Appendix E

Erosion and sedimentation management report

M1 Princes Motorway Improvements: Bulli Tops to Picton Road

Stage 1 – Picton Road to Bellambi Creek

Erosion and Sedimentation Management Report

Final

Prepared for: Roads and Maritime Services
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DOCUMENT CONTROL

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Prepared for	Roads and Maritime Services			
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TABLE OF CONTENTS

FIGURES

TABLES

ABBREVIATIONS & ACRONYMS

Abbreviation / Acronym	Description
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CCTV	Closed Circuit Television
CLM Act	*Contaminated Land Management Act 1997*
CPESC	Certified Professional in Erosion and Sediment Control
EEC	Endangered ecological communities
EPA	Environment Protection Authority
EPL	Environment protection licence
ESCPs	Erosion and Sedimentation Control Plans
ESMR	Erosion and Sedimentation Management Report
LGA	Local Government Area
NorBE	Neutral or Beneficial Effect on Water Quality
NWQMS	National Water Quality Management Strategy
POEO Act	*Protection of the Environment Operations Act 1997*
PESA	Preliminary Erosion and Sedimentation Assessment
REF	Review of Environmental Factors
RRT	*Dangerous Goods (Road and Rail Transport) Act 2008*
SCA	Sydney Catchment Authority
SWMP	Soil and water management plan
WM Act	*Water Management Act 2000*

1. INTRODUCTION

1.1 Purpose

Roads and Maritime propose to upgrade the M1 Princes Motorway (previously Mount Ousley Road) for 8.3 kilometres, between Picton Road at Mount Ousley and Bulli Pass at Bulli Tops. The upgrade involves road widening and realignment of the M1 Princes Motorway from a four lane divided road (two lanes in each direction), to a six lane divided road (three in each direction). The upgrade of M1 Motorway at Mount Ousley would be constructed in two stages as funding becomes available. Stage 1 (southern section) extends between the Picton Road interchange and Bellambi Creek (the proposal), Mount Ousley. Stage 2 (northern section) extends between Bellambi Creek and Bulli Pass at Bulli Tops.

This Erosion and Sedimentation Management Report (ESMR) has been prepared for the Stage 1 proposed works only and a subsequent report would be prepared to support the Stage 2 project at a later stage. This ESMR describes the existing soil and water environment, identifies the potential impacts that the proposal may have on soil and water environments and the management measures that would be appropriate to apply to mitigate the potential impacts. The ESMR has been prepared as a technical paper supporting a Review of Environmental Factors (REF) for the proposal.

1.2 The Proposal

Key features of the proposal include:

- Widening and realignment primarily on the eastern side of the existing alignment, to a six lane (three in each direction) divided road from Picton Road to south of Bellambi Creek bridge
- Widening sections of the existing road from four lanes to six lanes from:
    - Picton Road interchange to 600 metres north of Picton Road
    - 1.65 kilometres north of Picton Road to the Fire Trail (Access 7) location
- Realignment to the east of the existing road to provide six lanes from:
    - 600 metres north of Picton Road to 1.65 kilometres north of Picton Road
    - 2.7 kilometres north of Picton Road to 70 metres south of Bellambi Creek bridge
- Provision of a three metre wide shoulder for both carriageways
- Posted vehicle speed limit of 100 kilometres per hour
- Expansion of the road surface area including the replacement of safety barriers, relocation of road signage and infrastructure (such as permanent variable message signage)
- Realignment and earthworks including bank stabilisation works and environmental management measures
- Four major cuts up to 475 metres long and up to 14 metres in height
- Three major fill embankments up to 275 metres long and up to 20 metres in height

- Provision for ITS infrastructure including:
    - Vehicle detection loops in the pavement
    - CCTV infrastructure
    - Emergency phones and truck stopping bays (with storage for 25 metre B-Double)
- Water quality management measures and drainage structures
- Continued provision for public utilities within the proposal footprint, where practicable.
- Property acquisition at various location to provide construction and operational access to access tracks. (Wollongong Coal Limited, Endeavour Energy and WaterNSW)
- Temporary infrastructure to allow project works including site compounds, utility connections, sedimentation and erosion control, temporary access roads, temporary pavement for road traffic, stockpiling sites and other infrastructure as required
- Landscaping and urban design features.

2. POLICY SETTING

2.1 Statutory requirements

Legislation relating to soil, sediment and water management has been considered in the context of the proposal. A summary of this review is provided as follows.

2.1.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997 (POEO Act)* sets the framework for environment protection during the construction and operation of a development or during the undertaking of an activity. The POEO Act consolidates key pollution statutes relating to air, water and noise pollution and environmental offences, and establishes a duty to notify either the Environment Protection Authority (EPA) or the local council where incidents are likely to cause material harm to the environment.

The proposed upgrade would result in four lanes for a distance greater than five kilometres. Accordingly, the proposal fits the description of a 'scheduled activity' under the Act and as such an environment protection licence (EPL) would be required.

2.1.2 Soil Conservation Act 1938

The *Soil Conservation Act 1938* provides for the conservation of soil resources and farm water resources and for the mitigation of erosion. The Act allows the Minister to declare an area a protected area if it is land within a catchment area with a slope of greater than 18 degrees from the horizontal; land which is within 20 metres of the bed or bank of a river or lake.

The proposal crosses the Bellambi Creek and Cataract Creek. The design of the proposal would not affect these waterways, however if any works were to occur within them during construction, the provisions of the *Soil Conservation Act 1938* would need to be considered.

2.1.3 Dangerous Goods (Road and Rail Transport) Act 2008

The purpose of the *Dangerous Goods (Road and Rail Transport) Act 2008* (RRT Act) is to regulate the transport of dangerous goods by road and rail in order to promote public safety and protect property and the environment.

The fuel requirements of ancillary sites and construction plant to be used in the construction phase is classified as dangerous goods by the Australian Dangerous Goods Code and would require transport to each ancillary site and plant by road. The RRT Act would require both the vehicle transporting dangerous goods and the driver of the vehicle to be licensed under the RRT Act.

2.1.4 Water Management Act 2000

The *Water Management Act 2000 (WM Act)* provides for the protection of river and lakeside land in NSW and aims to provide for the sustainable management of the water resources throughout NSW. It identifies provisions relating to 'controlled activities' which includes (among other definitions) the carrying out of any activity that affects the quantity or flow of water in a water source' or affects land fronting a waterway.

Under clause 39A(1) of the Water Management (General) Regulation 2004, Roads and Maritime is exempted from the need to obtain a Controlled Activity Approval with regard to undertaking works within 40 metres of a watercourse.

2.1.5 Contaminated Land Management Act 1997

The *Contaminated Land Management Act 1997 (CLM Act)* establishes the processes for investigating and, where appropriate, remediating contaminated land and contaminated groundwater. Section 60 of the CLM Act imposes a duty for proponents to report to the NSW EPA if land contamination poses significant risk of harm. The CLM Act also regulates the provision of Investigation Orders (Section 17) and Remediation Orders (Section 23). SEPP 55 – Remediation of Land provides for the implementation of the CLM Act through the planning and environmental assessment processes.

In undertaking activities, Roads and Maritime must demonstrate appropriate management of contaminated land during the acquisition, management and divestment of property. The proposal engages a risk of potentially contaminated land being encountered during construction activity within the proposed area of works.

2.2 Water quality and soil guidelines

The following design guidelines and management procedures are relevant in determining the appropriate water quality management and mitigation measures to be implemented during the construction and operational phases of the proposal.

2.2.1 Water quality guidelines

The Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) have formulated the National Water Quality Management Strategy (NWQMS) with the objective of achieving sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The NWQMS contains guidelines for setting water quality objectives to sustain current or likely future environmental values for water resources (ANZECC & ARMCANZ, 2000). These guidelines have been used in this study to determine the existing condition of rivers and creeks along the motorway upgrade.

2.2.2 Construction phase guidelines

A number of guidelines are relevant to the management of land degradation and water pollution associated with road construction in NSW. These guidelines have been considered in the development of this technical study. They have been used to identify appropriate management procedures during construction works and physical controls to minimise erosion and to prevent sediment moving off site during the construction phase of development.

- DECCW 2008, Managing Urban Stormwater-Volume 2D Main Road Construction
- Landcom 2004, Managing Urban Stormwater- Soils and Construction, Volume 1, 4th Edition (referred to as the Blue Book)
- Roads and Traffic Authority 1999, Code of Practice for Water Management - Road Development and Management
- Roads and Traffic Authority 2001, Stockpile Site Management Procedures
- Roads and Traffic Authority 2003b, Road Design Guideline: Section 8 Erosion and Sediment.

- Roads and Traffic Authority 2003c, Guideline for Construction Water Quality Monitoring.
- Roads and Traffic Authority 2009a, Erosion and Sediment Management Procedure.
- Roads and Maritime Services 2011a, Technical Guideline: Temporary Stormwater Drainage for Road Construction.
- Roads and Maritime Services 2011b, Technical Guideline – Environmental Management of Construction Site Dewatering.
- Roads and Maritime Services 2012, Environmental Direction: Management of Tannins from Vegetation Mulch.

2.2.3 *Operational phase*

The following guidelines have been considered in the development of this technical study. They are concerned with how road development relates to land degradation and water pollution management:

- Austroads 2001, Road Runoff and Drainage: Environmental Impacts and Management Options, Austroads AP-R180
- Austroads 2003, Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure, Austroads AP-R232
- Austroads 2010, Guide to Road Design, Part 5: Drainage Design
- DECC 2008, Managing Urban Stormwater, Soils and Construction, Volume 2, Main Road Construction
- Roads and Traffic Authority 1997, Water Policy
- Roads and Traffic Authority 1999, Code of Practice for Water Management - Road Development and Management
- Roads and Traffic Authority 2003a, Procedures for Selecting Treatment Strategies to Control Road Runoff
- Sydney Catchment Authority 2011, Neutral or Beneficial Effect on Water Quality Assessment Guideline.

These documents provide guidance on water management and conservation practices related to the design, operation and maintenance of the roads and traffic systems in order to protect waterways and water quality where practicable and feasible. In addition, they provide guidance on designing permanent water quality treatment in a consistent and practicable manner.

The design for the proposed upgrade would address the sensitivity of receiving waters and local environment within the catchments of the proposal.

3. LANDFORM, GEOLOGY AND SOILS

3.1 Overview

The proposal study area has an elevation of between 320 metres and 400 metres and has been modified by the construction of the existing motorway.

The proposal is located within the Wollongong Local Government Area (LGA), the Hawkesbury-Nepean catchment, and the Sydney Basin Bioregion. The topography of the study area varies from very gently to gently inclined at the Picton Road off ramp then becomes moderately inclined along the western side of the Princes Motorway, with steep and cliffed sections along the north-west edge of the study area (Hazelton et al. 1990).

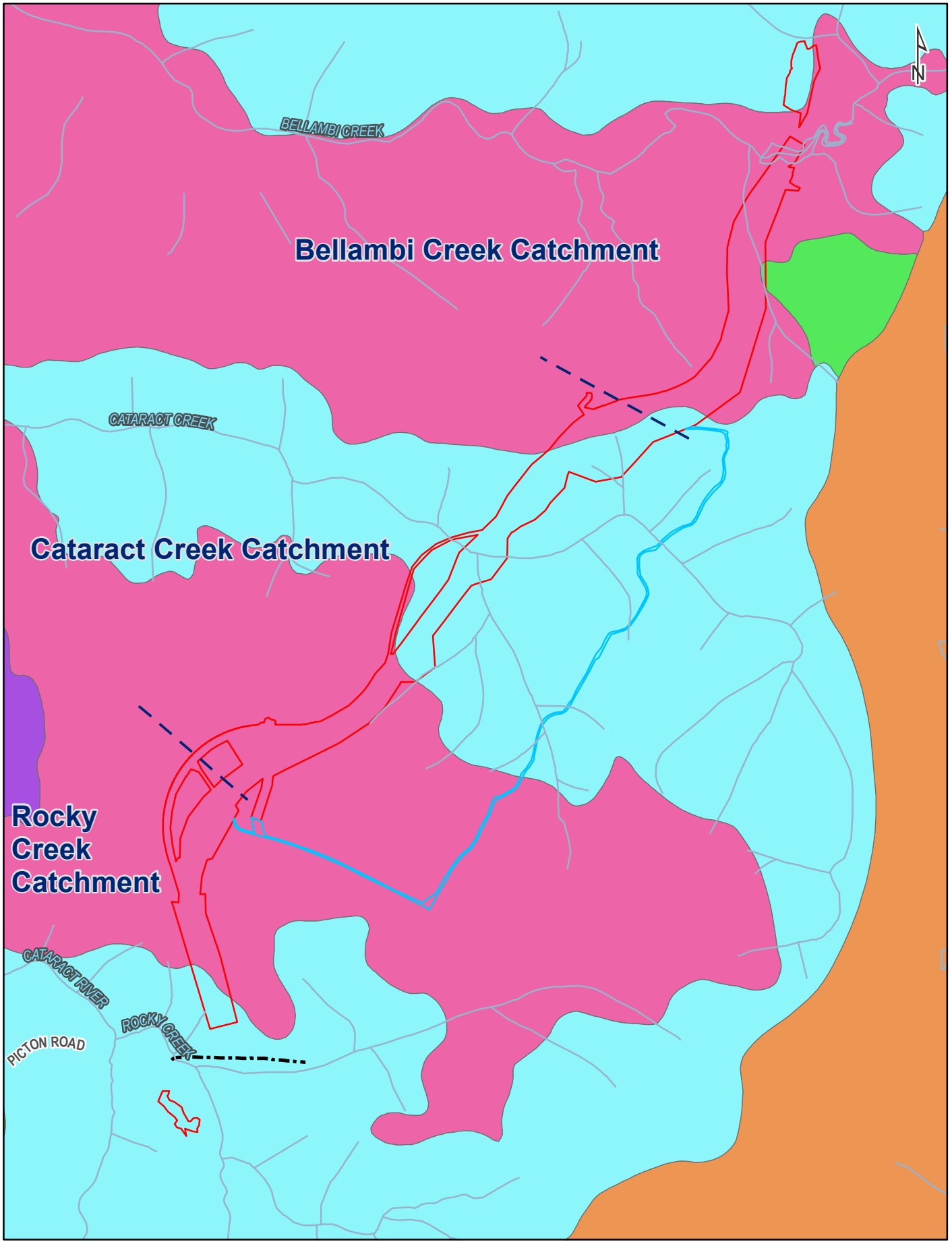
The proposal occurs in a constrained road corridor that traverses steep hilly country with extensive side slopes. The road passes through relatively uncleared forested vegetation. The existing road has a steep road grade of about 10 per cent and embankments about 1:1, due to the natural terrain of the alignment.

3.2 Soil, sediment and erosion

Large-scale mapping of Soil Landscape Series Sheet 9029-9129 (Hazelton et al. 1990) indicate the influence of three Soil Landscape Groups in the study area. They are:

- Lucas Heights (Lh) – At the Bellambi Creek crossing area soils are potentially in a transitional zone between Lh and Hawkesbury soil landscape. Soils of the Mittagong Formation occur as a shallow layer over Hawkesbury sandstone and consist of interbedded shale, laminate and fine to medium-grained quartz sandstone. Moderately deep hardsetting Yellow Podzolic Soils and Yellow Soloths occur on ridges and plateau surfaces, Lateritic Podzolic Soils on crests Yellow earths on shoulders of plateaux and ridges and earthy sands on valley flats.
- Warragamba (Wb) – Further to the north, on the lower slopes drained by Cataract Creek, the soils are derived from Narrabeen Sandstone of the Warragamba Group, consisting of fine-grained lithic sandstone occasionally interbedded with thin shale lenses. Shallow to deep Lithosols occur on crests, Brown Earths and Red Podzolic soils on upper slopes and Yellow Podzolic soils on lower slopes.
- Hawkesbury (Ha) – On the upper slopes and ridge lines, the Hawkesbury Sandstone Group is apparent, with broad sandstone outcrops and small cliffs. Soils are derived from medium- to coarse – grained quartz sandstone with minor shale and laminate lenses. Shallow discontinuous Lithosols/Siliceous sands occur in association with rock outcrops, while Earthy Sands, Yellow Earths and locally deep sands occur over the sandstone.

Soil Landscape Groups are shown in Figure 3-1.



M1 Princes Motorway Improvements - Picton Road to Bulli Tops (Stage 1)

Soils map **Fig. 3-1**

Source: Imagery from RMS

The proposal would require ground engaging works encountering the Warragamba and Hawkesbury soil landscapes The Lucas Heights soil landscape may be briefly encountered as in the north east portion of the alignment.

No salinity risk has been identified with these soil landscapes

The study area is identified as highly erodible according to the soil landscape mapping (Hazelton, 1990). A number of key erosion and sedimentation assessments have been reviewed. These included a soils, slope and rainfall assessment to determine the likely impact of soil erodibility, steep slopes and rainfall erosivity on the local environment. This information was used to identify site constraints that would potentially interact negatively with the construction zone.

Table 3-1 Characteristics of soils within the study area

Soil Unit	Characteristics			
	Occurrence	Erosion Hazard	Water Permeability	Fertility/ Nutrient Status
Lucas Heights (lh)	Residual Landscape Rounded narrow crests with moderate inclined slopes Mittagong formation Chainages 12,880 to 12,960	High	High	Low fertility
Warragamba (wb)	Colluvial Landscape Steep slopes produce an erosional hazard for non concentrated flows Chainages 9,740 to 9,840 11,160 to 12,460	Extreme	High	Strongly acidic and low fertility
Hawkesbury (ha)	Colluvial Landscape Rolling to very steep hills Hawkesbury Sandstone Formation Chainages 9,840 to 11,160 12,460 to 13,300	High	Seasonal waterlogging and impermeable soil	Strongly acidic and low fertility

Source: Soil conservation Services of NSW, Soil Landscapes of the Wollongong – Port Hacking 1:100,000 Sheet (C.L. Hazelton, 1990)

3.3 Contaminated land

Land contamination is most often the result of past land uses. It can arise from activities that took place on or adjacent to a site and result from improper chemical handling or disposal practices, or accidental spillages or leakages of chemicals during transport or storage. Activities not directly related to the site may also cause contamination; for example, from diffuse sources such as polluted groundwater migrating under a site or dust settling out from industrial emissions.

