Primary Industries (DPI). (Accessed 2015). Threatened and protected species records viewer. http://www.dpi.nsw.gov.au/fisheries/species-protection/records/viewer.

ERM. (2006). *Marulan South Quarry Environmental Assessment Report*. Prepared for Boral Resources Pty Ltd.

Franks D.M., Brereton D., Moran C.J. (2010). Managing the cumulative impacts of coal mining on regional communities and environments in Australia. *Impact Assessment Appraisal 28*, (4), 299-312.

Gehrke P.C., Gilligan D.M., Barwick (2001). *Fish communities and migration in the Shoalhaven River –Before construction of a fishway*. NSW Fisheries Office of Conservation.

Gehrke P.C., Gilligan D.M., Barwick (2002). Changes in fish communities of the Shoalhaven River 20 years after construction of Tallowa dam. *Australia River Research applications. 18,* 265-486.

GSS Environmental. (2010). *Surface Water Assessment Marulan Limestone Mine.* Prepared for Blue Circle Southern Cement Limited.

Landcom (2004). *Managing Urban Stormwater: Soils & Construction*.

Marchant, R. (1989). A subsampler for samples of benthic invertebrates. *Bulletin of the Australian Society for Limnology 12*, 49–52.

Nichols, SD., Sloane, P., Coysh, J., Williams, C., and Norris, R.(2000) *Australian Capital Territory Australian River Assessment System Sampling and Processing* Manual. University of Canberra.

Niche Environment and Heritage. (2018). *Stygofauna and Groundwater Dependant Ecosystems Assessment*. Prepared for Boral Resources Pty Ltd.

Office of Environment and Heritage (unpublished) AUSRIVAS monitoring data base.

Sydney Catchment Authority (unpublished). Macroinvertebrate data base.

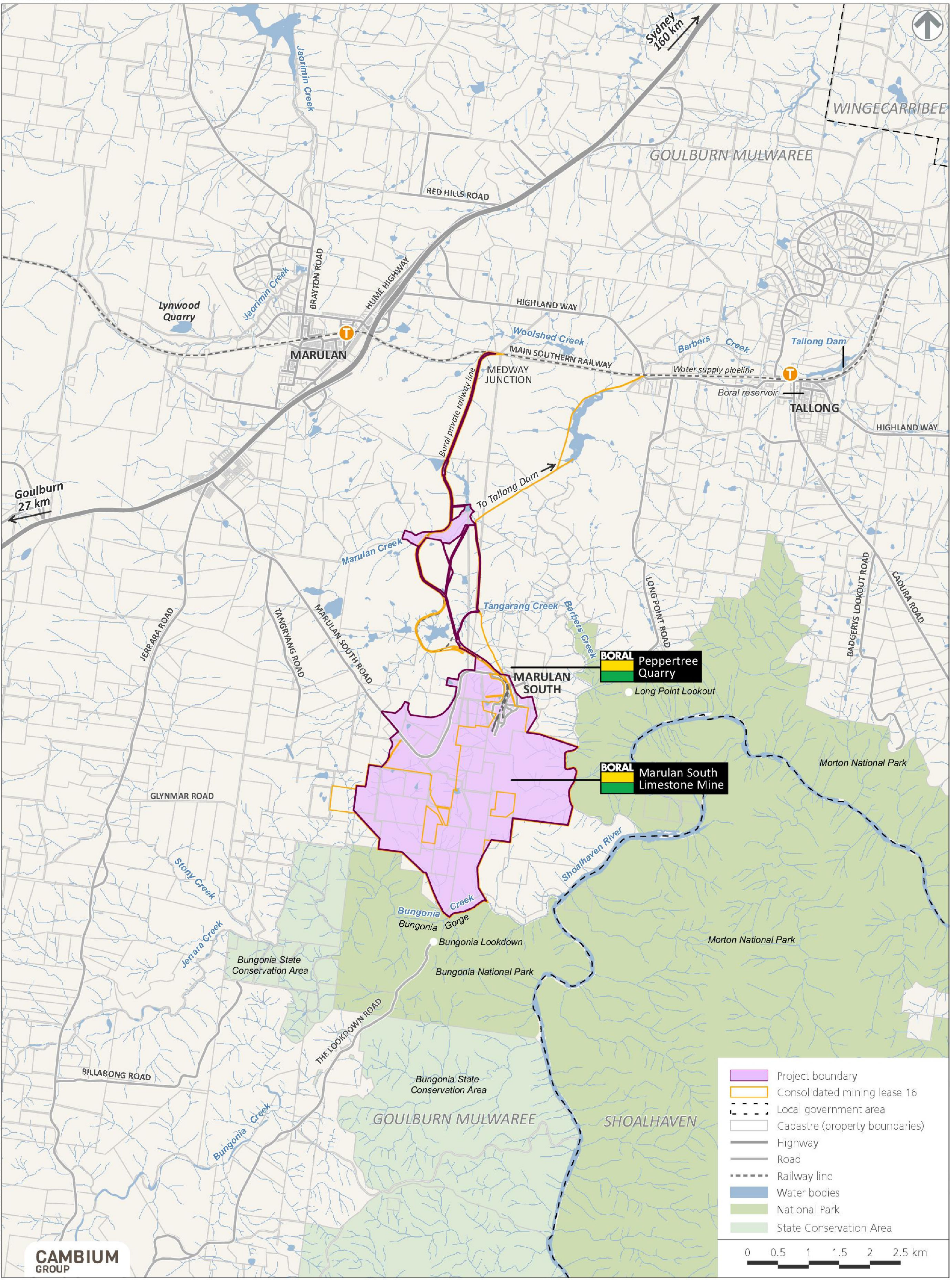
Turak, E., Waddell, N. and Johnstone, G. (2004) *New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual.* Department of Environment and Conservation, NSW

Underwood, A.J. (1994). Beyond BACI – sampling designs that might reliably detect environmental disturbances. *Ecological Applications 4*, 3-15