The natural soil formations have been generally overlaid with fill materials associated with the construction of the original freeway circa 1960-1970. The imported fill materials along the old road are likely to have been sourced for their engineering properties such as high compaction and load strength as required by geotechnical requirements for road construction. Contamination of these areas is unlikely, however the presence of slag material in the road profile may present as a source of heavy metals associated with early uses of slag materials in road making materials.

All construction activities prior to 1986 have the potential for asbestos containing materials to be present. The manufacture and use of asbestos products was banned nationally from 31 December 2003. Construction activities associated with the proposal could potentially encounter telecommunications pits, conduits and water mains piping manufactured with asbestos containing materials.

Road corridors can be subject to uncontrolled filling events from unknown sources, particularly in urban areas. Uncontrolled fill material being encountered within the road corridor during construction is a low risk scenario and is likely to be managed through an unexpected finds protocol developed for this purpose. Fill material from unknown sources may have contaminant concentrations that exceed the allowable criteria for the currently zoned or intended land use for the site, and may cause groundwater contamination.

There is a low risk of the proposal encountering contaminated land during construction activities along the existing corridor and proposed ancillary sites. The contamination (if encountered) is likely to be associated with the former road alignment and sealed with existing pavement.

A search of the EPA contaminated land record of notices returned eleven records for the Wollongong local government area. None are located near the proposal study area or within the proposed ancillary sites.

No potentially contaminating land uses where identified within the corridor catchments and adjoining areas.

3.4 Acid sulfate soils

The landform in the study area is identified by the soil maps as no risk of acid sulfate soil conditions occurring.

4. HYDROLOGY AND WATER QUALITY

4.1 Surface water

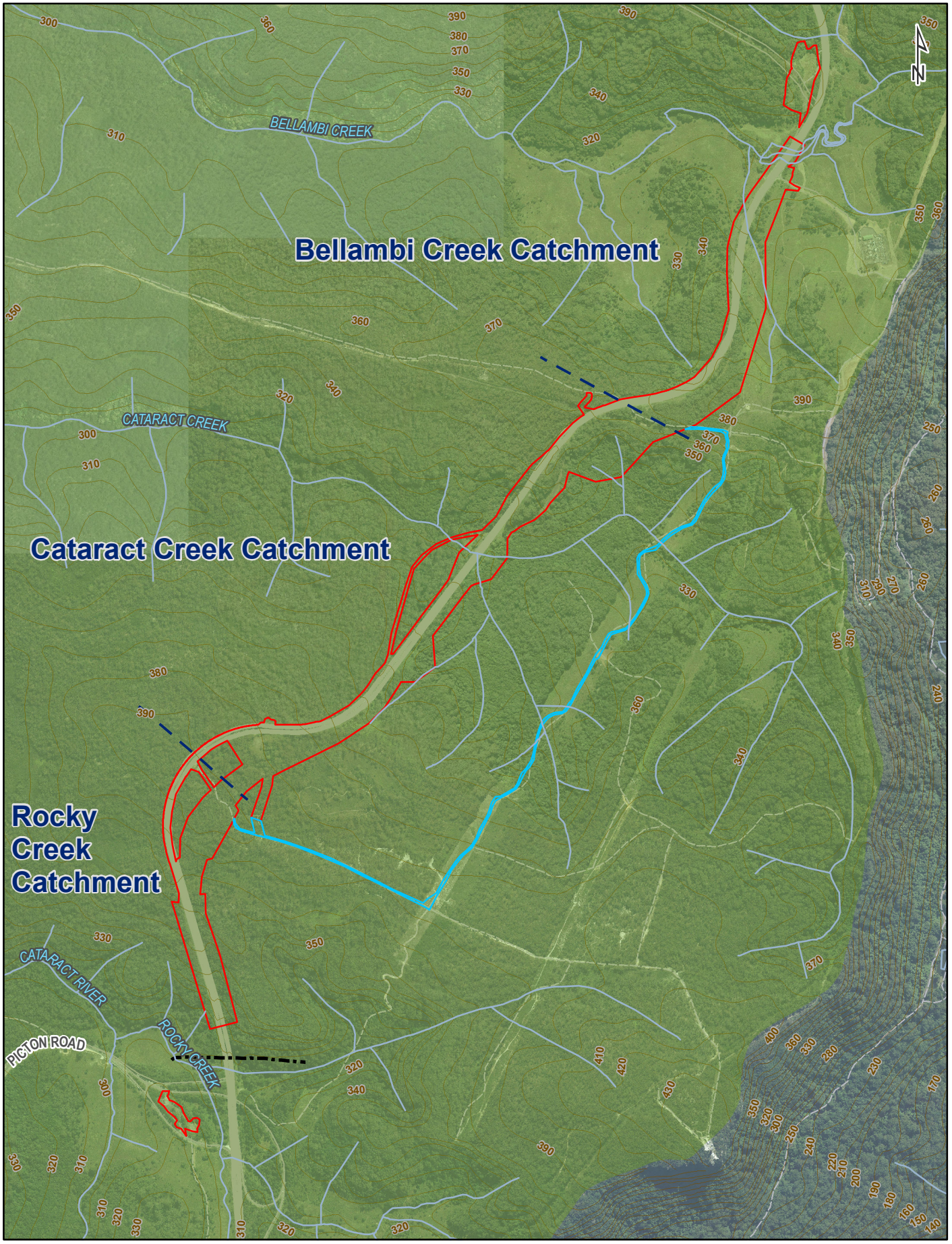
The proposal is located within the Upper Nepean River sub catchment. The proposed works falls within the WaterNSW's Metropolitan Special Area. Access is generally restricted in view of the WaterNSW's objective of managing risks to water quality.

Surface water across the majority of the proposal is inferred to flow west in accordance with the general topography of the catchments associated with Bellambi Creek, Cataract Creek and Rocky Creek. Surface water features that cross the study area and their flow direction are listed in Table 4-1 and mapped in Figure 4-1, where each catchment that feeds surface water crossing the study area is identified.

Table 4-1 Natural surface water catchment and drainage features

Feature	Chainage (m)	Flow direction
Bellambi Creek – Catchment only (C2)	12,500 – 13,300	West
Bellambi Creek (Charlesworth Dam) – Crossing (C2)	13,300	West
Minor Unnamed Creek – Crossing (C2)	13,000	North West
Cataract Creek – Catchment only (Catchment C3)	10,400 – 12,500	East
Cataract Creek – Crossing (C3)	11,600	West
Rocky Creek – Catchment only (Catchment C4)	9,800 – 10,400	South

The Cataract Creek catchment is primarily forested, however there are some areas that have been cleared for roads, high voltage power lines and colliery ventilation shafts. These activities are limited in extent and unlikely to have significant impacts on water quality.



- Catchment Dividers
- Streams/drainage lines
- Project extents
- Sydney Catchment Authority Special Area
- Contours (10m)
- Construction footprint
- Construction light vehicle access track

M1 Princes Motorway Improvements - Picton Road to Bulli Tops (Stage 1)

Proposal catchments **Fig. 4-1**

Source: Imagery from RMS

0 100 200 m

4.1.1 Cataract Creek

Cataract Creek runs west for 4.6 kilometres to meet Cataract River at Cataract Dam. Cataract Creek runs under the proposal corridor at Ch 11,600 as an intermittent creek in a westerly direction. The Cataract Creek catchment is entirely within the WaterNSW's Special Area with Cataract Dam being located downstream approximately 2.5 kilometres west of the study area.

4.1.2 Bellambi Creek

Bellambi Creek runs west for 5.5 kilometres to meet Cataract River at Cataract Dam. Bellambi Creek runs under the proposal corridor at Ch 13,300 as an intermittent creek in a westerly direction. Standing water occurs at this location due an abandon downstream dam feature referred to as Charlesworth Dam. Bellambi Creek catchment is entirely within the Sydney Catchment Authorities Special Area with Cataract Dam being located downstream approximately 3.8 kilometres west of the study area.

An unnamed minor tributary of Bellambi Creek crosses the alignment at Ch 13,000 in a north west direction. This tributary joins Bellambi Creek just below the Charlesworth Dam feature.

4.1.3 Water quality

Water quality is monitored at nine locations in the Metropolitan Special Area. Station E609 is located in the Cataract Catchment on Cataract River about one kilometre upstream from Lake Cataract, and is downstream of the proposal. Existing water quality for this station is summarised in the following table.

Table 4-2 Station E609 - physico-chemical characteristics

Parameter	Minimum	Median	Maximum
Alkalinity (mg $CaCO_3$/L)	7	10	34
Calcium Filtered (mg/L)	3	4	6
Chloride (mg/L)	14	23	27
Conductivity (mS/cm)	0.108	0.119	0.140
Dissolved Oxygen Carbon (mg/L)	2.0	3.0	4.1
Dissolved Oxygen (%Sat)	52.3	92.9	97.1
Dissolved Oxygen (mg/L)	4.9	9.4	11.7
pH	5.80	6.50	7.00
Sodium Filtered (mg/L)	13	14	20
Suspended Solids (mg/L)	1	2	5
Temperature (°C)	6.6	11.1	18.2
Total Hardness (mg $CaCO_3$/L)	16	22	27
Total Organic Carbon (mg/L)	1.8	3.2	4.7
Turbidity (NTU)	0.50	2.90	7.20
Total Nitrogen (mg/L)	0.03	0.09	0.49
Total Phosphorus (mg/L)	0.01	0.015	0.023

Source: Sydney Catchment Authority Annual water Quality Monitoring Report 2012-13

Water quality in Lake Cataract is good. Median values for most physico-chemical indicators of water quality are well within the recommended ANZECC guidelines.

Based on a single monitoring event conducted by Geoterra in May 2016, Bellambi Creek exceeded the ANZECC 2000 Upland Freshwater Stream and / or 95% Protection Level for aquatic ecosystems criteria for pH, total nitrogen, total phosphorous, copper and zinc.

4.1.4 Rainfall

There are a number of weather recording stations in the general locality. Rainfall records for Cataract Dam (BoM Station 68016) extend back to 1904 and provides a representative indication of rainfall characteristics in the study area. Long term monthly mean rainfall ranges from 55.4 mm (September) to 115.7 mm (February) with highest monthly rainfalls occurring in the late summer months (January to March). For the period 1961-1990, mean monthly rainfall ranges from 48.7 mm (July) to 145.5 mm (March). Months with high rainfall are more varied, occurring in March and April, and also in June and November.

Recorded highest daily rainfalls over the period of the length of record range from 165 mm (December) to 343 mm (October). Highest daily rainfalls over 200 mm occurred in nine months.

4.2 Groundwater

A preliminary search of the NSW Office of Water's 'Online Database' was undertaken to identify groundwater wells (bores) within the vicinity of the proposal. The search indicated that there are no wells registered within a 500 metre radius of the proposal.

A Stream, Swamp and Groundwater Assessment report was prepared by Geoterra Pty Ltd in July 2016. This report identified six upland headwater swamps that meet the definition of a Coastal Upland Swamp Endangered Ecological Community are located in close proximity to the proposed re-alignment works.

Ephemeral perched water tables within the upper 20 metres of the Hawkesbury Sandstone that are hydraulically disconnected from the underlying regional aquifer, can occur following extended rainfall recharge periods.

In rainfall recharge periods, water levels in shallow aquifers respond by rising, whilst in dry periods, levels are lowered through seepage to the local watercourses. During dry periods the salinity in surface drainages normally rises as the basement baseflow seepage proportionally increases.

Measured standing water levels in the Hawkesbury Sandstone range from to 6m to 39m below surface.

Water quality in the Hawkesbury Sandstone generally has low salinity (81 - 420µS/cm) with relatively acidic pH (3.22 - 5.45) and can contain high iron levels up to 12.0mg/L.

The Groundwater Assessment report concludes that the proposal is not anticipated to have any significant effect on local stream flow or water quality.

5. POTENTIAL IMPACTS

5.1 Construction phase

The proposed upgrade, is a mix of lane widening constructed along the existing motorway alignment and construction of new alignment and formation requiring cut and fill embankments and batters. Some ancillary works are required to upgrade existing lane alignments and nearby decommissioned road alignments.

The proposed new alignment works includes cut depth of up to 10.5 meters and cut width of up to 85 between stations 10,100 to 11,000 north of Picton Road and 11,900 to 13,200 south of Bellambi Creek.

The mainline carriageway lane widening pavement would be constructed by diverting traffic from the existing shoulder lanes. The extents of the reduced lane arrangements would be further defined in the final design option.

Construction activities that have the potential to impact on soil and water (surface and perched groundwater) quality include:

- Pavement removal
- Underground service relocation (if required)
- Ancillary site preparation and operation
- Bulk excavation and haulage
- Removal of vegetation on embankments and batter slopes
- Culvert extensions and restoration
- Embankment and batter construction, access and stabilisation
- Generation of building and construction waste
- Importing, handling, stockpiling and transporting material resources
- Plant maintenance
- General waste generation from compounds
- Clearing, grubbing and construction of site access tracks during construction.

5.1.1 Soil, sediment and water quality

During construction, there would be potential for sediment generation and nutrient runoff during rainfall events due to ground disturbance associated with construction activity including excavation and vegetation removal from embankment improvements and cuttings. Sediment mobilisation from soil deposited on the road pavement during works is a further potential impact.

In locations where construction works are conducted within the existing alignment and road formation, the majority of runoff encountered would come from the existing road pavement and drainage network.

At present runoff is generally shed towards the pavement edge where it is delivered from site via the existing road drainage system. The construction of the new alignment and lanes widening would cut across the existing flow path in places. This in turn may potentially direct road runoff onto the construction zone. Where pavement runoff is allowed to mix with dirty construction zone water then this extra volume of water must be included in the design calculations for the proposed control techniques.

New alignment cut and fill locations would receive run off from well vegetated up slope catchments requiring sized upstream diversion and temporary crossings to minimised contact with exposed soil areas requiring cut and fill in the Hawkesbury Sandstone and associated shallow colluvial soils.

A Preliminary Erosion and Sedimentation Assessment (PESA) has been prepared for the proposed works accordance with the *Roads and Maritime Erosion and Sedimentation Risk Assessment Procedure* (RTA, 2004). This procedure considers the proposal works to be high risk due to the following criteria being encountered:

- Soil erodibility and erosion hazard has been mapped as very high for some parts of the proposal.
- Illawarra Escarpment State Conservation Area is located to the east and west of the proposal.
- The entire proposal is within the Sydney Catchment Authority Special Area set aside for providing drinking water for Sydney.

The potential erosion hazard of the catchment being disturbed derived from the Blue Book is classed as a high risk hazard due to high slope percentage and high rainfall erosivity.

The level of soil erosion hazard at a site is an interaction between soil erodibility, rainfall erosivity and slope. An increase in slope can exacerbate the impact of a sites rainfall erosivity on the soils erodibility. The combination of steep slopes and high intensity rainfall could in the absence of appropriate mitigation measures being applied, could lead to a high to extreme risk (Hazelton, 1990) soil loss potential for sections of the proposal.

5.1.1.1 Proposal catchments

Bellambi Creek catchment

An estimated eight hundred meters of the proposal (Ch 12,500 to Ch 13,300) is within the Bellambi Creek Catchment (Figure 2).

Ground engaging works identified within this catchment area are as follows:

- Ch 12,500 to Ch 12,700 – New alignment, cut into Hawkesbury Sandstone for main road formation, benched cut batters and drainage basins
- Ch 12,700 to Ch 13,200 – New alignment, form in fill for main road formation, stabilised embankments and culvert crossing drainage basins
- Ch 13,200 to Ch 13,300 - Remove pavements, cut new embankments, conduct existing bank stabilisation, widen and reconstruct new pavement.

Cataract Creek catchment

Construction activities within the Cataract Creek catchment include excavation and filling as required across new alignment elevations, lane widening and culvert extensions. Lane realignment and reconstruction pose an elevated risk to water quality in downstream waterways through the increased likelihood of movement of sediment from exposed soils. It is understood that a minor diversion of Cataract Creek would be required during construction, so that additional/extended culverts can be constructed.

The exact construction methodology of the diversion would be determined by the construction contractor. It is likely that the existing corrugated culverts (there are two) would be trimmed at the end to be extended, followed by a concrete pit and then some form of drainage structure (to be confirmed). Channelling water flows into one of the culverts, and working on the other, before switching back, may be an option and would be considered by the construction contractor.

An estimated two kilometres (Ch 10,400 to Ch 12,500) of the proposed works is located within the Cataract Creek catchment (Figure2). Ground engaging works identified within this catchment area are as follows:

- Ch 10,400 to Ch 10,800 – New alignment, cut into Hawkesbury Sandstone for main road formation, benched cut batters and drainage basins
- Ch 10,800 to Ch 11,900 – Remove pavements, cut new lane, widen and reconstruct new pavement.
- Ch 11,600 continuous culvert extension (online) stabilising of inlet and outlet
- Ch 11,900 to Ch12,500 – Remove old alignment pavements, new cut batter slopes and embankment stabilisation for new alignment, including diversion drains, batter stabilisation, new pavement and drainage features across the alignment.

Rocky Creek catchment

The proposed works does not engaged Rocky creek directly, however works from Ch 9,700 to Ch 10,400 would drain to tributaries of Rocky Creek. Proposed works in this catchment includes:

- Ch 9,700 to Ch 10,000 - Remove pavements, cut new lane, widen and reconstruct new pavement.
- Ch 10,000 to 10,400 – New formation cut into Hawkesbury Sandstone, including diversion drains, batter stabilisation, new pavement and drainage features.

The potential for impacts on soil and water from the proposal in the catchment areas include the following:

- Changes to the local surface water hydrology (resulting in temporary loss of drainage capacity and temporary redistribution of stormwater flows) as a result of material stockpiles and works within flow paths and at culvert crossings.
- Water quality impacts related to potential pollution of stormwater runoff with sediments, fuels and other hazardous materials from the construction site and equipment.
- Increased sediment loading, including increased turbidity, and an increased potential for the transport of contaminants bound to sediment particles.

- Soil erosion as a result of exposure to wind and water runoff. The removal of topsoil may result in exposure of buried structures, sedimentation and increased turbidity levels in waterways and the local stormwater system (downstream).

5.1.2 Contaminated land

Potential environmental impacts associated with the proposal in relation to contaminated land management include:

- Pollution from improper practices such as poor fill management
- Contaminated or hazardous waste not being correctly disposed of
- Adverse effects on human health (construction personnel and the travelling public)
- Release of contaminants from construction plant and equipment into underlying soils and groundwater
- Movement of contaminated sediments into waterways.

5.1.3 Ancillary sites

The proposed ancillary sites are likely to include activities that have the potential to impact on soil and water. These include:

- Storage of fuels, chemicals, paints and oils
- Vehicle wash-down (release of pollutants such as concrete, fuels and oils)
- Vehicle refuelling (release of fuel and oils)
- Vehicle movements
- Material and stockpile storage (release of potentially contaminated soil and sediment)
- Construction personnel litter and waste generation.

5.2 Operational phase

5.2.1 Soil, sediment and water quality

Impacts on water quality from road operation can be directly influenced by road maintenance activities, vehicle movement and wear. Main risks are associated with mobilisation of unconsolidated materials if disturbed surfaces not stabilised or successfully revegetated following construction.

Sediment and suspended solids from road runoff can cause potential water quality impacts. Physically, sediment interferes with the respiration and feeding of aquatic plants and animals. Chemically, many other potential pollutants such as nutrients, heavy metals and organic substances, are adsorbed to, and travel with, sediments. Heavy metals of concern in road runoff include cadmium, chromium, copper, nickel, lead and zinc. The concentrations of metals found in road runoff, especially from heavily trafficked areas, are commonly far in excess of current ANZECC (2000) guidelines for the protection of fresh and marine waters.

Elevated levels of nutrients such as phosphorous and nitrogen are also found in road runoff and can contribute to the accelerated growth of nuisance aquatic plants and cause a reduction in

the levels of dissolved oxygen. Nutrients are usually associated with the fine suspended sediment in the runoff.

Given the proposal would not increase traffic volumes, no substantial increase in road drainage pollutants would be predicted which is attributable to the proposal.

5.2.1.1 *Assessment of neutral or beneficial effect*

Section 34B of the EP&A Act provides the context for State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011. This SEPP sets out the planning and assessment requirements for all new developments in the Sydney drinking water catchment to demonstrate a neutral or beneficial effect (NorBE) on water quality. For activities under Part 5 of the EP&A Act, the SEPP requires public authorities to consider whether the activity would have a neutral or beneficial effect on water quality.

Accordingly, a NorBE assessment has been undertaken for the proposal and is provided as Appendix A to this report. The assessment has been undertaken in accordance with the WaterNSW's (formerly SCA) *Neutral or Beneficial Effect on Water Quality Assessment Guideline* with the objective of demonstrating that, with appropriate treatment, the proposal would not affect receiving water quality.

The NORBE assessment requires consideration of nutrient impacts to groundwater to be modelled if the proposal requires an effluent management area (EMA). Impacts to groundwater are not considered significant in this assessment as an EMA is not required for the proposal and due to selection of treatment measures applied in this model. The treatment models selected rely on low permeable sub-bases associated with engineered fill materials that include in-built drainage features to prevent water ingress in the construction formation where appropriate.

Vegetated swales are generally used as a primary treatment device at the upper end of the treatment train, however these can be used as the sole treatment element. Vegetation is used to promote uniform flow and also the slowing of water velocity to encourage the settlement of course sediments and also capture significant amount of litter and organic matter in the process.

The WaterNSW guideline categorises development types as 'modules' based on the required development assessment process and the level of potential risk from the development. Table A1 in the guideline provides a list of development classes and descriptions and identifies the associated module. The proposal could be regarded as either 'Earthworks >2,500 m^2' (Class U_l) or 'Other development' (Class Z). In both cases, it is a Module 5 development.

Table A2 of the guideline sets out the documentation requirements for the NorBE assessment. For a Module 5 development where the impervious area is >2,500 m^2, the documentation must be based on MUSIC[1] stormwater modelling.

The full results of the MUSIC modelling are provided in Appendix A and a summary is provided in Table 9. Modelling has considered both pre and post-development conditions, the latter identifying the required treatments to achieve a neutral or beneficial effect on water quality.

The modelling indicates that a neutral or beneficial effect could be achieved, with improvements to water quality ranging from 2-100 per cent, through the provision of vegetated channels and

[1] 'Model for Urban Stormwater Improvement Conceptualisation', a software tool to facilitate planning and concept design of urban stormwater management systems.

basins. The latter could initially serve to manage water quality during construction and subsequently during operation.

Table 5-1 MUSIC summary for percentage of water quality improvements post treatment

Parameter	Road catchment and percentage reduction(+)/increase(-)		
	Bellambi Creek catchment - C2	Cataract Creek catchment - C3	Rocky Creek Catchment - C4
Flow (ML/yr)	-15%	-2%	-33%
Peak flow (m^3/s)	34%	17%	42%
Total Suspended Solids (kg/yr)	60%	29%	76%
Total Phosphorus (kg/yr)	40%	25%	56%
Total Nitrogen (kg/yr)	2%	6%	5%
Gross Pollutants (kg/yr)	100%	100%	100%

5.2.2 *Contaminated land*

There is potential for accidental spillage of hazardous materials during the operational stage of the proposal. Without satisfactory means of containment, the spillage of contaminants could pass rapidly into the drainage system and impact downstream ecosystems. Spills of chemicals or petrol in accidents can impact the ecology of waterways and terrestrial ecosystems. The likelihood of a potential spill of hazardous substances would be minimised as a result of the motorway upgrade and improved road design standards..

5.2.2.1 *Groundwater*

During operation, the proposal has a low potential to result in changes in local recharge of groundwater. This is predominantly due to the natural environment setting of the study area and because the change in impervious area as a result of the proposal would be minor in comparison to the large area available for recharge in the catchment. Additional discussion of groundwater impacts associated with the proposed works can be reference in the M1 Princes Motorway Stream, Swamp and Groundwater Assessment Bellambi, NSW (Geoterra, 2016)

6. SAFEGUARDS AND MANAGEMENT MEASURES

This section identifies safeguards and management measures to reduce the potential soil and water impacts associated with the proposal. These safeguards and management measures are separated into those required to be addressed in the detailed design phase, and the construction and the operational phases.

6.1 Detailed design phase

Detailed design will seek to minimise soil and water quality impacts by incorporating the following design principles:

- The drainage design should simulate the existing hydrologic flow regime in and around the proposal (volume and velocity)
- Roads and Maritime will develop a ESCP in parallel during the concept/detailed design phase in consultation with WaterNSW.
- Vegetated drainage lines should be used in preference to engineered structures wherever practicable
- Operational water quality control measures will be developed to ensure that a neutral or beneficial effect on water quality is achieved
- Water treatment structures will be further considered during detailed design to minimise potential water quality impacts and incorporated in the pavement drainage
- Appropriate energy dissipation and scour prevention measures will be incorporated downstream of culverts and other drainage structures to minimise soil erosion. Site restoration and landscaping design will incorporate natural landscape features including existing vegetation and topography. Consideration would be given to using native plant species endemic to the area for restoration
- Staged construction reduces the area of exposed soil and would retain drainage controls of clean water on existing pavements and stabilised areas.
- Sediment basins would provide treatment to construction runoff where the calculated total annual soil loss from the disturbed area is more than 150 cubic metres. This is in line with the requirement of the Blue Book (Landcom 2004 and DECC 2008).

6.2 Construction phase

The potential impacts during construction detailed in Section 5.1 would be managed through the safeguards and management measures outlined below.

6.2.1 Management plans

A Soil and Water Management Plan (SWMP) would be developed to manage disturbed, excavated and imported materials and prevent erosion and sediment impact during construction. The project review of environmental factors (REF) report would also be referenced when developing the SWMP. It would be applicable to all activities during the construction phase of the proposal. Its key objective is to ensure that impacts to soils and water quality are minimised.

The SWMP would be prepared and implemented in consultation with WaterNSW as part of the Construction Environmental Management Plan (CEMP) prepared for the proposal.

The SWMP would address the Roads and Maritime's Code of Practice for Water Management (1999) and incorporate the following specifications:

- RMS QA Specification G36 – Environmental Protection (Management System)
- RMS QA Specification G38 – Soil and Water Management (Soil and Water Management Plan)
- RMS QA Specification G40 – Clearing and Grubbing.

The SWMP would also address the principles and practises detailed in *Managing Urban Stormwater: Soils and Construction (*Landcom, 2004) and *Managing Urban Stormwater-Volume 2D Main Road Construction* (DECC, 2008).

The SWMP will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction.

The SWMP will be reviewed by a soil conservationist on the Roads and Maritime list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. Due to the sensitive and high risk erosion of the proposal, the implementation of enhanced controls should be independently audited at least fortnightly through the construction period. The auditor should also be a soil conservationist or an accredited erosion control specialist.

The SWMP should contain as a minimum the following elements:

- Consideration of appropriate erosion and sediment controls
- Consideration of appropriate erosion and sediment controls at ancillary sites with particular consideration of sediment basins at sites where material processing or stockpiling would occur
- Measures to develop, maintain, monitor and improve progressive, site specific Erosion and Sedimentation Control Plans (ESCPs)
- Procedure to be developed for early warnings of imminent and severe weather approaching site and response required by site for preparation of the forecasted event
- Identification of site conditions or construction activities that could potentially result in erosion and associated sediment runoff
- Methods to minimise potential adverse impacts of construction activities on the water quality within surrounding waterways
- Details of specific measures to protect sensitive areas including drinking water catchments and sensitive vegetation such as (EECs)
- Details of measures to minimise any adverse impacts of sedimentation on the surrounding environment
- Details of measures to minimise soil erosion caused by all construction works including clearing, grubbing and earthworks

- Details of measures to provide spill management and basin discharge procedures
- Details of measures to make site personnel aware of the requirements of the SWMP by providing information within induction, toolbox and training sessions
- Details of the roles and responsibilities of personnel responsible for implementing the SWMP
- Details of measures for the inspection and maintenance of construction phase water treatment devices and structures.

6.2.2 *General erosion and sediment controls*

Erosion and sediment controls during the construction phase are to be implemented and maintained to:

- Prevent sediment moving off-site and sediment laden water entering any water course, drainage lines, or drain inlets
- Reduce water velocity and capture sediment on site
- Minimise the amount of material transported from site to surrounding pavement surfaces
- Minimise the extent and duration of disturbance.

The following general measures should be implemented to control soil erosion and sedimentation as a result of construction activities

- Erosion and sedimentation controls are to be checked and maintained on a regular basis (including clearing of sediment from behind barriers) and records kept and provided on request
- Erosion and sediment control measures are not to be removed until the works are complete and areas are stabilised
    - Erosion control measures including material covers, mulch spreading, approved soil binders etc. should be utilised where possible
    - Sediment control measures including, vegetative windrows, sediment fencing, soil berms, rock checks etc. should be constructed in accordance with the approved guidelines.
- Work areas are to be stabilised progressively during the works
- A progressive erosion and sediment control plan is to be prepared for the works
- The maintenance of established stockpile sites during is to be in accordance with the Roads and Maritime Services *Stockpile Site Management Guideline (EMS-TG-10).*ESCPs should be developed progressively through the constructing phase by a registered soil conservationist or Certified Professional in Erosion and Sediment Control (CPESC). ESCP's should be in accordance with the requirements of Managing Urban Stormwater: Soils and Construction (Landcom, 2004) and Managing Urban Stormwater-Volume 2D Main Road Construction (DECC, 2008)

- A registered soil conservationist or Certified Professional in Erosion and Sediment Control (CPESC) should periodically inspect the construction site to ensure compliance with the SWMP and site specific ESCP's.

Due to the proposed operational life of the required erosion and sediment controls, additional maintenance effort is likely to be required for long-term controls. For example:

- Erosion and sediment control measures should be maintained in a functioning condition until individual areas have been revegetated
- Structures for diverting and conveying runoff should be inspected after significant storms so that sediment can be removed and damaged works promptly repaired or replaced
- Inflow points and outflow structures (e.g. riser pipes and spillways) to sediment basins should be inspected after major storms and repaired as necessary.

6.2.3 Contaminated land

To comply with the CLM Act and relevant EPA guidelines in relation to disturbance or treatment of potentially contaminated land, a Contaminated Land Management Plan must be prepared as part of the CEMP for any areas of the construction site and other areas affected by the contractor's work which are identified as contaminated land or any land contamination caused by the proposal. The Contaminated Land Management Plan should details the procedures to:

- Identify potentially contaminated land by monitoring for:
  - Discolouration or staining of soil.
  - Bare soil patches both on-site, and off-site adjacent to site boundary
  - Visible signs of plant stress
  - Presence of drums, wastes and fill material
  - Odours.
- Protect the environment by implementing control measures to divert surface runoff away from the contaminated land
- Capture and manage any surface runoff contaminated by exposure to the contaminated land
- Investigate suspected contamination to determine the concentration and type of contaminants and the extent of contamination
- Assess the requirement to notify relevant Authorities, including the EPA
- Manage the remediation and subsequent validation of the contaminated land, including any certification required.

The Roads and Maritime *Guideline for the Management of Contamination (2013)* is to be consulted to assist with development of measures to prevent, identify and manage contamination affecting Roads and Maritime assets within the proposed works. This guideline deals with contaminated soils, sediments, surface water and groundwater in land-based, estuarine and marine environments (described generically in this document as 'contaminated land') – both during the planning and approval of new developments and for the operation and

maintenance of existing Roads and Maritime assets. It outlines best practice principles and the contamination management processes to be followed. This Guideline replaces the Roads and Traffic Authority (RTA) Contaminated Land Management Guideline (2005).

Excavated material that is not suitable for on-site reuse or recycling, such as contaminated material should be transported to a site that may legally accept that material for reuse or disposal. Soils leaving the site should be waste classified so that correct resource recovery and or off-site disposal occur.

If previously unidentified contamination (excluding asbestos) is discovered during construction, work in the affected area must cease immediately, and an investigation must be undertaken and report prepared to determine the nature, extent and degree of any contamination. The level of reporting must be appropriate for the identified contamination in accordance with *Guidelines for Consultants Reporting on Contaminated Sites* (OEH, 2011).

If asbestos is identified on site, an Asbestos Management Plan would be developed for the construction of the proposal, in accordance with the *Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia* (Western Australia Department of Health, 2009).

If previously unidentified asbestos contamination is discovered during construction, work in the affected area must cease immediately, and an investigation must be undertaken and report prepared to determine the nature, extent and degree of the asbestos contamination. The level of reporting must be appropriate for the identified contamination in accordance with the relevant EPA and SafeWorks Guidelines and include the proposed methodology for the remediation of the asbestos contamination. Remediation activities must not take place until receipt of the investigation report by occupational health professional.

Works may only recommence upon receipt of a validation report from a suitably qualified contamination specialist that the remediation activities have been undertaken in accordance with the investigation report and remediation methodology.

Where excavated material cannot be classified as virgin excavated natural material, it would need to be classified and disposed of (when it cannot be re-used) to an appropriately licensed landfill in accordance with the *Waste Classification Guidelines – Part 1: Classifying Waste* (NSW EPA, 2014) and *Part 2: Immobilisation of Waste* (NSW EPA, 2014).

A classification system should be used to control the excavation, stockpiling and disposal of all potentially contaminated materials. Soils should be classified in-situ prior to excavation or when stockpiled during excavation, depending on available time and room for stockpile areas. Any unexpected finds should follow the same procedures.

Bulk project waste (eg. fill) sent to a site not owned by Roads and Maritime (excluding Office and Environment and Heritage licensed landfills) for land disposal is to have prior formal written approval from the landowner, in accordance with RTA Environmental Direction No. 20 – Legal Off-site disposal of Bulk RTA Project Wastes.

6.2.4 Ancillary sites

Bulk stockpiles of materials or storage of fuels or chemicals should be located greater than 100 metres from any watercourse or mapped EEC. In constrained areas where this criteria cannot be achieved, additional risk assessment and additional mitigation measures may need to be considered and implemented to manage risk to sensitive receivers to an acceptable level.

The maintenance of established stockpile sites during construction is to be in accordance with the Roads and Maritime Services *Stockpile Site Management Guideline* detailed in Section 6.2.2.

Vehicles and machinery should be properly maintained to minimise the risk of fuel/oil leaks.

All fuels, chemicals and hazardous liquids would be stored within an impervious bunded area in accordance with Australian Standards and EPA Guidelines.

6.2.5 General water quality management measures

Measures to be implemented to minimise potential impacts to water quality during the construction phase should include the following:

- There is to be no release of dirty water into drainage lines and/or waterways
- Visual monitoring of local water quality (ie turbidity, hydrocarbon spills/slicks) is to be undertaken on a regular basis to identify any potential spills or deficient erosion and sediment controls
- Water quality control measures are to be used to prevent any materials (eg. concrete, grout, sediment etc) entering drain inlets or waterways
- Measures to control pollutants from stormwater and spills would be investigated and incorporated in the pavement drainage system at locations where it discharges to the receiving drainage lines. Measures aimed at reducing flow rates during rain events and potential scour would also be incorporated in the design of the pavement drainage system.
- Potable water will be used for wash down
- Excess debris from cleaning and washing is removed using hand tools
- Containment material is used to capture / filter water used in wash down. Divert clean water around the site (in accordance with the *Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines* (the Blue Book))
- Pass ‘clean’ water through the site without mixing it with ‘dirty’ sediment-contaminated runoff from the works. This may require temporary solutions, such as temporary flexible pipes to convey water across a working site
- Break up slope lengths and minimise catchment areas within the work area, to reduce runoff volume and velocities to manageable levels.