Figures

Regional context

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



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

031140_EIS_180820_v05

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

Regional context

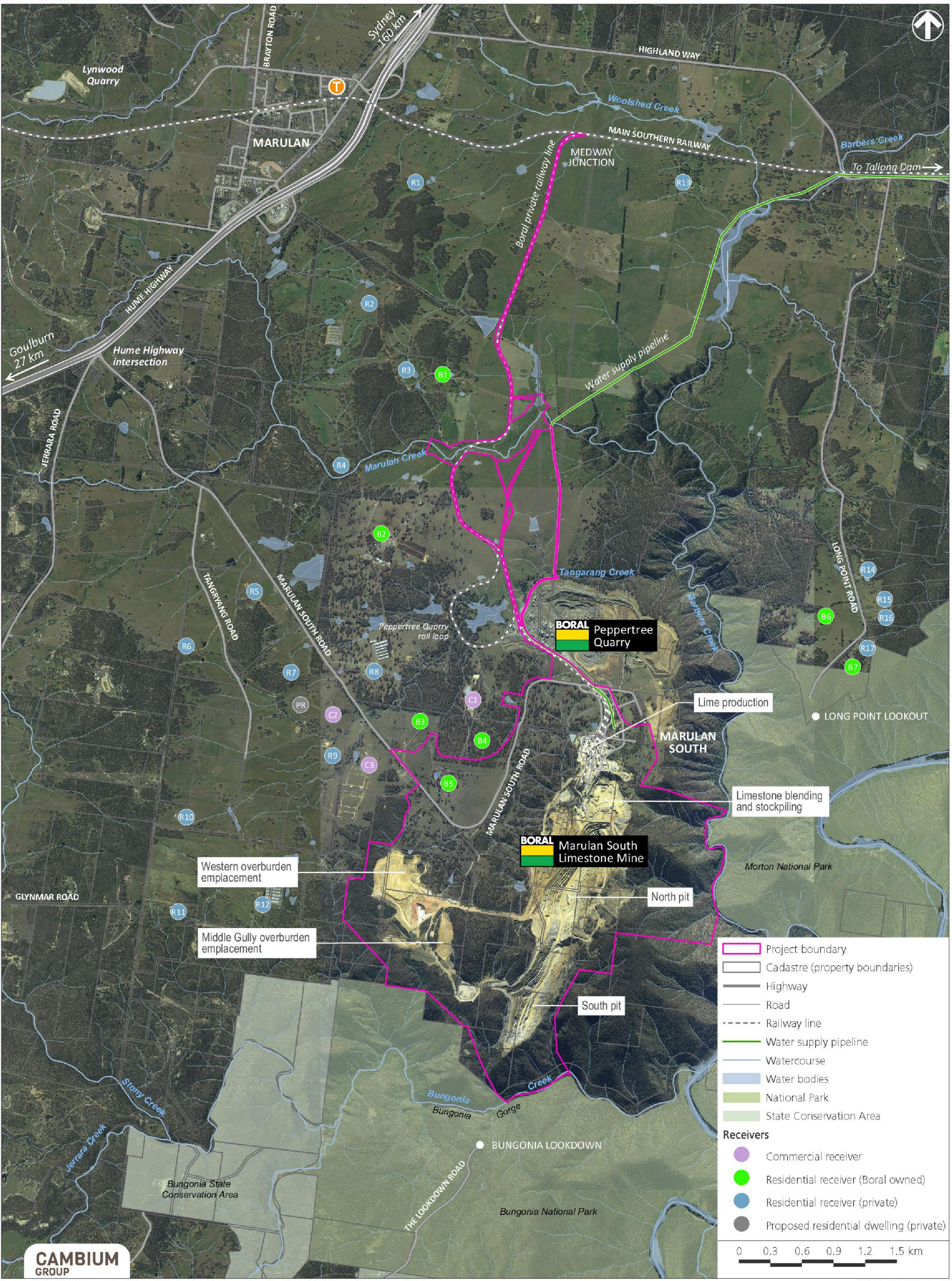
Marulan South Limestone Mine Continued Operations

FIGURE 1

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_1_element.mxd

Local context

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



DISCLAIMER
Cambium Group Pty Ltd disclaims all liability for all claims, expenses, losses, damages, and costs any person/company may incur as a result of their /its reliance on the accuracy or completeness of this document or its capability to achieve any purpose. © Cambium Group Pty Ltd 2018

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

031140_EIS_180830_v05

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

Local context

Marulan South Limestone Mine Continued Operations

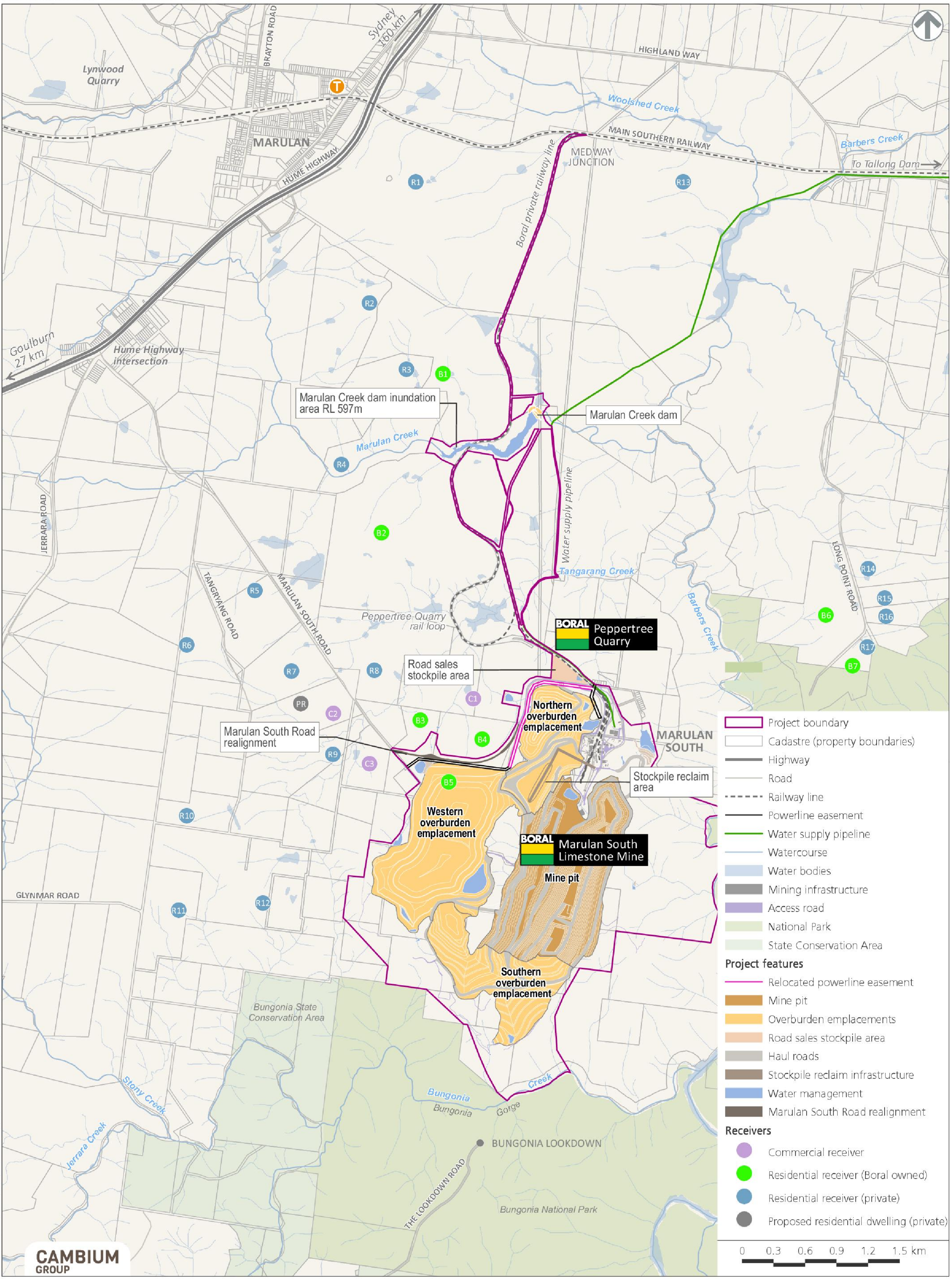
FIGURE 2

niche Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_2_element.mxd

Figure
The Project

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



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

031140_EIS_180831_v05

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

The Project

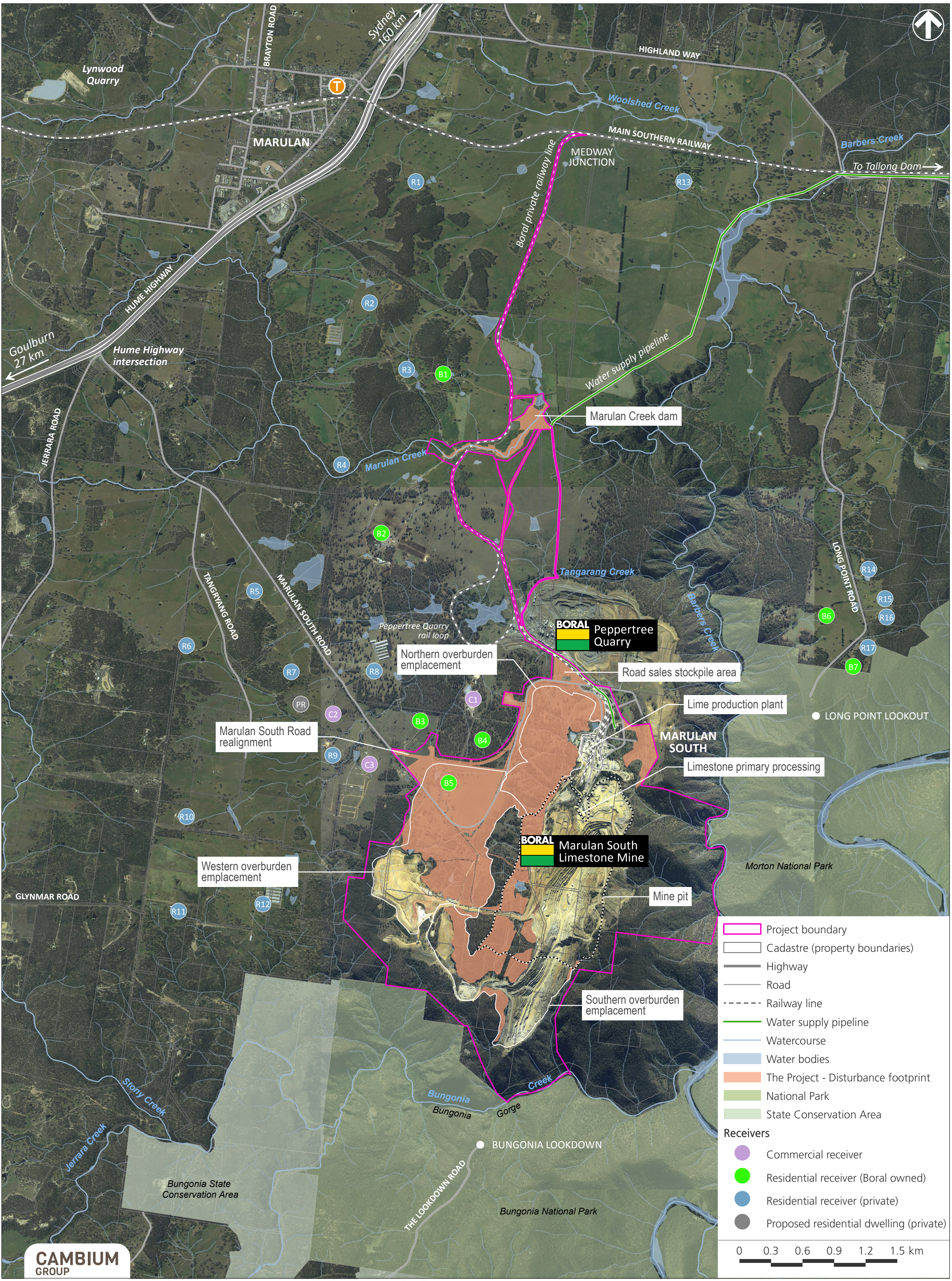
Marulan South Limestone Mine Continued Operations