Where possible, permanent erosion control measures should be integrated with temporary measures during the construction phase. For example:

- Catch drains located above a cut batter to minimise long-term flows over the batter should be installed before earthworks commence, to divert runoff around the earthworks area
- Down drains on a fill batter designed to convey road runoff should be installed
- Erosion control measures will be implemented immediately after completion of the earthworks, to convey the runoff from the pavement area down the batter while the batter is being stabilised and prevent scouring

- Energy dissipaters should be installed on pipe and culvert outlets before the drainage system or culvert becomes operational.

All water released from construction impacted areas is to achieve the water quality criteria detailed in Table 6-1, (or as detailed in an Environment Protection Licence) prior to discharge. Visual monitoring of local water quality is to be undertaken on a monthly basis and post rainfall to identify changes in water quality (ie. turbidity, hydrocarbon spills / slicks) which may be a result of construction activities. Where changes are identified as a result of construction activities, controls should be inspected and rectified where required (e.g. deficient erosion and sediment controls) and the issue investigated in accordance with the Roads and Maritime's *Environmental Incident Classification and Reporting Procedure*.

6.2.6 Receiving Waters

All drainage from the project site drains into Cataract Dam via Rocky Creek, Cataract Creek and Bellambi Creek. This proposal is development of an existing and new road alignment, however, this proposed project footprint is considered to be a sensitive receiving environment and catchment.

Safeguards and management measures to protect water quality during construction include:

- If an incident (eg spill) occurs, the Roads and Maritime *Environmental Incident Classification and Management Procedure* would be followed and the Roads and Maritime Contract Manager notified as soon as practicable
- Roads and Maritime would immediately advise the WaterNSW of any spills during the construction works on the WaterNSW incident number 1800 061 069.Visual monitoring of the water quality of the creek lines downstream of the subject site would be undertaken on a regular basis to identify any potential spills or increased sediment loads
- Spill kits, including hydrocarbon absorbent booms would be kept at the works compound in clearly marked and accessible locations
- The refuelling of plant and equipment would occur in a designated impervious. Bunded area located as far as possible from drainage lines or waterways
- Scour protection measures developed in the detailed design should be scheduled to be installed as early as practical during the construction.

Under the *Protection of the Environment Operations Act 1997*, there is a legal responsibility to ensure that runoff leaving a construction site, including water being discharged from sediment basins after storm events, has an acceptable water quality. The Managing urban stormwater: soils and construction, Volume 1 (Landcom, 2004) and Managing Urban stormwater Soils and Construction Volume 2D Main road construction (DECC, 2008) nominates water quality criteria for construction runoff. These criteria are considered suitable release criteria due to:

- The relatively short-term construction period (estimated at 24 months maximum) so long-term impacts are unlikely
- The application of enhanced erosion controls (refer to Section 6.24) significantly reduces the potential for sediment generation

- The creeks would be relatively resilient to the potential impacts on water quality caused by construction, particularly as they are well vegetated which would provide a buffer to runoff from the surrounding area.

The water quality criteria in Table 6-1 should be adopted for any site dewatering required through the construction phase. On projects such as this, the parameters and limits to be monitored in the management of sediment basins correspond to the Water Quality Parameters listed in Table 6. These parameters are required to be achieved usually within 5 days (or less if required by constrained site requirements) of a rainfall event.

Table 6-1 Water quality parameters (Source Blue Book Vol 1 and Vol 2 Appendix B

Water Quality Parameter	Criterion
Total Suspended Solids (TSS)	<50 mg/L
pH	6.5 to 8.5
Oil & grease	<10 mg/L

6.2.7 Groundwater

Groundwater encountered during the construction of the proposal would be managed and disposed of in accordance with NSW EPA requirements, including the *Waste Classification Guidelines* (NSW EPA, 2014).

Requirements for the management and disposal of groundwater waste should be included in the SWMP.

Drainage systems and water management measures will be designed to reduce the risk of pollution of stream/aquifers and any reduction in base flows.

6.2.8 Constrained Site Erosion and Sediment Control

Due to the proposed construction period and sensitive catchment, a priority system for repairs and maintenance following large storms should be developed. This should focus on initially restoring controls in areas with high erosion risk which may impact immediately on water bodies, followed by restoration of controls in other areas. Constrained sites may need to consider the following in further detailed during detailed design and construction staging to allow effective erosion and sediment control in narrow road corridors and in areas of high-conservation-value vegetation. These constraints can impact on the ability to install conventional sediment basins designed for a five-day management period. In these circumstances, options may include:

- Installing smaller basin(s) designed for a reduced retention and management period. This would require more intense on-site management or alternate approaches such as pumping water to a ‘turkeys nest’ dam for treatment prior to either reuse or discharge
- Greater investment in erosion control. This particularly applies where sediment basins may not be installed or suitable off-site sediment control – in some cases, land for

sediment control may need to found downstream of the site and appropriate arrangements made with the landowner.

- Use of non-standard sediment control techniques may be required where enhanced erosion control cannot be implemented and insufficient space is available for standard sediment controls such as basins.

6.3 Operational phase

The potential impacts during operation detailed in Section 5.2 would be managed through the safeguards and management measures outlined below.

An operational environmental management plan should be prepared to include incident response plans that would address any changes or issues attributable to the upgrade works and which adequately incorporate the latest environmental procedures and technologies for dealing with accidental contaminant spills. Maintenance plans and schedules should be reviewed and updated at regular intervals.

6.3.1 General water quality management measures

Any spill control basins included in the proposal should be inspected and maintained regularly.

Any water quality control systems included in the proposal should be inspected and maintained regularly.

The MUSIC assessment developed to support the NorBE assessment to achieve the operational water quality objectives is based on the following treatment train concepts for each catchment and is to be included in the design phase and implemented in the construction and operational phase. It should be noted that the proposed water quality management measures are based on the current design and would be refined and finalised during detailed design. Typical proposed treatment measures can include water quality basins, swales, vegetated channels, bio filtration swales. Methods should be considered and determined in detailed design to ensure they can be feasibly and practicably implemented and safely maintained.

6.3.1.1 Catchment 1

Not applicable to these proposed works

6.3.1.2 Bellambi Creek catchment

1. Three new basins required to match or improve the existing conditions. Each basin to have a surface area of 200 square metres and extended detention depth of one metre.
2. New vegetated channels with a total length of 300 metres required as additional treatment train.
3. Option exists for the three construction basins to be retained and utilised during the operational phase of the project.

6.3.1.3 Cataract Creek catchment

1. One new basin required to match or improve the existing conditions. Basin to have a minimum surface area of 200 square metres and extended detention depth of one metre.

2. Option exists for the construction basin to be retained and utilised during the operational phase of the project.

6.3.1.4 Rocky Creek catchment

1. Two new basins required to match or improve the existing conditions. Each basin to have a minimum surface area of 200 square metres and extended detention depth of one metre.
2. New vegetated channels of 100 metres length required as an additional treatment train.
3. Option exists for the construction basins to be retained and utilised during the operational phase of the project.

7. REFERENCES

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APPENDIX A: NORBE ASSESSMENT

NorBE Assessment – will there be a neutral or beneficial effect on water quality (Assessment must consider surface and groundwater and must consider construction and operational stages)	
Project Name: M1 Princes Motorway Improvements, Picton Road to Bulli Tops (Stage 1)	
Name of catchment/sub catchment: Sydney Drinking Water Catchment – the proposed highway upgrade is located within the Cataract River catchment, a sub-catchment of Sydney's drinking water supply hydrologic catchment that flows to Cataract Dam	
Project Activities: The proposed upgrade involves the following construction activities: • Construction near Bellambi Creek, Cataract Creek, such as new pavement and drainage. • General earthworks, including stripping of topsoil and other construction related materials, excavation or raising. • Construction of drainage devices on new alignment. • Stockpiling of decommissioned road pavement, topsoil and vegetation. • Transportation of cut and/or fill materials. • Movement of heavy vehicles across exposed earth. • Removal of established vegetation. • Construction in steep areas. • Construction in areas upstream of sensitive receiving environments. • Construction in highly erodible areas, if present. During the operational phase of the project, the roads are sealed and the embankments are landscaped. It is assumed that there would be no exposed topsoil along the highway. Hence, potential water quality risks would be due to pollutants from atmospheric deposition, vehicles and motorists as well as maintenance activities. Impacts to groundwater quality are not considered to be significant as the MUSIC model water quality features applied do not rely on soil treatment in the water quality improvement process and are built on impervious barriers preventing groundwater ingress.	
1. Are there any identifiable potential impacts on water quality? What pollutants are likely? Major potential pollutants are sediments (fine & coarse), nitrogen, phosphorus, pathogens and hazardous chemicals and contaminants such as oil/fuel. During construction and/or post	Construction Impacts - The primary potential impacts to surface water quality would be during construction activities and if not mitigated could result in: • Increased sediment loads from exposed soil during rainfall events and dust blown off site causing high sediment loads to be washed or deposited into nearby creeks. • Increased sedimentation of downstream watercourses smothering aquatic life and affecting the ecosystems of downstream sensitive waterways, wetlands and floodplains. • Increased levels of nutrients, metals and other pollutants, transported via sediment to downstream water courses. • Chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery directly polluting downstream waterways. • Increased levels of litter from construction activities polluting downstream watercourses.

NorBE Assessment – will there be a neutral or beneficial effect on water quality (Assessment must consider surface and groundwater and must consider construction and operational stages)	
construction?	• Tannin leachate from clearing and mulching.
	Potential construction-related pollutants 1) Sediments (fine and coarse) and suspended solids. 2) Increased levels of nutrients transported via sediment to downstream water courses. 3) Chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery directly polluting downstream waterways Increased levels of litter from construction activities polluting downstream watercourses. 4) Tannin leachate from stockpiling of cleared or mulched vegetation. 5) Acidification of receiving waters from disturbance of acid sulfate soils. 6) General waste and litter.
	Operation Impacts Once the highway upgrade is complete and the new highway becomes operational, the main risk to water quality is surface runoff from impervious surfaces and concentration of runoff by drains and kerbs. This can result in the build-up of contaminants on road surfaces, median areas, rest areas and roadside corridors in dry weather which, during rainfall events, can be transported to surrounding watercourses or infiltrate into the groundwater system. Potential operational-related pollutants 1) Suspended sediment from the paved surface and landscaped batters during the establishment period. 2) Heavy metals attached to particles washed off the paved surface. 3) Oil, grease and other hydrocarbon products. 4) Litter from the road corridor. 5) Nutrients such as nitrogen and phosphorus in road runoff due to natural atmospheric deposition of fine soil particles.
2. For each pollutant list the safeguards needed to prevent or mitigate potential impacts on water quality (*these may be SCA endorsed*	Construction 1) Sediments (fine and coarse), and 2) Suspended solids and increases levels of nutrients, metals and other pollutants, transported via sediment to downstream water courses

NorBE Assessment – will there be a neutral or beneficial effect on water quality (Assessment must consider surface and groundwater and must consider construction and operational stages)	
current recommended practices (CRPs) and/or equally effective other practices)?	Construction would be undertaken in line with a Soil and Water Management Plan (SWMP) that includes Erosion and Sediment Control Plans (ESCP) for all stages of construction. The SWMP would be prepared and implemented in consultation with relevant government departments and councils as part of the Contractor Environmental Management Plan (CEMP). Construction activities would be sequenced and managed to minimise potential water quality degradation due to erosion. Management would include: • Early installation of physical controls, including cross drainage to convey clean water around or through the site. • Minimising the duration of exposed topsoil by retaining topsoil cover, grassed drainage lines and shrub cover on the soil surface for as long as possible Minimising the extent of disturbed areas. • Minimising stockpiling. • Minimising the lengths of slopes through limiting the extent of excavations and the use of diversion drains to reduce water velocity over disturbed areas. • Where possible cleared native vegetation and native mulch would be used to reduce erosion and contain sediment during construction through use of small vegetation filter windrows placed across the contour in drainage lines, below fill batters, below cutting works at the head of cleared minor drainage lined and before the inlet to sediment basins and waterways. • Where possible, constructing working platforms from rock fill so that bare earth is not exposed. • Progressive rehabilitation or sealing of works areas. • Restricting vehicle movements to designated pathways and paving vehicle movement areas that will be exposed for extended periods, such as carparks and main access roads, where feasible. Physical controls would be installed to reduce potential water quality degradation due to erosion and sedimentation during construction. Controls include the use of: • Offsite diversion drains to collect clean runoff from upstream of the construction area and divert it around or through the site without it mixing with construction runoff. • Lining of channels and other concentrated flowpaths. • Sediment fences and filters to intercept and filter small volumes of construction runoff. • Rock check dams that are built across a swale or diversion channel to reduce the velocity of flow in the channel and thus reduce erosion of the channel bed, as well as trapping sediment. • Level spreaders to convert erosive, concentrated flow into sheet flow. • Onsite diversion drains that collect construction runoff and direct it to treatment facilities. • Sediment basins to capture sediment and associated pollutants in construction runoff, along with a permanent supply of gypsum flocculent agent available on site. • Specific measures and procedures for works within waterways such as the use of silt barriers and temporary creek diversions. Details of some of these measures are covered in detail in the RMS document: Technical Guideline - Temporary Stormwater

Drainage for Main Road Construction (RMS, 2011).

3) Chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery directly polluting downstream waterways

An Emergency Spill Plan would be developed and incorporated in the CEMP. This would include measures to avoid spillages of fuels, chemicals, and fluids into any waterways. The storage, handling and use of the materials would be undertaken in accordance with the Occupational Health and Safety Act 2000 and Workcover's Storage and Handling of Dangerous Goods Code of Practice (Workcover, 2005).Procedures would include:

- Bunded storage facilities for chemicals.
- Bunded areas for refuelling and washdown.
- Sediment basins with sufficient storage capacity to capture spills.
- Spill kits.
- Training of staff.

4) Tannin leachate and sediments from stockpiling of earthworks or vegetation

During the construction phase, cut and fill material would generally not be locally stockpiled, but would be removed from the site (source) of excavation and transported directly to the related project construction face for immediate reuse as compacted fill or would be transported to the crushing and screening area where it would be processed and then stockpiled in a centralised facility. Fill or excavated material that cannot be immediately reused would be transported to identified and approved locations within the road corridor to be stockpiled for reuse.

The maintenance of established stockpile sites during construction is to be in accordance with the RTA Stockpile Site Management Procedures (2001), in order to prevent erosion of the stockpile flowing into downstream waterways. Also, mitigation of tannins leaching from mulch stockpiles into waterways should be in line with RMS' Environmental Direction - Management of Tannins from Vegetation Mulch (2012). These, and additional recommendations include:

- Inclusion of stockpile sites within the ESCP.
- Diverting runoff around stockpiles sites where required, as identified in Table 5-1.
- Minimising the number and size of stockpiles.
- Lining the base of stockpiles if they are located over a shallow water table.
- Treating stockpiles at the source by covering with plastic sheets.
- Establishing effective sediment control works to contain any runoff including cut-off drains, vegetation and silt fences to minimise risk of sediments entering waterways.
- Treating with a construction or stockpile-specific sediment basin and monitoring the sediment basin for parameters such as

NorBE Assessment – will there be a neutral or beneficial effect on water quality (Assessment must consider surface and groundwater and must consider construction and operational stages)	
	dissolved oxygen levels and organics to determine suitable discharge to the environment (such basins would be considered once stockpile locations have been finalised). 5) General waste All waste materials on site would be disposed of in accordance with the Waste Classification Guidelines (DECCW, 2009). Designated waste storage areas would be implement on site. All working areas would be maintained, kept free of rubbish and cleaned up at the end of each working day.
	Operation 1) Suspended sediment from the paved surface and landscaped batters during the establishment period. Treatment would be provided to the pavement runoff from the upgraded highway by a treatment train of water quality controls that reduced the annual average load of suspended solids by 80 percent in line with Managing Urban Stormwater: Council Handbook' (NSW EPA, 1997). 2) Heavy metals attached to particles washed off the paved surface. Water quality ponds or specific spill basins would capture heavy metals from spills for removal by maintenance teams 3) Oil, grease and other hydrocarbon products. Treatment would be provided through a treatment train of water quality control that reduced the annual average load of oil and grease so that none is visible, in line with OEH guidelines (EPA, 1998). Water quality ponds or specific spill basins would capture oil and other hydrocarbon products from spills for removal by maintenance teams. 4) Litter from the road corridor. Litter from the road corridor would be capture by trash racks prior to entering water quality ponds and would be periodically removed by maintenance teams. 5) Nutrients such as nitrogen and phosphorus in road runoff due to natural atmospheric deposition of fine soil particles Treatment would be provided to the pavement runoff from the upgraded highway by a treatment train of water quality controls that reduced the annual average load of nitrogen by 45 percent and phosphorus by 45 percent in line with Managing Urban Stormwater: Council Handbook' (EPA, 1997). In general for the operational phase of the project, where traffic loads are sufficient, rainfall runoff and accidental spills would be treated and contained through the provision of a water quality treatment train combining grassed swales (where possible) leading to permanent water quality ponds or spill containment basins.