FIGURE 3

niche
Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_3_element.mxd

The Project - Disturbance footprint



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

031040_EIS_180830_v04

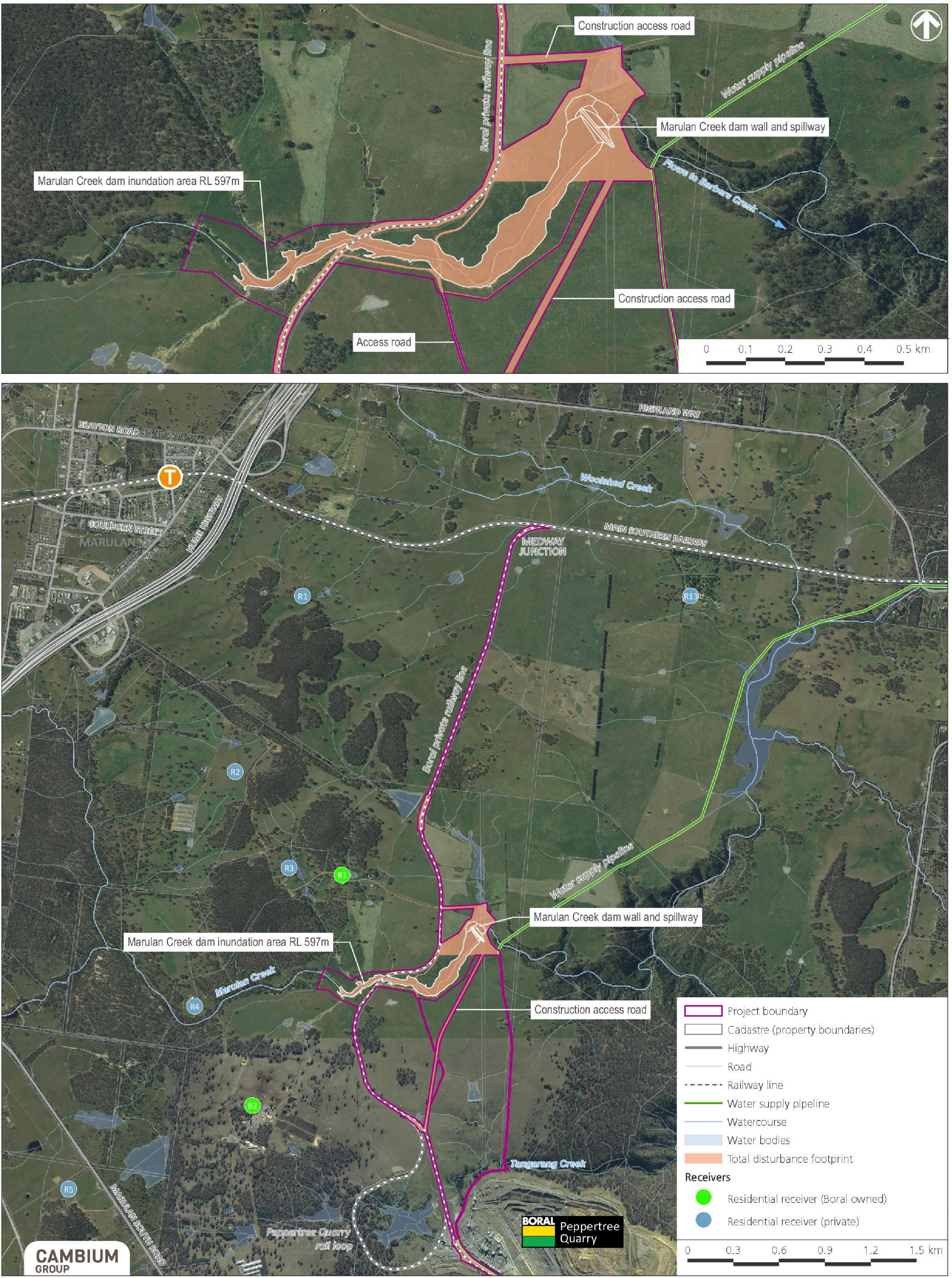
The Project Disturbance Footprint

Marulan South Limestone Mine Continued Operations

FIGURE 4

Marulan Creek Dam - Disturbance footprint

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



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

031140_EIS_180830_v03

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

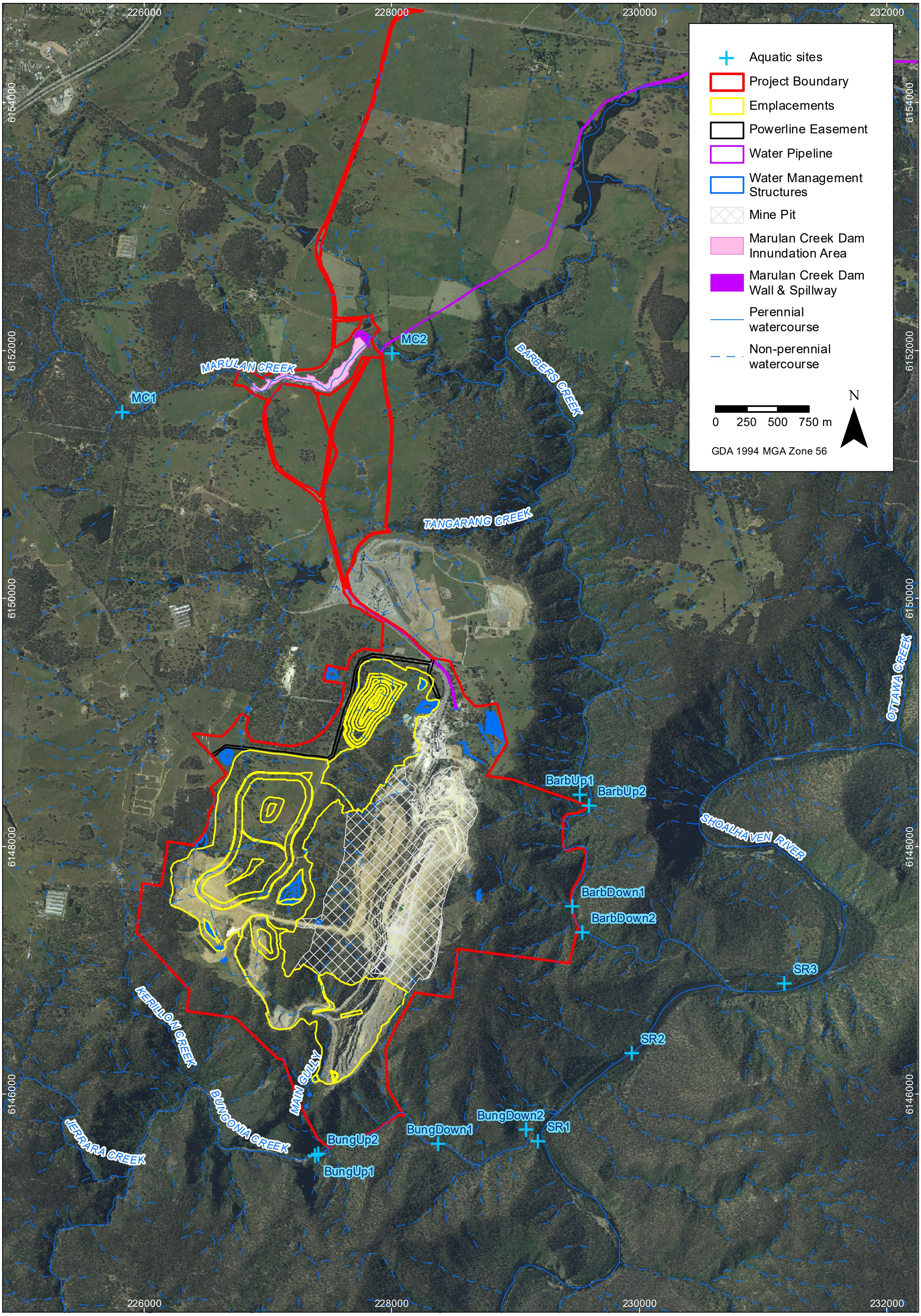
Marulan Creek Dam - Disturbance footprint

Marulan South Limestone Mine Continued Operations

FIGURE 5

Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Element_2018\2155_Figure_5_element.mxd



Drawn by: RJ Project Manager: LB Project Number: 2155 Date: 11/27/2018

Location of aquatic survey sites

Marulan Limestone Mine EIS

FIGURE 6

niche Environment and Heritage

Path: T:\spatial\projects\a2100\a2155_Marulan\Maps\Aquatic\2155_Figure_6_Aquatic_2018.mxd

Imagery: (c) Boral 2014-11-02

Appendix 1: Threatened Species Likelihood of Occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of Occurrence	Potential for Impacts
Macquaria australasica	Macquarie Perch	E (FM Act)	E	Macquarie perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments. The conservation status of the different populations is not well known, but there have been long-term declines in their abundance. Macquarie Perch are found in both river and lake habitats; especially the upper reaches of rivers and their tributaries. They are quiet, furtive fish that feed on aquatic insects, crustaceans and molluscs. Sexual maturity occurs at two years for males and three years for females. Macquarie perch spawn in spring or summer in shallow upland streams or flowing parts of rivers and females produce around 50,000-100,000 eggs which settle among stones and gravel of the stream or river bed. Populations from the eastward-flowing Shoalhaven and Hawkesbury rivers are genetically distinct and may represent an undescribed species (Allen et al., 2002).	Low- –potential habitat exists in upper reaches and tributaries of Shoalhaven River where one observation was recorded in 2007 (3 km upstream of Bungonia confluence). However there is no preferred habitat in Bungonia Creek or Barbers Creek and no records from extensive surveys in these systems.	Low