NorBE Assessment – will there be a neutral or beneficial effect on water quality (Assessment must consider surface and groundwater and must consider construction and operational stages)	
3. Will the safeguards be adequate for the time required? How will they need to be maintained?	Construction Yes, construction is anticipated to last for 12 months and the Blue Book parameters for the design of sediment basins have been selected based on this time frame. All erosion and sediment control measures would be regularly inspected and maintained. This would include regular engagement of a qualified soil conservation officer to inspect temporary and permanent erosion and sediment control devices, and to ensure the most appropriate controls are implemented and maintained. The following management and maintenance procedures for sediment basins would be adopted to ensure effective functioning and compliance with the anticipated Environment Protection Licence (EPL) conditions: • Inspections would be undertaken at regular intervals and following significant rainfall events to assess available water storage capacity, water quality, structural integrity and debris levels. • Where appropriate, an approved flocculent would be applied to sediment basins as early as possible so that early mixing of flocculants occurs. Water quality would be tested prior to discharge in accordance with any EPL requirements. • Where excessive sediment has built up in the basin to a point where greater than 30 per cent of the total capacity has been utilised, sediment would be removed and adequately disposed of. • Water from sediment basins would be utilised for construction purposes such as dust suppression where feasible. • When sediment basins require pumping out rather than discharge via a flow outlet, a float (or effective equivalent) would be attached to the hose suction or located inside a bucket to ensure that sediment from the basin floor is not discharged. • Records regarding water quality and functionality or erosion and sediment control devices would be kept, including details of rain events, use of flocculants, discharge, sediment removal and dewatering activities in accordance with EPA reporting procedures and licence conditions. • A checklist would be completed when treated water is to be discharged from the basin in accordance with a construction environmental management plan (CEMP).
	Operation Yes, the design life of the water quality ponds is between 20 and 50 The maintenance requirements for the various elements of the potential treatment train are provided below. Water quality ponds • Removal of rubbish and debris from trash racks. • Removal of sediment at 5 to 10 year intervals. • Maintenance access to water quality ponds would be provided.

NorBE Assessment – will there be a neutral or beneficial effect on water quality (Assessment must consider surface and groundwater and must consider construction and operational stages)	
	• Fencing of ponds may be required and would be subject to a risk assessment Spill basin Spill basins to be emptied after spills by emergency response team Swales Maintenance of the swales should ensure that grades are maintained and that grass is kept at a length of 200 to 300 millimetres. Weeds, rubbish and sediment would be regularly removed by maintenance teams. Biofiltration swales Biofiltration swales would require a higher level of maintenance than grassed swales, to ensure that the filtration media does not become clogged with fine sediment and in need of replacement. The following elements would need to be maintained (Upper Parramatta River Catchment Trust, 2003): • Flow to and through the system to ensure no blockages. • Surface vegetation. • Prevention of undesired overgrowth and weeds. • Removal of accumulated sediments. • Removal of debris and litter.
4. Will all impacts on water quality be effectively contained on the site by the identified safeguards (above) and not reach any watercourse, waterbody or drainage depression? Or will impacts on water quality be transferred outside the site for treatment? How? Why?	Yes. All potential impacts as a result of both construction and operation of the proposal would be treated prior to discharge to the surrounding environment or receiving water bodies.
5. Is it likely that a neutral or beneficial effect on water quality will occur? Why?	Yes, NORBE is achieved by implementation of measures identified in Table A1. Refer to following Technical Note and treatment model below for details regarding the MUSIC compliance with NORBE.

Appendix A – Mt Ousley Water Quality Assessment- Technical Note

Technical Note No. 1 Date: 08/09/2015

M1 Princes Motorway Improvements, Picton Road to Bulli Tops (Stage 1) - Pre and Post Water Quality Assessment

Discipline Type

Drainage - Water Quality

Scope

Roads and Maritime Services (Roads and Maritime) has requested SMEC to carry out preliminary water quality assessment of the proposed M1 Princes Motorway strategic design, provide the basis of the water quality strategy, identify potential sites for water quality devices and their preliminary sizes.

The information provided in this Technical Note is based on the strategic design files provided as part of the Roads and Maritime Request for Tender (RFT) information package (August 2013) The outputs provided are preliminary in nature and to further developed during future design stages.

Site Identification and Constraints

This technical note is to be read with reference to the MUSIC Treatment Train Schematic prepared for the catchments associated with the proposal.

The proposed works are located within a highly constrained road corridor, traversing through steep hilly country, with relatively intact vegetation communities in most locations. The existing road has a steep longitudinal grade at some locations with high embankments.

Design Strategy

The water quality strategy applied to the proposed upgrade focused on assessing the pre and post development conditions with an aim to provide neutral or beneficial effect on storm water runoff in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act). In order to identify whether the aim has been met a Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was developed. This was used to estimate stormwater pollutant generation and the performance of stormwater treatments for both existing and proposed conditions.

The strategy referenced the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 and complies with Roads and Maritime policies and relevant legislation.

The following pollutants formed the basis of assessment for a neutral or beneficial effect;

- Total suspended solids (kg/yr)
- Total Phosphorus (kg/yr)
- Total Nitrogen (kg/yr)
- Gross Pollutants (kg/yr)

Receiving Waterways

There are three main receiving waterways along the section of the proposed upgrade;

- Bellambi Creek receives runoff from the upgrade (approximate chainages 12 450 to 15 800) and flows westerly direction and ultimately discharging to Lake Cataract.

- Cataract Creek receives runoff from the upgrade (approximate chainage 10 550 to 12 450). The Creek flows in a westerly direction prior to becoming estuarine and discharging to Lake Cataract.
- Cataract River receives runoff from the southern section of the upgrade (approximate chainage 9 800 to 10 550). The river flows in a north westerly prior to becoming estuarine, ultimately discharging to Lake Cataract.

Assessment Results and Recommendations

Table A1 below presents the proposed treatments to provide a neutral or beneficial effect as part of the upgrade. For this assessment basins and channels have been considered.

Table A1 – Proposed treatment measures

Proposed Treatments	Approximate road chainage	Receiving Waters	Basin Volume (m3)	Channel Length (m)	Comments
C2 – Bellambi Creek					
Basin and Channel	12 950	Bellambi Creek	875	100	Construction basins can be retained for permanent works
Basin and Channel	14 650	Bellambi Creek	875	100	
Basin and Channel	15 100	Bellambi Creek	875	100	
C3 – Cataract Creek					
Basin	11 000	Cataract Creek	750	-	Construction basins can be retained for permanent works
C4 – Rocky Creek					
Basin and Channel	10 100	Cataract River	750	100	Construction basins can be retained for permanent works
Basin	10 250	Cataract River	750	100	

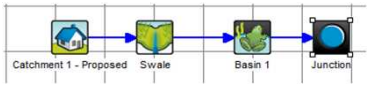
Catch 1 - Existing			
Catchment Area	4.14ha		
	Source	**Residual Load**	**Treatment**
Flow (ML/yr)	48.3	48.3	0
Peak Flow (m3/s)	1.19	1.19	0
Total Suspended Solids (kg/yr)	1.01E+04	1.01E+04	0
Total Phosphorus (kg/yr)	2.02E+01	20.2	0
Total Nitrogen (kg/yr)	136	136	0
Gross Pollutants (kg/yr)	1.06E+03	1.06E+03	0

Catch 1 - Proposed				
Catchment Area	5.56ha			
	Source	**Residual Load**	**Treatment**	**NorBE**
Flow (ML/yr)	64.9	63.3	2.4	-31%
Peak Flow (m3/s)	1.6	0.587	63.3	51%
Total Suspended Solids (kg/yr)	1.31E+04	2.25E+03	82.9	78%
Total Phosphorus (kg/yr)	27.2	9.12	66.5	55%
Total Nitrogen (kg/yr)	187	130	30.5	4%
Gross Pollutants (kg/yr)	1.43E+03	0	100	100%

Comments

1. Three new basins required to to match or improve the existing conditions. Each basin to have a surface area of 200 square meter and extended detention depth of 1m.
2. New vegatated channels with a total length of 400m required as additional treatment train.
3. New basins located on old M1 Princes Motorway alignment.
4. No construction basin proposed in the area.

MUSIC Treatment train Schematic



Catch 2 - Existing			
Catchment Area	11.75ha		
	Source	**Residual Load**	**Treatment**
Flow (ML/yr)	137	137	0
Peak Flow (m3/s)	3.39	3.39	0
Total Suspended Solids (kg/yr)	2.93E+04	2.93E+04	0
Total Phosphorus (kg/yr)	56.6	56.6	0
Total Nitrogen (kg/yr)	390	390	0
Gross Pollutants (kg/yr)	3.02E+03	3.02E+03	0

Catch 2 - Proposed				
Catchment Area	13.63			
	Source	**Residual Load**	**Treatment**	**NorBE**
Flow (ML/yr)	159	158	1	-15%
Peak Flow (m3/s)	3.93	2.24	43.1	34%
Total Suspended Solids (kg/yr)	3.16E+04	1.18E+04	62.5	60%
Total Phosphorus (kg/yr)	64.2	33.8	47.4	40%
Total Nitrogen (kg/yr)	459	384	16.3	2%
Gross Pollutants (kg/yr)	3.50E+03	0	100	100%

Comments

1. Three new basins required to match or improve the existing conditions. Each basin to have a surface area of 200 square meter and extended detention depth of 1m.
2. New vegatated channels with a total length of 300m required as additional treatment train.
3. Option exists for the 3 construction basin to be retained and utilised during the operational phase of the project.

Catch 3 - Existing			
Catchment Area	6.03ha		
	Source	**Residual Load**	**Treatment**
Flow (ML/yr)	70.4	70.4	0
Peak Flow (m3/s)	1.74	1.74	0
Total Suspended Solids (kg/yr)	1.40E+04	1.40E+04	0
Total Phosphorus (kg/yr)	29.8	29.8	0
Total Nitrogen (kg/yr)	204	204	0
Gross Pollutants (kg/yr)	1.55E+03	1.55E+03	0

Catch 3 - Proposed				
Catchment Area	6.2ha			
	Source	**Residual Load**	**Treatment**	**NorBE**
Flow (ML/yr)	72.3	72.1	0.3	-2%
Peak Flow (m3/s)	1.79	1.45	1.87E+01	17%
Total Suspended Solids (kg/yr)	1.44E+04	9.96E+03	30.7	29%
Total Phosphorus (kg/yr)	29.2	22.3	23.6	25%
Total Nitrogen (kg/yr)	211	191	9.30E+00	6%
Gross Pollutants (kg/yr)	1.59E+03	0	100	100%

Comments

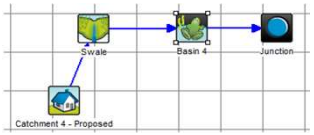
1. One new basin required to match or improve the existing conditions. Basin to have a minimum surface area of 200 square meter and extended detention depth of 1m.
2. Option exists for the construction basin to be retained and utilised during the operational phase of the project.

Catch 4 - Existing			
Area	1.75ha		
	Source	**Residual Load**	**Treatment**
Flow (ML/yr)	20.1	20.1	0
Peak Flow (m3/s)	0.496	0.496	0
Total Suspended Solids (kg/yr)	4.25E+03	4.25E+03	0
Total Phosphorus (kg/yr)	8.32	8.32	0
Total Nitrogen (kg/yr)	57.3	57.3	0
Gross Pollutants (kg/yr)	442	442	0

Catch 4 - Proposed				
Area	2.35ha			
	Source	**Residual Load**	**Treatment**	**NorBE**
Flow (ML/yr)	27.4	26.7	2.5	-33%
Peak Flow (m3/s)	0.677	0.288	57.4	42%
Total Suspended Solids (kg/yr)	5.73E+03	1.00E+03	82.5	76%
Total Phosphorus (kg/yr)	11.4	3.63	68.1	56%
Total Nitrogen (kg/yr)	78	54.3	30.3	5%
Gross Pollutants (kg/yr)	603	0	100	100%

Comments

1. Two new basins required to match or improve the existing conditions. Each basin to have a minimum surface area of 200 square meter and extended detention depth of 1m.
2. New vegatated channels of 100m length required as an additional treatment train.
3. Option exists for the construction basins to be retained and utilised during the operational phase of the project.



Appendix F

PACHCI Stage 2 assessment

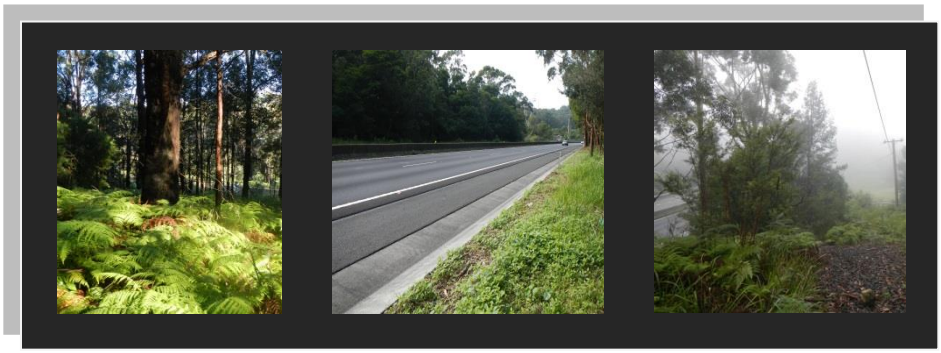
M1 Princes Motorway Climbing Lanes

Stage 2 PACHCI Archaeological Survey Report

Wollongong Local Government Area

Report to Roads and Maritime

November 2016



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A	11 April 2014	JS	JS	11 April 2014	Internal review
B	12 May 2014	NB	NB	12 May 2014	Final review
C	23 October 2014	JS	SW	22 October 2014	Amendments to included additional study area
D	10 November 2016	JS	JS	10 November 2016	Final

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File name:	M1 Princes Motorway Climbing Lanes
Author:	Alyce Howard
Project manager:	Sandra Wallace
Name of organisation:	Artefact Heritage
Name of project:	AJ140209 M1 Princes Motorway Climbing Lanes
Name of document:	Stage 2 PACHCI Aboriginal Archaeological Survey Report
Document version:	Final report

Executive summary

Roads and Maritime proposes to adjoin climbing lanes to the existing M1 Princes Motorway (previously Mount Ousley Road) between Picton Road and Bulli Pass. The proposed addition comprises approximately eight kilometres of additional lane that generally adheres to the existing road alignment. Artefact Heritage was engaged by Roads and Maritime to conduct an Aboriginal archaeological survey and assessment for the proposal in accordance with Stage 2 of the Roads and Maritime Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI). This Archaeological Survey Report (ASR) will be used to guide future planning of the climbing lane additions to the M1 Princes Motorway.

This study forms part of an initial constraints analysis for the proposed addition of climbing lanes to the M1 Princes Motorway between Picton Road and Bulli Pass. This ASR complies with Stage 2 of the Roads and Maritime PACHCI and the Office of Environment and Heritage (OEH) *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (referred to in this document as 'the OEH code of practice'). Desktop research and an analysis of sites previously registered with AHIMS in the wider region of the proposed works have also been undertaken.

22 Aboriginal sites were previously recorded in the region of the proposed works and no Aboriginal sites have been recorded within the study area.

This ASR complies with the requirements of Stage 2 of the Roads and Maritime PACHCI. Roads and Maritime and Artefact consulted with the Illawarra Local Aboriginal Land Council (ILALC) during Stage 2. A representative from ILALC participated in the field survey.

As no Aboriginal objects or areas were identified during Stage 2 of this proposal it is recommended that Stage 3 of the PACHCI need not be initiated. This recommendation pertains only to the proposed works detailed in this ASR. Should Roads and Maritime propose adjustments or alternatives to the current project, reassessment may be required.

Contents

Figures

Plates

Tables

1.0 Introduction

Roads and Maritime proposes to adjoin climbing lanes to the existing M1 Princes Motorway (previously Mount Ousley Road) between Picton Road and Bulli Pass. The proposed addition comprises approximately eight kilometres of additional lane that generally adheres to the existing road alignment (see Figure 1). Artefact Heritage was engaged by Roads and Maritime to conduct an Aboriginal archaeological survey and assessment for the proposal in accordance with Stage 2 of the Roads and Maritime Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI). This Archaeological Survey Report (ASR) will be used to guide future planning of the climbing lane additions to the M1 Princes Motorway.

1.1 Scope of the study

This study forms part of an initial constraints analysis for the proposal. This ASR complies with Stage 2 of the Roads and Maritime PACHCI and the Office of Environment and Heritage (OEH) *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (referred to in this document as 'the OEH code of practice'). If Aboriginal sites or archaeological deposits were to be impacted by the proposal, Stage 3 PACHCI would be initiated by Roads and Maritime. The study area is the road corridor as shown in Figure 1. Desktop research and an analysis of sites previously registered with AHIMS in the wider region of the proposed works have also been undertaken.

1.2 Description of the proposal

The proposal involves the addition of climbing lanes to the M1 Princes Motorway between Picton Road and Bulli Pass. This will involve widening sections of the M1 Princes Motorway and adding approximately eight kilometres of additional lane. For the purposes of this investigation, the works can generally be divided into three sections (see Figures 2, 3 and 4), including:

- Section 1 – on the eastern and western side of the M1 Princes Motorway travelling north towards the Bulli Pass end of the study area.
- Section 2 – on the eastern side of the M1 Princes Motorway travelling south towards the Picton Road end of the study area.
- Section 3 – on the western side of the Princes Motorway towards the Picton Road end of the study area and divided from Section 1 at the Bellambi Creek Crossing.

At the northern end of Section 1 towards Bulli Pass, Roads and Maritime is investigating three different road alignments. Each road alignment is set on a different curve radius, and are all shown in Appendix A. Option 400R involves the addition of climbing lanes in close alignment to the existing road easement. Option 460R involves a slightly greater deviation to the east of the existing road

easement. Option 600R involves a completely new road alignment through bushland to the east of the existing road easement.

A proposed access and stockpile area is located to the west of Mount Ousley Road in the northern section of the study area (Figure 4).

The study area for this investigation incorporates all three options.

1.3 Objectives of the study

The objectives of this study are to comply with the Roads and Maritime PACHCI, and the OEH code of practice. The main objectives of this study include providing:

- A description of the proposal and the extent of the study area.
- A description of Aboriginal community involvement and Aboriginal consultation.
- Discussion of the environmental context of the study area.
- Discussion of the Aboriginal historical context of the study area.
- A summary of the archaeological context of the study area including a discussion of previous archaeological work.
- Development of an archaeological predictive model.
- Description of the field survey.
- Recommendations for whether further archaeological investigation is necessary, including preparation of Stage 3 PACHCI documents.