Prototroctes maraena	Australian Grayling	-	V	Historically, this species occurred in coastal streams from the Grose River Valley, southwards through NSW, Vic. and Tas, With occurrences in the Shoalhaven catchment below Tallowa Dam. It also occasionally occurred high upstream in the Snowy R. A single juvenile specimen was collected from Lake Macquarie in 1974. This species spends only part of its lifecycle in freshwater. The Tambo River population inhabits a clear, gravel-bottomed stream with alternating pools and riffles, and granite outcrops. It has also been associated with clear, gravel-bottomed habitats in the Mitchell & Wonnangatta Rivers but was present in a muddy-bottomed, heavily silted habitat in the Tarwin River.	None –no records upstream of Tallowa Dam.	None

Appendix 2: Macroinvertebrate results

Table 13 Quantitative - Spring 2014 macroinvertebrates for all sites. Subsampled using Marchant box.

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Nemertea	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turbellaria	0.00	0.00	0.00	4.17	0.00	0.00	13.33	0.00	0.00	0.00	3.33	0.00	20.00
Lymnaeidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ancylidae	0.00	66.67	0.00	4.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.33	0.00
Pyralidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
hyrobiidae	65.00	510.00	45.71	66.67	1245.00	740.00	446.67	220.00	0.00	0.00	13.33	0.00	0.00
Physidae	10.00	0.00	0.00	4.17	0.00	15.00	66.67	130.00	0.00	2.86	0.00	0.00	30.00
Planorbidae	0.00	6.67	0.00	0.00	0.00	0.00	6.67	10.00	0.00	0.00	0.00	6.67	0.00
Corbiculidae	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	8.57	16.67	0.00	0.00
Oligochaeta	250.00	90.00	157.14	75.00	5.00	0.00	26.67	110.00	4.00	8.57	0.00	76.67	620.00
Gripopterygidae	0.00	0.00	0.00	0.00	10.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Pyrilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acarina	5.00	6.67	2.86	8.33	10.00	0.00	0.00	10.00	0.00	8.57	0.00	3.33	0.00
Ceinidae	0.00	0.00	0.00	0.00	35.00	35.00	0.00	10.00	0.00	0.00	0.00	0.00	160.00
Atyidae	5.00	20.00	11.43	20.83	0.00	15.00	20.00	0.00	72.00	34.29	60.00	0.00	0.00
Parastacidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dytiscidae L	65.00	10.00	2.86	12.50	20.00	80.00	66.67	200.00	0.00	0.00	0.00	93.33	290.00
Dytiscidae A	5.00	0.00	0.00	4.17	15.00	0.00	26.67	0.00	0.00	2.86	0.00	10.00	40.00
Gyrinidae L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00
Elmidae L	0.00	6.67	11.43	8.33	20.00	0.00	0.00	340.00	0.00	20.00	0.00	0.00	40.00
Elmidae A	0.00	0.00	0.00	0.00	5.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Hydrophilidae L	10.00	10.00	14.29	4.17	15.00	0.00	6.67	10.00	0.00	0.00	0.00	0.00	0.00