Figure 1: The study area. Background image source Land and Property Information NSW.

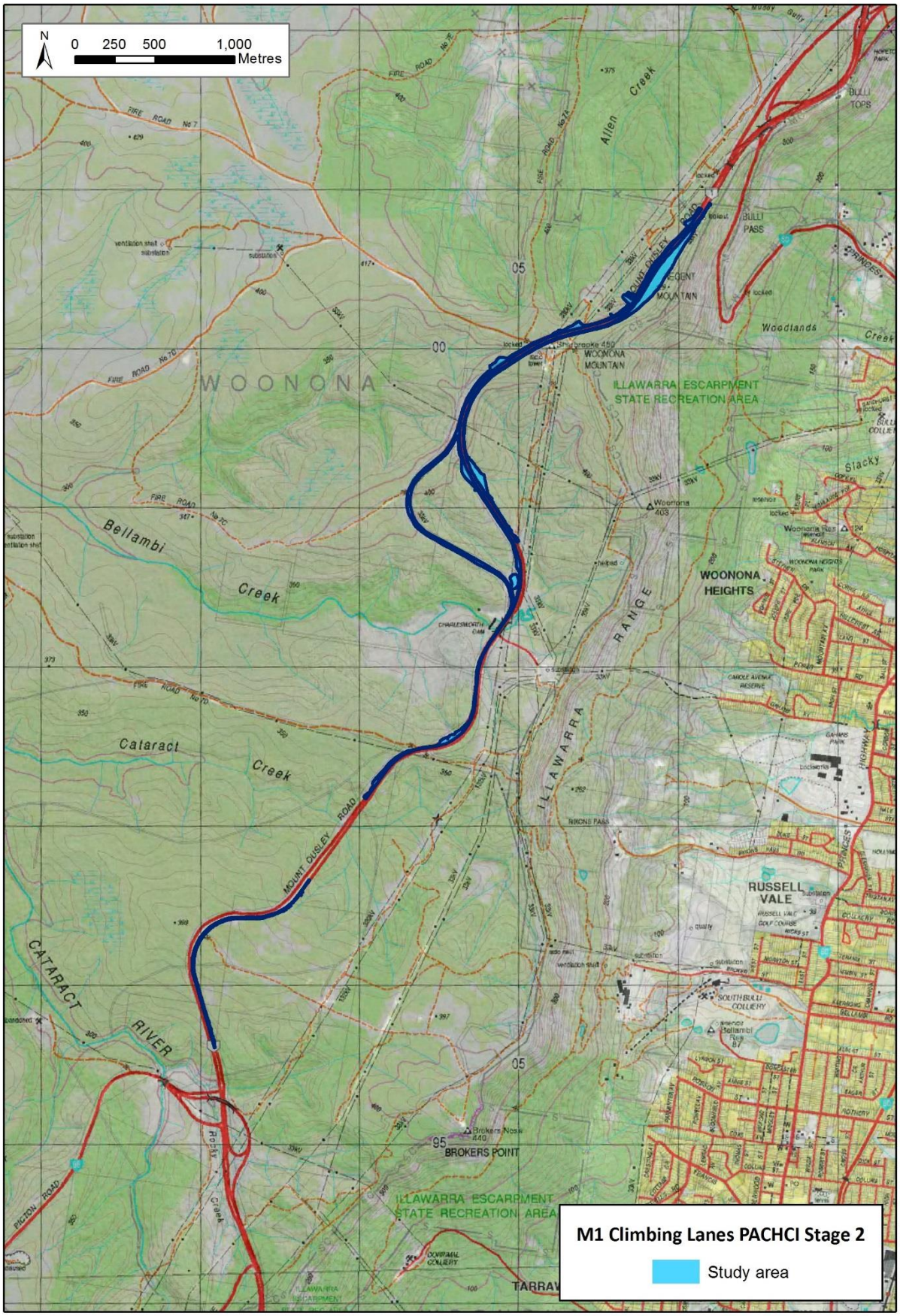


Figure 2: Overview of Section 1

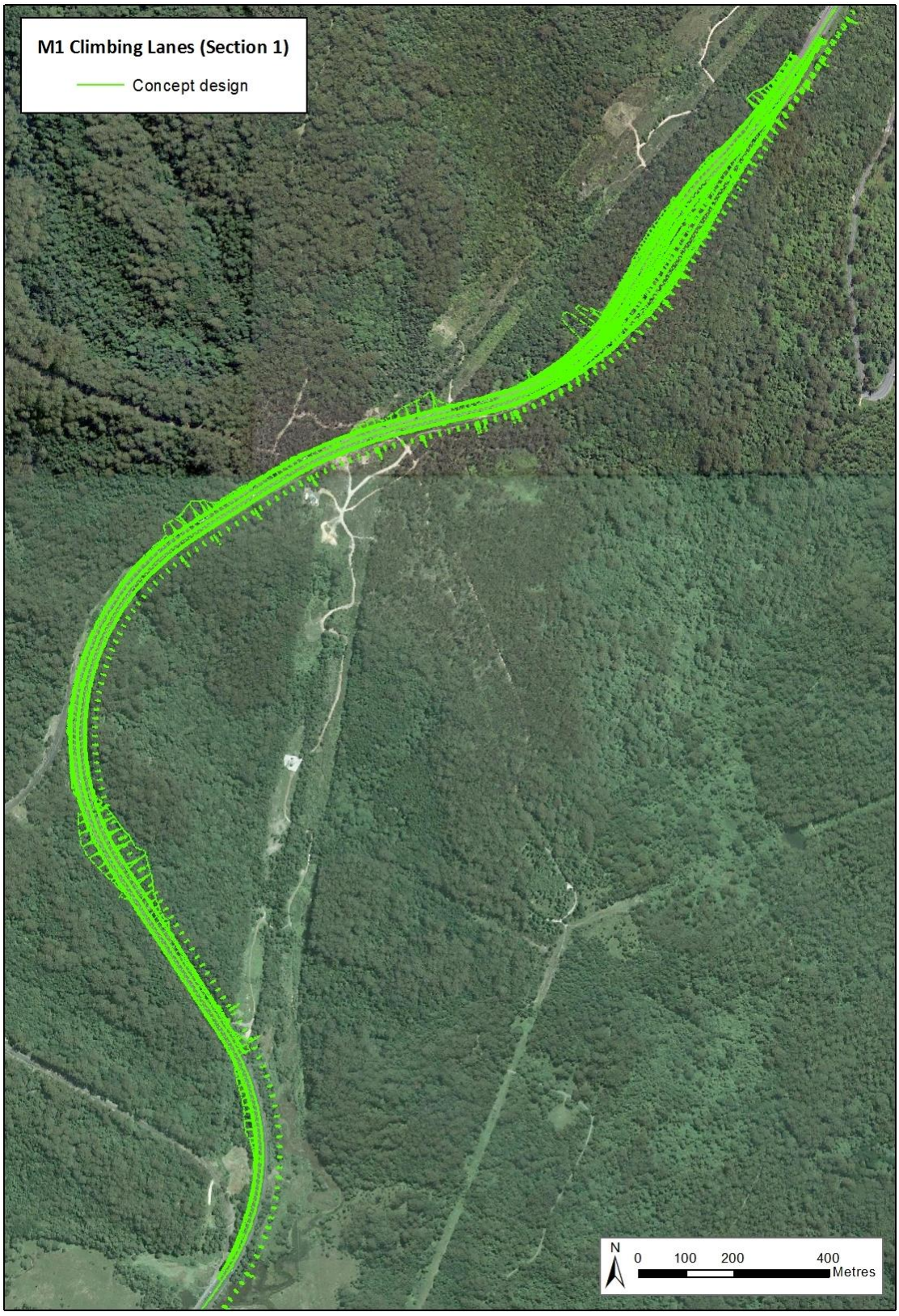
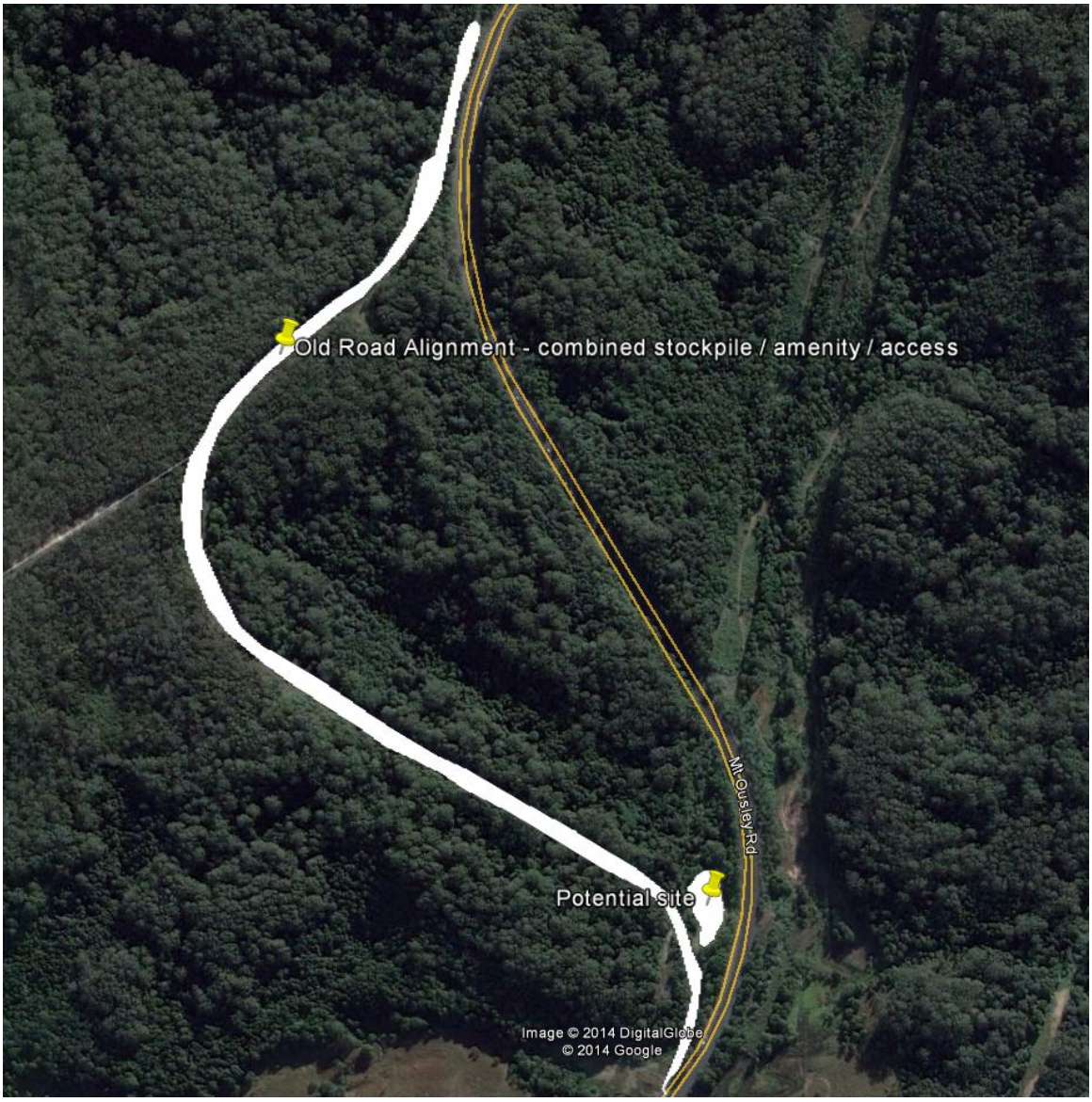


Figure 3: Overview of Section 2

Figure 4: Overview of Section 3

Figure 5: Stockpile and access locations



1.4 Development context

The study area borders the existing M1 Princes Motorway (previously Mount Ousley Road) between Picton Road and Bulli Pass. Development projects in the study area include the existing M1 Princes Motorway and its associated infrastructure.

1.5 Investigator and contributions

Josh Symons, Senior Archaeologist at Artefact Heritage, undertook this study along with Archaeologist Alyce Howard. Alyce Howard prepared this report with management input from Josh

Symons. Principal Archaeologist Dr Sandra Wallace provided management input and reviewed the report. Josh Symons and Alyce Howard attended the site survey.

1.6 Aboriginal community involvement

Aboriginal consultation has been conducted in accordance with Stage 2 of the Roads and Maritime PACHCI. A Native Title search was requested on the 7 April 2014 by Artefact. The results indicated that there were no Native Title claims granted or registered for consideration within the study area. The study area is within the boundary of Illawarra Local Aboriginal Land Council (ILALC). Troy Tungai represented ILALC throughout the survey. Roads and Maritime forwarded a copy of this report to ILALC for review and comment.

2.0 Environmental Context

2.1 Geology

The study area is located within the Sydney Basin, a large sedimentary basin extending from Newcastle to Batemans Bay and west to Lithgow. The upper geological layers of the study area are dominated by the Hawkesbury Sandstone unit, the predominant sandstone layer of the Sydney Basin. The eastern portion of the study area is interspersed with small regions of Narrabeen Group sandstones, including Newport and Garie formations, as well as small regions of Bulga Sandstone (Stroud *et al* 1985).

Underlying the Sydney Basin sandstone units across the study area are units of the Illawarra Coal Measures. These predominantly consisted of the Sydney Subgroup and the Pheasants Nest Formation. The Sydney Subgroup included interbedded quartz-lithic sandstone, grey siltstone, and claystone, carbonaceous claystone, clay, laminate, and coal (Stroud *et al* 1985). The Pheasants Nest Formation consisted of interbedded lithic sandstone, coal, carbonaceous claystone, siltstone, and claystone (Stroud *et al* 1985).

The dominant landform feature of the Illawarra, an escarpment comprising a large vertical exposure of Sydney Basin sedimentary units, runs through eastern portion of the study area. The M1 Princes Motorway approximates the contour of the Illawarra Escarpment and is located to its west, atop the associated plateau. The Illawarra Escarpment in this region features an outlying high point called Mt Keira, located south of the study area. The crest of Mt Keira is formed by a remnant layer of Hawkesbury Sandstone that has remained more resistant to erosional processes than surrounding sandstone.

The highest point on Mt Keira is 464 metres above sea level (ASL), with the relief sloping down in all directions from this point. The study area is bordered to the West by Lake Cataract, which is approximately 180 metres lower in elevation than the crest of Mt Keira and the lowest elevation within the study area.

2.2 Geomorphology

The study area is dominated by the wide, undulating plateau to the west of the Illawarra Escarpment. The terrain to the west of the study area slopes gradually downward until it meets the southernmost catchment of Lake Cataract. The Illawarra Escarpment borders the eastern edge of the study area, where it slopes steeply to the east and is interspersed with outcropping bluffs. Undulating hills continue to the north and south of the study area, punctuated only by Mt Keira, located approximately 4.5 kilometres south of the study area.

The study area encapsulates the Illawarra Escarpment between Woonona and the southernmost catchment of Lake Cataract. The study area is predominately characterised by Hawkesbury and Warragamba soil landscapes (Hazelton & Tille 1990). The Hawkesbury soil landscape generally comprised shallower soils across the crest and upper slope landforms within the study area, whilst the Warragamba soil landscape was associated with the lower elevation, incised drainage channels within the study area.

2.3 Hydrology

The study area is generally located across the higher portions of the Illawarra Escarpment, a landform feature which forms the watershed between drainage to the east across the Illawarra Plain, and drainage to the west and inland to the Nepean / Hawkesbury River system. The study area is therefore generally associated with unnamed ephemeral headwaters, with one more significant water crossing consisting of Bellambi Creek at the intersection of study area Sections 3 and 4.

2.4 Natural resources

The study area lies in close proximity to a large range of natural resources. The coastal plain at the base of the Illawarra Escarpment comprised freshwater, marine and estuarine resources, as well as terrestrial resources.

The raised escarpment and plateau area to the west of the study area would have provided a different range or resources. Early European observations of the plateau region to the west indicated that the Aboriginal population of the area was either sparsely distributed or that the local Aboriginal people were deliberately avoiding contact (Rich 1988: 25; Umwelt 2005: 3.4). Rich (1988: 35) suggested that ‘the region was probably occupied all year by mobile family groups’, and that the population was probably lower than on the coast. The Wodi Wodi may have used the area through Bong Bong and Mittagong further to the south of the current study area to reach the Cowpastures and Burrogorang in the south-west Sydney region (Rich 1988: 35).

Types of shelter utilised in the region would have included bark huts and naturally occurring sandstone overhang formations. Bark huts were generally located in tandem with a fire (hearth), were constructed with bark removed from nearby gum trees, and could vary in size depending on the size of the family group (Rich 1988: 29). Sandstone overhangs were frequent features of the region based on the exposure of the underlying sandstone geology along weathered scarps and well incised drainage channels. Use of sandstone overhangs is evidenced in the archaeological record mainly by sub-surface archaeological deposit and pigment or charcoal motifs on shelter walls. Evidence of bark hut use is harder to discern, as bark removal scars on gum trees would have largely disappeared with European vegetation clearance, and archaeological excavation would generally be required to determine the presence of absence of hearths in any particular area. The variety of landforms in the

area, including creeks, rivers and swamps, would have provided a wide range of subsistence resources.

Early European observations in the area made reference to the wide variety of food types consumed by the local Aboriginal inhabitants. In 1802, Barrallier observed that Aboriginal people in the vicinity of the current study area ate a wide variety of animal foods, including kanagroos, possums, wombat, wild dog, lizards, lizard eggs, large ant eggs, fish, shellfish, eels, platypus, parrot eggs and honey (cited in Rich 1988: 29).

2.5 Land use history

Present day Wollongong was an attractive region in early colonial history due to its proximity to Sydney, fertile land and the presence of woodland and natural mineral resources. The Illawarra Escarpment, however, has been notoriously difficult to traverse. Historic and modern land use in the study area predominately concerns transport and access to the Wollongong region. In 1821 Cornelius O'Brien found a pass from Mt Nebo to Figtree and utilized it as a private toll road (Hagan & Wells 1997). Numerous alternative and precarious routes were found over the following years as the need for overland transport increased until 1868 when wheeled vehicles were able to use the Bulli Pass (Bayley 1989). Mount Ousley Road was built as an alternative route to Bulli Pass, traversing the Illawarra Escarpment further south and entering Wollongong just north of the city (Kass 2010).

2.6 Archaeological implications for the study area

The wider region of the study area would have provided a range of food and manufacturing resources for the local Aboriginal population. It is also located within close proximity to perennial fresh water. The region provides access to coastal and estuarine resources to the east. The study area has been highly disturbed and modified throughout historic and contemporary times, predominately by the construction of the existing road easement. Open sites are not likely to be located across the steep slopes that border the study area, with site more likely associated with overhang shelter formations. Areas within the study area that may have retained archaeological materials are generally highly disturbed and modified. Any areas that have not been disturbed and modified may present outcropping sandstone which may have archaeological significance. The combination of these factors implies that Aboriginal objects are unlikely to be present throughout most of the study area. Where natural landforms and sandstone outcrops remain it is possible that these areas may have some archaeological potential.

3.0 Aboriginal Historical and Archaeological Context

3.1 Aboriginal material culture

The oldest dated sites for Aboriginal occupation in the Sydney Basin are from the late Pleistocene period, with a securely dated site at the base of the Blue Mountains of 14,700 years before present (yBP), and two coastal sites south of Wollongong at Bass Point and Burrill Lake in the Shoalhaven both dated to around 20,000 yBP (Lampert 1971 and Nanson *et al* 1987). Evidence of Aboriginal occupation has been found dated to 50-60,000 yBP at Lake Mungo in NSW (Bowler *et al* 2003). As such, it would be likely that Aboriginal people have lived in the Illawarra region for even longer than indicated by the oldest recorded dates available at present. The archaeological material record provides evidence of this long occupation, but also provides evidence of a dynamic culture that has changed through time.

The existing archaeological record is limited to certain materials and objects that were able to withstand degradation and decay. As a result, the most common type of Aboriginal objects remaining in the archaeological record are stone artefacts. Archaeological analyses of these artefacts in their contexts have provided the basis for the interpretation of change in material culture over time. Technologies used for making tools changed, along with preference of raw material. Different types of tools appeared at certain times, for example ground stone hatchets are first observed in the archaeological record around 4,000 yBP in the Sydney region (Attenbrow 2010: 102). It is argued that these changes in material culture were an indication of changes in social organisation and behaviour.

The Eastern Regional Sequence was first developed by McCarthy in 1948 to explain the typological differences he was seeing in stone tool technology in different stratigraphic levels during excavations such as Lapstone Creek near the foot of the Blue Mountains (McCarthy *et al* 1948). The sequence had three phases that corresponded to different technologies and tool types (the Capertian, Bondaian and Eloueran). The categories have been refined through the interpretation of further excavation data and radiocarbon dates (Hiscock & Attenbrow 2005; JMcD CHM 2005). It is now thought that prior to 8,500 yBP tool technology remained fairly static with a preference for silicified tuff, quartz and some unheated silcrete. Bipolar flaking was rare with unifacial flaking predominant. No backed artefacts have been found of this antiquity. After 8,500 yBP silcrete was more dominant as a raw material, and bifacial flaking became the most common technique for tool manufacture. From about 4,000 yBP to 1,000 yBP backed artefacts appear more frequently. Tool manufacture techniques become more complex and bipolar flaking increases (JMcD CHM 2006). It has been argued that from 1,400 to 1,000 years before contact there is evidence of a decline in tool manufacture. This reduction may be the result of decreased tool making, an increase in the use of organic materials, changes in the way tools were made, or changes in what types of tools were preferred (Attenbrow 2010: 102). The reduction in evidence coincides with the reduction in frequency of backed blades as a percentage of the assemblage.

3.2 Aboriginal Ethno-Historic Context

Aboriginal people traditionally lived in small family or clan groups that were associated with particular territories or places. The study area is located within the Dharawal language group area (Attenbrow 2010: 34). The Dharawal language group was largely coastal and is thought to have extended from the Shoalhaven River in the south, to Botany Bay in the north and then inland to Camden (Attenbrow 2010: 34). The Dharawal language group was bordered to the north in the Botany Bay – southern Sydney region by the Darug and to the west in the Mittagong – Moss Vale region by the Gundungurra. The study area falls within the territory of the Dharawal-speaking Wodi Wodi people. Tindale (1974) described the territory of the Wodi Wodi as extending from north of the Shoalhaven River at Nowra to Wollongong and inland to Moss Vale.

The area covered by the Dharawal language included a variety of landscape and resource types, including coastal and estuarine environments, rolling hills and creeks bordering the coastal environment, and the large sandstone escarpment and plateau. Sullivan (cited in Rich 1988: 23) suggested that the boundary between the Gundungurra and the Dharawal was the divide between the coastal and inland river systems, which runs on an approximate south-west to north-east line east of Wingello, Bundanoon, Robertson and Mittagong. Movement across these different terrain types and resource areas may have been dictated by the season or purpose (DEC 2005: 8). Additionally, exchange with people from surrounding language groups included Gundungarra and Wiradjuri people travelling to the coast to exchange foods and raw materials, whilst the Dharawal and Awabakal (Central Coast region) shared ceremonies (DEC 2005: 8).

Long-term areas of interaction and ‘travel corridors’ for movement between different language groups may have existed where there were shared boundaries. Laila Haglund has suggested that the Campbelltown area in south-west Sydney may have represented the intersection between the boundaries of the Dharawal, Darug and Gundungurra, and that the Narrelan Valley may have been part of a ‘travel corridor’ facilitating movement between the north-western Sydney and the Illawarra (JMcD CHM 2007: 21 after Haglund 1989).

Early interaction between the Dharawal and the British was intermittent and brief. The earliest sighting of British people by the Dharawal would most likely have been when they saw sailing ships along the coast. The records of Captain Cook and several of his crew document seeing numerous fires and occasional Aboriginal people on the coastline in the Illawarra region (Organ 1993: 46). Organ (1993: 49) documents an anonymous exploration journal attributed to surveyor George William Evans, which recorded an overland expedition north from Jervis Bay via Wollongong in 1812. The exploration party encountered several groups of Aboriginal people, and at one point exchanged some of their possessions with one of the groups for oysters (Organ 1993: 49).

Several of the early British settlers in the Illawarra documented large gatherings of Aboriginal people, including a reference by Navin (1994: 8) that Robert James, a local resident of the area, recorded a camp of around 100 Aboriginal people on the banks of American Creek at Mount Kembla. In 1836 a

group of around 200 Aboriginal people were observed in the Illawarra area as they were preparing to travel to Cowpastures in south-west Sydney (Griffin 1986: 6 cited in AMBS 2010: 33).

A variety of flora and fauna resources were utilised in the Illawarra region for subsistence, personal ornament and tool requirements. The variety of subsistence resources in the Illawarra included marine, estuarine, freshwater and hinterland flora and fauna. Early British records documented torchlight spearing of bream and consumption of whale meat (Organ 1993: 262). The consumption of whale was documented as an important event linked to the spirits of their ancestors (Organ 1993: 262). Cabbage trees were used for various purposes, including utilisation of the fibre (Organ 1993: 155), used to make bridges over creeks and for food (AMBS 2010: 35). Other plant species utilised for food and tolls included bats-wing tree, grass tree, Gymea lily, various Eucalypt *sp*., mat-rush, sticky hop bush, Melaleuca and black wattle (AMBS 2010: 35).

3.3 Registered Aboriginal sites in the study area – AHIMS search

An area of approximately 7 km (east-west) by 10 km (north-south) was searched to gain information on the archaeological context of the study area, and to ascertain whether there are any previously recorded Aboriginal sites within the study area. An extensive search of the Aboriginal Heritage Information System (AHIMS) database was undertaken on the 10 November 2016 for sites registered within the following coordinates:

GDA 1994 MGA 56	301934 – 307267
	6193959 – 6202028
Buffer	1000 m
Number of sites	62
AHIMS Search ID	253472

The distribution of recorded sites within the AHIMS search area is shown in Figure 5.

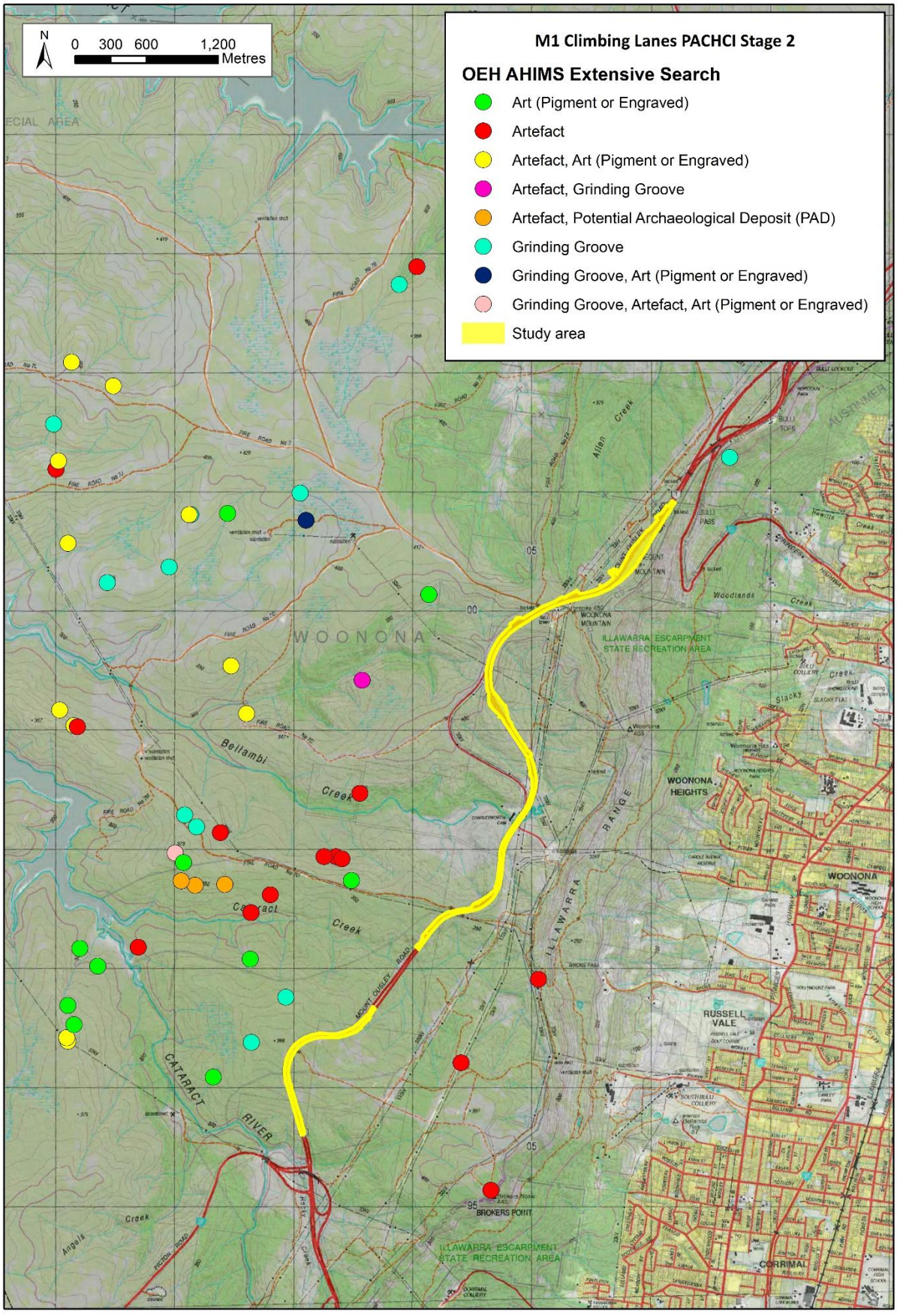
The location of Aboriginal sites is considered culturally sensitive information. It is advised that this information, including the AHIMS data appearing on the heritage map for the proposal be removed from this report if it is to enter the public domain.

The frequency of recorded site types is summarised in Table 1 below.

Table 1: Frequency of site features from AHIMS data

Site Feature	Frequency	Percentage
Artefact	17	27
Grinding Groove	13	21
Artefact, Art (Pigment or Engraved)	12	19
Art (Pigment or Engraved)	10	16
Grinding Groove, Artefact, Art (Pigment or Engraved)	3	5.5
Artefact, Potential Archaeological Deposit (PAD)	3	5.5
Grinding Groove, Art (Pigment or Engraved)	1	1.5
Burial	1	1.5
Artefact, Grinding Groove	1	1.5
Aboriginal Resource and Gathering, Stone Arrangement	1	1.5

Figure 6: OEH AHIMS Extensive Search



The predominant site type located within the AHIMS search area is artefact sites (n=17, 27%), followed by grinding grooves (n=13, 21%), artefact and art sites (n=12, 19%), and art (pigment or engraved) sites (n=10, 16%). The remaining sites types include grinding groove, artefact and art sites (n=3, 5.5%), artefact, potential archaeological deposit (n=3, 5.5%), grinding groove, art (n=1, 1.5%), burial (n=1, 1.5%), artefact and grinding groove (n=1, 1.5%), Aboriginal resource and gathering, stone arrangement (n=1, 1.5%).

It can be seen in Figure 5 that the majority of sites are located within 2 kilometres of Lake Cataract and associated water sources. The site distribution is also a reflection of the pattern of archaeological assessments undertaken in relation to development activities.

No previously recorded sites are located within the current study area (see Figure 6). Seven sites were located within 1 kilometre of the study area. Descriptions of these sites are provided below.

AHIMS site 52-3-0313 (Bulli Mine Shaft 29: Broker's Nose Ridge) comprises 9 artefacts over 125 metres squared on the northern side of Broker's Nose Ridge. The site is bordered by a sharp drop approximately 100 metres to the north. The Illawarra Prehistory Group noted that a light vehicle track and large pole in a series of transmission lines disturb the site. A single flake was found approximately 100m from the site, along the vehicle track, and is believed to have been disturbed or eroded from the original site. The assemblage is dominated by flakes, with two cores and 1 blade noted. Raw materials of the assemblage include silcrete, chert and fossilized wood. All artefacts recorded feature little to no cortex.

AHIMS site 52-3-0324 (Bulli Mine Shaft 28) comprises 3 small stone artefacts, located on a high narrow ridge at the junction of the Rixons Pass track and another light vehicle track. All 3 artefacts are flakes, 2 of which are chert and 1 is fossilized wood. The fossilized wood flake exhibits use wear on one margin. The Illawarra Prehistory Group noted that the site is highly disturbed by the two tracks.

AHIMS site 52-3-0320 (Bulli Mine Shaft 25: Appin) is characterised as a grinding groove found on a 22 x 2.5 metre outcrop of sandstone. The outcrop is located across an upland swamp, part of the greater Cataract Catchment area. The grinding groove measures 400 x 90 x 9 centimetres. The Illawarra Prehistory Group recorded the site as reasonably intact although the site is subject to varying levels of water seepage.

AHIMS site 52-3-0322 (Bulli Mine Shaft 31) is characterised as a grinding groove site. Two grinding grooves were found on an 11 x 20 metre outcrop of sandstone. The site is located on the southern side of a small ridge which gradually slopes south toward swamp, which is part of the greater Cataract Catchment. The Illawarra Prehistory Group recorded the site as reasonably intact.

AHIMS site 52-3-0314 (Bulli Mine Shaft 21: Bulli) is characterised as a shelter containing 2 charcoal drawings. The site is located on the northern side of a prominent outcrop, atop a ridge within the greater Cataract catchment area. The shelter is provided by a sandstone overhang caused by rock fall and cavernous weathering. The shelter measures approximately 6 metres wide, 3 metres deep

and 2. 5 metres high and has a north-eastern aspect. The floor of the shelter is mostly stone and covers an area of approximately 1 square metre. The sediment towards the mouth of the shelter is white sand with a depth of approximately 25 centimetres. The charcoal drawings are located on the roof. The Illawarra Prehistory Group describes one figure as an 'unusual figure with extended front legs and distinct eyes' and the other as an indeterminate charcoal figure. A series of scratches are noted nearby the drawings. The talus slopes very minimally away from the mouth of the shelter and features two large sandstone boulders.

AHIMS site 52-3-0318 (Bulli Mine Shaft 30: Bulli) is characterised as a shelter with two areas of charcoal drawings. The shelter is formed by overhanging sandstone on the upper slopes of a small valley, within the greater Cataract catchment area. The aspect of the shelter is to the west and a small creek originates below the mouth of the shelter. The sandstone overhang measures approximately 10 metres wide, 4 metres deep and 4.5 metres high. The floor provides an approximately 27 square metre living area and is composed of sandy sediments of a depth greater than 40 centimetres. The floor is flat and continues beyond the mouth of the shelter. The walls and roof of the shelter are generally covered by lichen growth and mineralization, but there are two areas of a wall where charcoal drawings are discernible. The first is a human figure outlined in charcoal with infill. The second is an area of indeterminate charcoal drawings on the wall at the southern end of the shelter. The Illawarra Prehistory Group notes that the art is in poor condition but the deposit is undisturbed.

AHIMS site 52-3-0325 (Bulli Mine Shaft 27) is characterized as a shelter with art by AHIMS, although the original recorders, the Illawarra Prehistory Group, also noted the presence of 5 artefacts within the shelter. The shelter is located the northern side of a valley slope which borders an upland swamp, within the greater Cataract Catchment area. The shelter comprises two chambers and is formed by large blocks of sandstone rock fall from the above cliff line. The aspect of the first chamber is to the west and the second chamber faces north. Both sections feature clay sediments within the shelter and white sand deposits toward the mouth. The depth of sediment throughout the shelter was measured as greater than 45 centimetres. Remnants of sprayed red ochre are visible on the eastern end of the rear wall. The artefacts recorded are predominately flakes, with one quartz core noted. Raw material present is generally quartz, with one flake of silcrete and one flake of fossilised wood observed. The Illawarra Prehistory Group notes that the art is in very poor condition and that the north facing chamber of the shelter has been disturbed by wombat activity.