	Bungonia BungUp1	**Bungonia BungUp2**	**Bungonia BungDown 1**	**Bungonia BungDown2**	**Barbers BarbUp 1**	**Barbers BarbUp 2**	**Barbers BarbDown1**	**Barbers BarbDown2**	**Shoalhaven SR1**	**Shoalhaven SR2**	**Shoalhaven SR3**	**Marulan MC1**	**Marulan MC2**
Hydrophildae A	0.00	6.67	0.00	4.17	15.00	15.00	6.67	0.00	2.00	0.00	0.00	0.00	30.00
Hydraenidae	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scirtidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psephenidae	0.00	3.33	0.00	0.00	10.00	0.00	0.00	10.00	0.00	0.00	6.67	0.00	0.00
Curculionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tipulidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dolichopodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Stratiomiyidae	0.00	13.33	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
Culicidae	0.00	0.00	2.86	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00
Ceratopogonidae	10.00	16.67	20.00	4.17	10.00	10.00	0.00	50.00	0.00	20.00	0.00	10.00	0.00
Tanypodinae	60.00	66.67	31.43	29.17	130.00	95.00	106.67	380.00	12.00	57.14	46.67	146.67	80.00
Orthocladiinae	2200.00	490.00	68.57	204.17	0.00	15.00	20.00	50.00	4.00	45.71	6.67	3.33	1230.00
Chironominae	580.00	366.67	125.71	191.67	95.00	35.00	326.67	340.00	8.00	82.86	96.67	223.33	450.00
Baetidae	0.00	13.33	28.57	45.83	20.00	10.00	33.33	50.00	8.00	48.57	66.67	23.33	20.00
Leptophlebiidae	10.00	30.00	8.57	41.67	325.00	45.00	33.33	530.00	8.00	54.29	26.67	20.00	50.00
Caenidae	0.00	0.00	5.71	0.00	25.00	0.00	13.33	40.00	2.00	8.57	60.00	0.00	70.00
Veliidae	0.00	0.00	0.00	0.00	5.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Gerridae	0.00	0.00	5.71	8.33	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	30.00
Corixidae	0.00	0.00	0.00	0.00	0.00	20.00	0.00	10.00	192.00	28.57	36.67	23.33	10.00
Notonectidae	5.00	0.00	0.00	0.00	0.00	0.00	13.33	0.00	10.00	2.86	3.33	6.67	0.00
Hydrometridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pleidae	0.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coenagrionidae	10.00	0.00	0.00	4.17	0.00	0.00	0.00	0.00	2.00	0.00	16.67	0.00	20.00

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Megapodagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
Synlestidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
Aeshnidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphidae	0.00	0.00	0.00	0.00	5.00	0.00	0.00	20.00	2.00	0.00	0.00	0.00	0.00
Telephlebiidae	0.00	3.33	0.00	0.00	20.00	10.00	0.00	0.00	0.00	2.86	10.00	0.00	30.00
Synthemistidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemicorduliidae	0.00	0.00	5.71	8.33	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
Cordulephyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Libellulidae	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrobiosidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Calocidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conoesucidae	5.00	10.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polycentropodidae	0.00	0.00	0.00	4.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	590.00	150.00	0.00	8.33	5.00	255.00	73.33	60.00	0.00	51.43	140.00	0.00	100.00
Heliopsychidae	0.00	20.00	0.00	4.17	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecnomidae	0.00	0.00	0.00	8.33	0.00	0.00	0.00	0.00	2.00	2.86	16.67	0.00	0.00
Philorheithridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Odontoceridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atriplectididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calamoceratidae	0.00	0.00	0.00	0.00	5.00	0.00	6.67	0.00	2.00	2.86	3.33	0.00	0.00
Leptoceridae	5.00	13.33	8.57	108.33	100.00	55.00	113.33	10.00	38.00	94.29	113.33	6.67	0.00

Table 14 Quantitative - Autumn 2015 macroinvertebrates for all sites. Subsampled using Marchant box.

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Nemertea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turbellaria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	2.00	2.00	0.00	0.00
Lymnaeidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Ancylidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pyralidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
hyrobiidae	500.00	13.33	0.00	5.00	1290.00	266.67	240.00	50.00	0.00	0.00	0.00	0.00	0.00
Physidae	0.00	0.00	0.00	0.00	60.00	6.67	10.00	90.00	0.00	0.00	2.00	0.00	0.00
Planorbidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corbiculidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	4.00	22.00	0.00	0.00
Oligochaeta	80.00	140.00	35.00	35.00	0.00	6.67	30.00	0.00	0.00	0.00	4.00	0.00	0.00
Gripopterygidae	0.00	0.00	0.00	0.00	10.00	6.67	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Pyrilidae	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acarina	30.00	6.67	10.00	10.00	0.00	0.00	30.00	20.00	0.00	4.00	0.00	0.00	0.00
Ceinidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00
Atyidae	0.00	0.00	50.00	60.00	0.00	20.00	0.00	0.00	108.00	82.00	12.00	0.00	0.00
Parastacidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
Dytiscidae L	10.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dytiscidae A	0.00	0.00	0.00	5.00	10.00	133.33	30.00	80.00	0.00	0.00	0.00	1.00	64.00
Gyrinidae L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elmidae L	20.00	0.00	55.00	0.00	10.00	6.67	20.00	90.00	0.00	2.00	2.00	0.00	0.00
Elmidae A	0.00	0.00	5.00	5.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrophilidae L	100.00	73.33	0.00	15.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Hydrophildae A	10.00	26.67	0.00	0.00	10.00	0.00	0.00	10.00	0.00	0.00	0.00	2.00	0.00
Hydraenidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scirtidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	8.00
Psephenidae	20.00	0.00	0.00	0.00	0.00	6.67	10.00	40.00	0.00	0.00	0.00	1.00	0.00
Curculionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Tipulidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixidae	10.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00
Dolichopodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stratiomiyidae	30.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	4.00
Culicidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceratopogonidae	10.00	0.00	0.00	0.00	20.00	0.00	10.00	0.00	2.00	2.00	8.00	0.00	8.00
Tanypodinae	290.00	120.00	0.00	45.00	110.00	26.67	130.00	250.00	30.00	12.00	20.00	8.00	24.00
Orthocladiinae	240.00	586.67	40.00	45.00	10.00	6.67	0.00	40.00	4.00	4.00	0.00	12.00	12.00
Chironominae	730.00	993.33	200.00	425.00	20.00	53.33	80.00	30.00	50.00	30.00	44.00	141.00	208.00
Baetidae	520.00	253.33	425.00	105.00	200.00	353.33	330.00	1240.00	62.00	14.00	16.00	14.00	16.00
Leptophlebiidae	290.00	80.00	15.00	20.00	710.00	286.67	780.00	650.00	4.00	10.00	36.00	0.00	4.00
Caenidae	40.00	73.33	5.00	115.00	50.00	26.67	20.00	30.00	2.00	16.00	6.00	3.00	32.00
Veliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gerridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
Corixidae	0.00	0.00	0.00	50.00	60.00	113.33	470.00	190.00	26.00	8.00	66.00	2.00	4.00
Notonectidae	0.00	0.00	20.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	2.00	0.00	0.00
Hydrometridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
Pleidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coenagrionidae	0.00	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	16.00

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Megapodagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Synlestidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aeshnidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Gomphidae	10.00	0.00	0.00	0.00	30.00	6.67	20.00	70.00	0.00	0.00	2.00	0.00	0.00
Telephlebiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synthemistidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Hemicorduliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Cordulephyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Libellulidae	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrobiosidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calocidae	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
Conoesucidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Polycentropodidae	0.00	0.00	5.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	4.00
Hydroptilidae	230.00	266.67	0.00	0.00	0.00	33.33	0.00	0.00	0.00	6.00	0.00	10.00	0.00
Heliopsychidae	190.00	0.00	0.00	0.00	0.00	0.00	30.00	20.00	0.00	0.00	0.00	0.00	0.00
Ecnomidae	0.00	6.67	45.00	30.00	0.00	0.00	30.00	50.00	0.00	0.00	2.00	7.00	20.00
Philorheithridae	0.00	0.00	5.00	0.00	40.00	13.33	10.00	50.00	0.00	0.00	0.00	0.00	0.00
Odontoceridae	0.00	0.00	5.00	0.00	0.00	46.67	20.00	30.00	0.00	0.00	2.00	0.00	0.00
Atriplectididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calamoceratidae	0.00	6.67	0.00	5.00	0.00	6.67	30.00	20.00	2.00	34.00	0.00	0.00	0.00
Leptoceridae	30.00	33.33	30.00	55.00	190.00	160.00	330.00	160.00	34.00	106.00	160.00	2.00	0.00

Table 15 Quantitative - AUSRIVAS Spring 2014

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Turbellaria	0	0	0	1	0	0	2	0	0	0	1	0	2
Ancylidae	0	20	0	1	0	0	0	0	0	0	0	13	0
Hyrobiidae	13	153	16	16	249	148	67	22	0	0	4	0	0
Physidae	2	0	0	1	0	3	10	13	0	1	0	0	3
Planorbidae	0	2	0	0	0	0	1	1	0	0	0	2	0
Corbiculidae	0	0	0	0	0	0	1	0	0	3	5	0	0
Oligochaeta	50	27	55	18	1	0	4	11	2	3	0	23	62
Gripopterygidae	0	0	0	0	2	0	0	1	0	0	0	0	0
Acarina	1	2	1	2	2	0	0	1	0	3	0	1	0
Ceinidae	0	0	0	0	7	7	0	1	0	0	0	0	16
Atyidae	1	6	4	5	0	3	3	0	36	12	18	0	0
Parastacidae	0	0	0	0	0	0	0	0	0	0	0	0	0
Dytiscidae	14	3	1	4	7	16	14	20	0	1	0	31	33
Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	3	0
Elmidae	0	2	4	2	5	2	0	35	0	7	0	0	4
Hydrophilidae	2	5	5	2	6	3	2	1	1	0	0	0	3
Hydraenidae	0	0	0	0	1	0	0	0	0	0	0	0	0
Psephenidae	0	1	0	0	2	0	0	1	0	0	2	0	0
Dolichopodidae	0	0	0	0	0	0	0	1	0	0	0	0	0
Stratiomyidae	0	4	0	0	1	0	0	0	0	0	0	0	4
Culicidae	0	0	1	0	2	0	0	0	0	0	0	0	2
Ceratopogonidae	2	5	7	1	2	2	0	5	0	7	0	3	0
Tanypodinae	12	20	11	7	26	19	16	38	6	20	14	44	8

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Orthocladiinae	440	147	24	49	0	3	3	5	2	16	2	1	123
Chironominae	116	110	44	46	19	7	49	34	4	29	29	67	45
Baetidae	0	4	10	11	4	2	5	5	4	17	20	7	2
Leptophlebiidae	2	9	3	10	65	9	5	53	4	19	8	6	5
Caenidae	0	0	2	0	5	0	2	4	1	3	18	0	7
Veliidae	0	0	0	0	1	0	0	1	0	0	0	0	0
Gerridae	0	0	2	2	0	0	0	0	0	0	10	0	3
Corixidae	0	0	0	0	0	4	0	1	96	10	11	7	1
Notonectidae	1	0	0	0	0	0	2	0	5	1	1	2	0
Pleidae	0	0	0	0	0	3	0	0	0	0	0	0	0
Coenagrionidae	2	0	0	1	0	0	0	0	1	0	5	0	2
Megapodagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Synlestidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Gomphidae	0	0	0	0	1	0	0	2	1	0	0	0	0
Telephlebiidae	0	1	0	0	4	2	0	0	0	1	3	0	3
Hemicorduliidae	0	0	2	2	2	0	0	0	0	0	0	0	4
Libellulidae	0	0	1	0	0	0	0	0	0	0	0	0	0
Hydrobiosidae	0	0	0	0	0	0	0	1	0	0	0	0	0
Conoesucidae	1	3	0	0	2	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	1	0	0	0	0	0	0	0	0	0
Hydroptilidae	118	45	0	2	1	51	11	6	0	18	42	0	10
Helicopsychidae	0	6	0	1	1	0	0	0	0	0	0	0	0
Ecnomidae	0	0	0	2	0	0	0	0	1	1	5	0	0
Calamoceratidae	0	0	0	0	1	0	1	0	1	1	1	0	0

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Leptoceridae	1	4	3	26	20	11	17	1	19	33	34	2	0

Table 16 Quantitative - AUSRIVAS Autumn 2015

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Turbellaria	0	0	0	0	0	0	0	1	0	1	1	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Pyralidae	0	0	0	0	0	0	0	0	2	0	0	0	0
Hyrobiidae	50	2	0	1	129	40	24	5	0	0	0	0	0
Physidae	0	0	0	0	6	1	1	9	0	0	1	0	0
Corbiculidae	0	0	0	0	0	0	0	0	3	2	11	0	0
Oligochaeta	8	21	7	7	0	1	3	0	0	0	2	0	0
Gripopterygidae	0	0	0	0	1	1	0	1	0	0	0	0	0
Pyrilidae	0	0	2	0	0	0	0	0	0	0	0	0	0
Acarina	3	1	2	2	0	0	3	2	0	2	0	0	0
Ceinidae	0	0	0	0	0	0	0	0	0	0	0	4	0
Atyidae	1	0	10	12	0	3	1	1	54	41	6	0	0
Parastacidae	0	0	0	0	0	0	0	0	0	0	0	1	0
Dytiscidae	1	1	0	1	1	20	3	8	0	0	0	1	16
Elmidae	2	0	12	1	1	2	2	9	0	1	1	0	0
Hydrophilidae	10	11	0	3	0	0	0	2	0	0	0	0	0
Scirtidae	0	0	0	0	0	0	0	0	0	0	1	0	2
Psephenidae	2	0	0	0	1	1	1	4	0	0	0	1	0
Dixidae	1	0	0	0	0	0	0	2	0	0	0	0	0
Stratiomiyidae	3	0	0	0	1	0	0	0	0	0	1	0	1
Ceratopogonidae	1	0	0	0	2	0	1	0	1	1	4	0	2
Tanypodinae	29	18	0	9	11	4	13	25	15	6	10	8	6
Orthocladiinae	24	88	8	9	1	1	0	4	2	2	0	12	3

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Chironominae	73	149	40	85	2	8	8	3	25	15	22	141	52
Baetidae	52	38	85	21	20	53	33	124	31	7	8	14	4
Leptophlebiidae	29	12	3	4	71	43	78	65	2	5	18	0	1
Caenidae	4	11	1	23	5	4	2	3	1	8	3	3	8
Gerridae	0	0	0	0	0	0	0	0	0	0	1	0	0
Corixidae	1	0	0	10	6	17	47	19	13	4	33	2	1
Notonectidae	0	0	4	0	1	0	0	1	0	0	1	0	0
Hydrometridae	0	0	0	0	0	0	0	0	0	0	1	0	0
Coenagrionidae	0	0	8	0	0	0	0	0	0	0	0	7	4
Megapodagrionidae	0	0	0	0	0	0	0	0	0	0	0	2	0
Aeshnidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Gomphidae	1	0	0	0	3	1	2	7	0	0	1	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Teleplebiidae	0	0	0	0	0	0	0	0	1	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	0	2	0
Libellulidae	0	0	0	1	0	0	0	0	0	0	0	0	0
Calocidae	0	0	0	0	0	0	1	0	0	0	0	0	0
Conoesucidae	0	0	0	0	0	0	0	1	0	0	0	0	0
Polycentropodidae	0	0	1	3	0	0	0	0	0	0	0	1	1
Hydroptilidae	23	40	0	0	0	5	0	0	0	3	0	10	0
Helicopsychidae	19	0	0	0	0	0	3	2	0	0	0	0	0
Ecnomidae	0	1	9	6	0	0	3	5	0	0	1	7	5
Philorheithridae	0	0	1	0	4	2	1	5	0	0	0	0	0
Odontoceridae	0	0	1	0	0	7	2	3	0	0	1	0	0

	Bungonia BungUp1	Bungonia BungUp2	Bungonia BungDown 1	Bungonia BungDown2	Barbers BarbUp 1	Barbers BarbUp 2	Barbers BarbDown1	Barbers BarbDown2	Shoalhaven SR1	Shoalhaven SR2	Shoalhaven SR3	Marulan MC1	Marulan MC2
Calamoceratidae	0	1	0	1	0	1	3	2	1	17	0	0	0
Leptoceridae	3	5	6	11	19	24	33	16	17	53	80	2	0
Tasmiidae	0	0	0	0	1	0	0	0	0	0	0	0	0

Niche Environment and Heritage

A specialist environmental and heritage consultancy.

Head Office

Niche Environment and Heritage
PO Box W36 Parramatta NSW 2150
Email: info@niche-eh.com

All mail correspondence should be through our Head Office


BORAL
Air quality monitoring
CAMBIUM
GROUP