3.4 Previous archaeological investigations

A number of Aboriginal sites have been recorded in the region of the study area. Most of these sites, however, were recorded by the Illawarra Prehistory Group and no associated archaeological reports could be accessed during preparation of this document. As such, archaeological investigations from the broader Illawarra region will provide the necessary context for this study. The following discussion of previous archaeological investigations is broken up into thematic areas; the Woronora Plateau

which extends west and north of the current study, the Mt Kembla region to the south and the coastal plain of Sandon Point to east.

Woronora Plateau

The section of the Woronora Plateau near the current study area includes the Avon, Cordeaux and Cataract catchment areas. These regions are incised by watercourses and feature steep valleys and bluffs that may contain sandstone overhangs (Biosis 2009). Open sections of exposed sandstone are frequently found atop these ridges (Biosis 2009).

Sefton has conducted numerous investigations into the archaeology of the Woronora Plateau and catchment areas. Sefton has noted that the Woronora catchment features higher numbers of grinding groove sites and shelters with art than the Cordeaux catchment (1990, 1991 1997). Sefton postulates that the increased frequency of these site types may indicate that the Woronora catchment may have sustained a larger population than the Cordeaux catchment area (1991). Sefton went on to infer that the increase in artistic expression seen in the Woronora catchment area may indicate more complex social and spiritual life (1991).

Biosis (2009) undertook a comprehensive Aboriginal Cultural Heritage Assessment of the region between Appin, Wilton, Douglas Park, Picton and Menangle. Biosis (2009) reassessed hundreds of previously recorded sites and recorded 44 new sites. Of all sites found and reassessed by Biosis (2009), shelters (featuring art/deposits/engravings/grinding grooves or some combination) were the dominant site type, followed by sandstone platforms (featuring grinding grooves and/or engravings) and artefact sites. Much of the catchment areas within the Woronora Plateau have been designated as catchment areas and national parkland. As such, many areas are relatively pristine and retain undisturbed Aboriginal sites. Much of the Woronora Plateau, therefore, preserves a history of occupation before European arrival and has high cultural significance for Aboriginal people of the Illawarra (Biosis 2009).

Mt Kembla region

Navin Officer (2000) undertook a large scale archaeological investigation in the region between Mt Kembla, Mt Nebo and the Woronora Plateau, south of the current study area. Navin Officer relocated 19 previously recorded sites and recorded 11 new sites (2000). Navin Officer conducted targeted surveys with dual aims, to a) locate sandstone outcrops for potential shelters and open platforms and b) locate areas of exposure for potential open campsites. This investigation highlighted issues concerning representativeness of the recorded archaeology of the region, as it is influenced by the visibility and obtrusiveness of sites (Navin Officer 2000). Sites such as rock shelters and overhangs are usually highly visible and are obtrusive, even in dense vegetation, and are therefore more likely to be identified and recorded (Navin Officer 2000). Sites such as grinding grooves, motifs on sandstone platforms and artefact scatters, while frequent throughout the landscape, are less obtrusive and less visible. The lessened visibility and obtrusiveness of these site types hinders identification and therefore their representation archaeological recordings (Navin Officer 2000).

Sandon Point

Located east of the Illawarra Escarpment and the current study area, Sandon Point has been the subject of extensive archaeological investigations. Since Fullager & Head began excavation of a midden at Sandon Point in 1990, several large scale investigations have taken place, culminating in the Aboriginal Heritage Study of Sandon Point, commissioned by Wollongong City Council (Therin 2003). The Sandon Point Aboriginal Place was gazetted on 16 February 2007 following the identification of Aboriginal heritage value including middens, burials of Aboriginal people, and a meeting place for Aboriginal groups. There are several AHIMS sites recorded across Sandon Point and the area retains great cultural value. Though Sandon Point retains high cultural and archaeological significance, the archaeological record and environmental context of the area is quite dissimilar to that of the Woronora Plateau and region bordering the Illawarra escarpment, such as where the current study area is located. The Woronora Plateau features more grinding groove, open campsite, and shelter sites, whereas sites on the coastal plains of Sandon point are a product of their coastal setting and feature more middens. While previous archaeological investigations at Sandon Point provide context for the wider region, predictive models based on these investigations are less applicable to the current study than those which are based on the areas of the Woronora Plateau.

3.6 Previous predictive models

Previous predicative models for the Woronora Plateau are most applicable to the current study area, as it located along the eastern edge of this landform. However, while previous predictive models are useful in informing an approach to this study, they may not be wholly pertinent. This is due partly to the high levels of disturbance throughout the current study area, and partly to the focus of previous archaeological investigations, which were primarily based on the catchment areas to the west and south of the current study area.

Biosis (2009) developed a predictive model for the Woronora Plateau, located northwest of the current study area. Biosis (2009) characterised the Woronora Plateau by incised Hawkesbury Sandstones that feature steep rocky drainage lines, ridges and outcrops. Biosis (2009) deemed the likeliest site types to be sandstone shelters with art and/or deposit, grinding grooves, engravings and open artefact scatters.

Sefton (1994) formed a predictive model, based on research throughout the Avon catchment area. Sefton's model stated that:

- stone arrangements and rock engravings were considered more likely to occur on the flat sandstone caps on ridge crests / saddles;
- grinding grooves were considered more likely to occur where water collects at the ridge crest level or sandstone associated with swamps;
- engraved groove channels and rock engravings were likely to be associated with swamps; and,

- sandstone overhangs beneath ridge crest settings may contain art, archaeological deposit and/or grinding grooves (Sefton 1994).

Concerns regarding the representativeness of recorded Aboriginal sites made by Navin Officer (2000) are equally applicable to the current study area. While shelter sites are certainly prevalent throughout the region, it is probable that they are somewhat overrepresented in part to their visibility and obtrusiveness in the landscape. Similarly, less visible and obtrusive sites, while present in the landscape, may be underrepresented in the region despite being equally as (or more) prevalent as shelter sites. These statements concerning the representation of different site types throughout the landscape are important theoretical considerations. However, site survey and observation of factors such as visibility, vegetation and disturbance will ultimately inform the interpretation of the archaeological record in the study area

4.0 Predictions

4.1 Aboriginal land use

Assumptions about Aboriginal land use patterns are made on the basis of archaeological information gained from the local area, from observations made by Europeans after settlement of the area, and from information known about available natural resources.

As Aboriginal people were mobile hunter-gatherers, it would be likely that they moved across the landscape between resources. It would also be likely that movement was related to socio/cultural factors such as gatherings and ceremonial obligations. Campsites would have provided temporary residences such as bark structures. It is difficult to ascertain whether a campsite existed at a given location, but correlations between stone artefact density and campsites are often assumed. While it would be likely that knapping would have occurred at a campsite, it would also be likely that knapping would have occurred during movement across the landscape, as tools were prepared or repaired during hunting and gathering activities.

Archaeological data gathered in the locality suggests that artefacts would be found across the landscape in varying densities, with higher densities expected in close proximity to water sources. The main limitations to the survivability of archaeological material in the study area include impacts of soil erosion, flooding, and infrastructure development.

4.2 Predictive model

The predictive model used in the current study comprises a series of statements about the nature and distribution of evidence of Aboriginal land use that is expected in the study area. These statements were based on the information gathered regarding:

- Landscape context and landform units.
- Ethno-historical evidence of Aboriginal land use.
- Distribution of natural resources.
- Results of previous archaeological work in the vicinity of the study area.
- Predictive modelling proposed in previous investigations.

Predictive statements for the study area are as follows:

- Shelter sites, possibly containing combinations of art/engravings/grinding grooves/deposit, will occur where suitable sandstone overhang formations occur.
- Stone artefacts/artefact scatters, generally the most common Aboriginal site type, visibility can occur in varying densities across the landscape. Geomorphological factors such as steep eroding slopes and shallow soils may preclude the survivability of intact deposits in those contexts.

- Artefact densities are likely to be low.
- *In situ* artefacts will be located in areas of least ground disturbance.

It is possible that previously unrecorded rock shelters, grinding grooves and art may exist within the study area, in light of the numerous previously recorded sites of these types. The potential for midden sites is limited by the local geomorphology and hydrological characteristics of the area. The narrow extent of the study area (less than one kilometre wide) coupled with the disturbed and modified terrain surrounding the existing M1 Princes Motorway would limit the possibilities of identifying suitable old growth trees within the study area.

Areas of PAD would be dependent on landform and levels of disturbance. Areas of PAD are not likely to be identified across steep slopes, in areas of flooding, or in areas of high disturbance.

Overall, the narrow extent of the study area and the high levels of disturbance and modification throughout would lessen the chance of identifying Aboriginal objects.

5.0 Field Methods

5.1 Site definition

An Aboriginal site is generally defined as an Aboriginal object or place. An Aboriginal object is the material evidence of Aboriginal land use, such as stone tools, scarred trees or rock art. Some sites, or Aboriginal places can also be intangible and although they might not be visible, these places have cultural significance to Aboriginal people.

OEH guidelines state in regard to site definition that one or more of the following criteria must be used when recording material traces of Aboriginal land use:

- The spatial extent of the visible objects, or direct evidence of their location.
- Obvious physical boundaries where present, e.g. mound site and middens (if visibility is good), a ceremonial ground.
- Identification by the Aboriginal community on the basis of cultural information.

For the purposes of this study an Aboriginal site was defined by recording the spatial extent of visible traces or the direct evidence of their location.

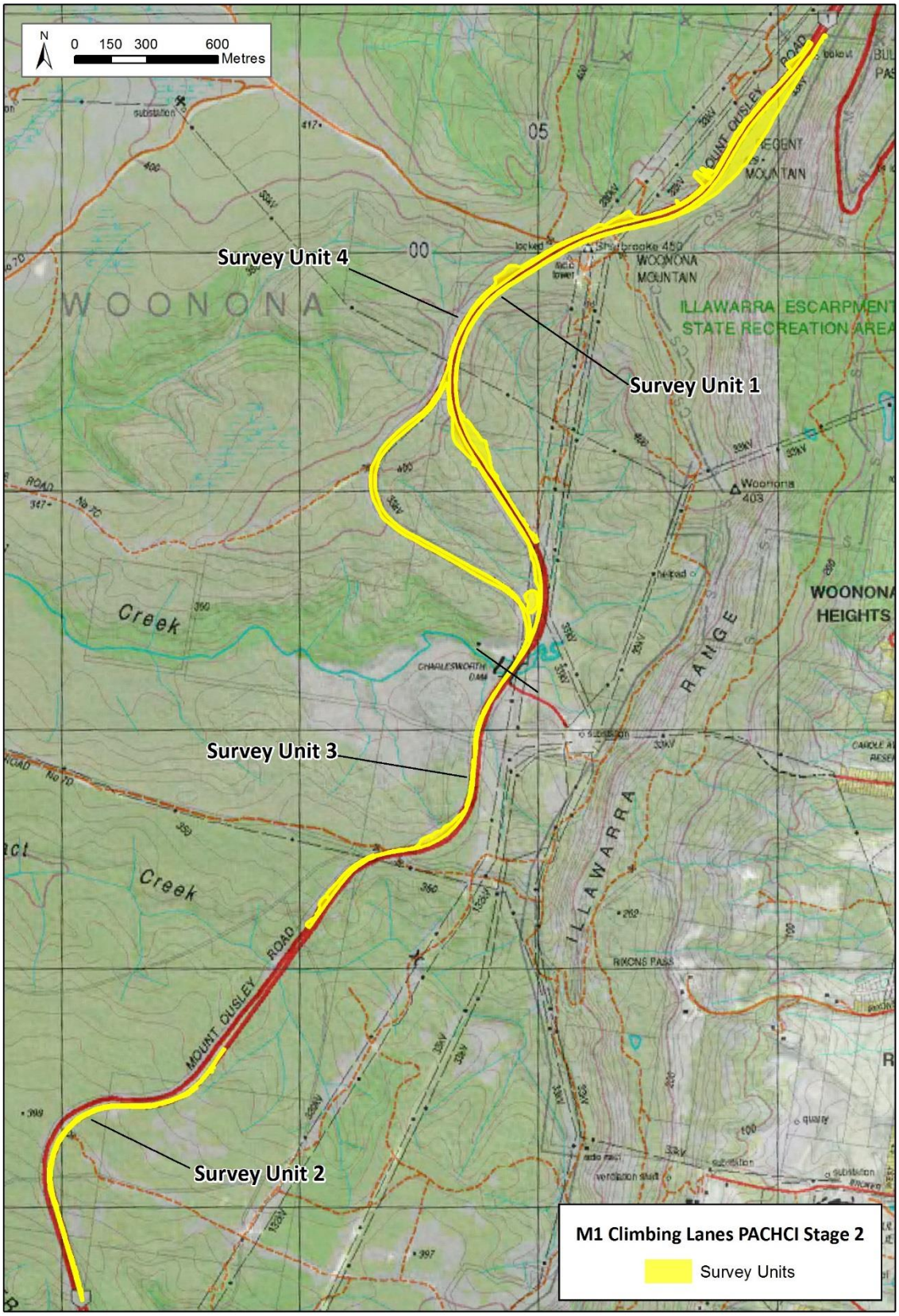
PADs are areas where sub-surface stone artefacts and/or other cultural materials are likely to occur (DECCW 2010: 38). These areas may be associated with recorded sites but are often greater in extent, taking in areas around the visible artefacts where there is a potential for further buried artefacts to exist. PADs may also be present where no visible artefacts are located. This may be the case when there is no ground surface visibility, but the area is seen to have a high likelihood of containing artefacts.

5.2 Survey methodology

The survey was conducted on foot over two and a half days (28 March, 31 March and 1 April). Heavy rain prevented the survey from continuing on the first day. The survey was undertaken by Josh Symons and Alyce Howard (Artefact Heritage). Troy Tungai represented ILALC throughout the survey. Julian Watson (Roads and Maritime) was present on the first morning.

The study area is a long, linear strip of land that crosses multiple landform units. The study area was divided into four survey units, each containing several landform units (see Figure 7). In several small areas, steep slopes and dense vegetation inhibited full survey coverage. These sections were highly disturbed and immediately adjacent to the existing M1 Princes Motorway. Where access to these areas could not be found through alternative routes, photos of these sections were taken. The current survey canvassed the majority of the study area and is deemed to have accurately characterised the study area.

Figure 7: Overview of survey units. Background image source Land and Property Information NSW.



The survey was undertaken in accordance with relevant OEH standards and guidelines, as part of Stage 2 of the Roads and Maritime PACHCI. A handheld Global Positioning System (GPS) was used to track the path of the surveyors, and to record the co-ordinates of sites, features and location of landform units within the study area. An aerial map of the study area was also carried by members of the survey team in the field.

All ground exposures were examined for stone artefacts, shell, or other traces of Aboriginal occupation. Old growth trees were examined for signs of cultural scarring or marking.

A photographic record was kept of all sections of the study area. Photographs were taken to record different aspects of the landform units within the study area, vegetation, levels of disturbance, Aboriginal sites and PADs. Scales were used for photographs where appropriate.

6.0 Results

6.1 Effective survey coverage

The study area was divided into four survey units, each containing several landform units. Most of the study area is modified due to the construction of the existing M1 Princes Motorway. Native scrub is found approximately 20 metres from the road in most areas, although non-native shrubs and weeds dominate the immediate roadside. Surface visibility was extremely low throughout the study area, excepting areas of vehicle tracks, some eroded areas and outcrops of sandstone. Vegetation was impenetrable or extremely dense in several sections of the study area. These sections were accessed via alternative routes and, where access was not possible, photos were taken of the section from without. Drainage channels within the study area were predominately artificial, likely having been created as part of the initial M1 Princes Motorway construction. Visibility and exposure levels have been taken into consideration in determining the effective coverage area on this survey (Table 2 and Table 3); please note that descriptions of visibility and exposure are provided in Section 6.2 below.

Table 2: Survey Coverage

Survey Unit	Landform	Survey unit area (m^2)	Visibility (%)	Exposure (%)	Effective coverage area (m^2)	Effective coverage (%)
1	Slope, crest	56,475	10	10	564.7	1
2	Slope, crest	14,755	10	10	147.5	1
3	Slope, crest	27,773	10	10	277.7	1
4	Slope, crest	37,945	10	10	379.4	1

Table 3: Landform survey coverage

Landform	Landform area (m^2)	Area effectively surveyed (m^2)	% of landform effectively surveyed	Number of sites	Number of artefacts or features
Slope	57,494	574.6	1	-	-
Crest	79,454	794.7	1	-	-

6.2 Survey observations

Survey Unit 1 (see Figure 8)

Survey Unit 1 has been extremely disturbed and modified in places from the construction of the M1 Princes Motorway (Plate 1). Survey Unit 1 includes the widest deviation from the existing M1 Princes Motorway road alignment and, due to this, features the greatest variability of all the survey units. Heavy modification and disturbance borders the existing M1 Princes Motorway road alignment with a width of approximately 15 to 30 metres. Original landforms and native vegetation remain at distances greater than this. Other disturbances within the survey unit include the installation of overhead transmission lines, embankments, and construction of artificial drainage channels (Plate 1, Plate 2 and Plate 4).

Ground surface visibility across the survey unit varied from nil to 40% due to dense vegetation, with overall visibility around 10%. Infrequent exposures were observed along outcrops of sandstone and in areas of roadside disturbance. The main observed landforms include modified crests that border the existing road alignment. Artificial embankments also feature frequently alongside the existing road alignment. At distances greater than 15 to 30 metres from the existing road, natural slopes and crests were observed. Outcrops of sandstone were observed in relatively undisturbed areas and were found to be void of archaeological material.

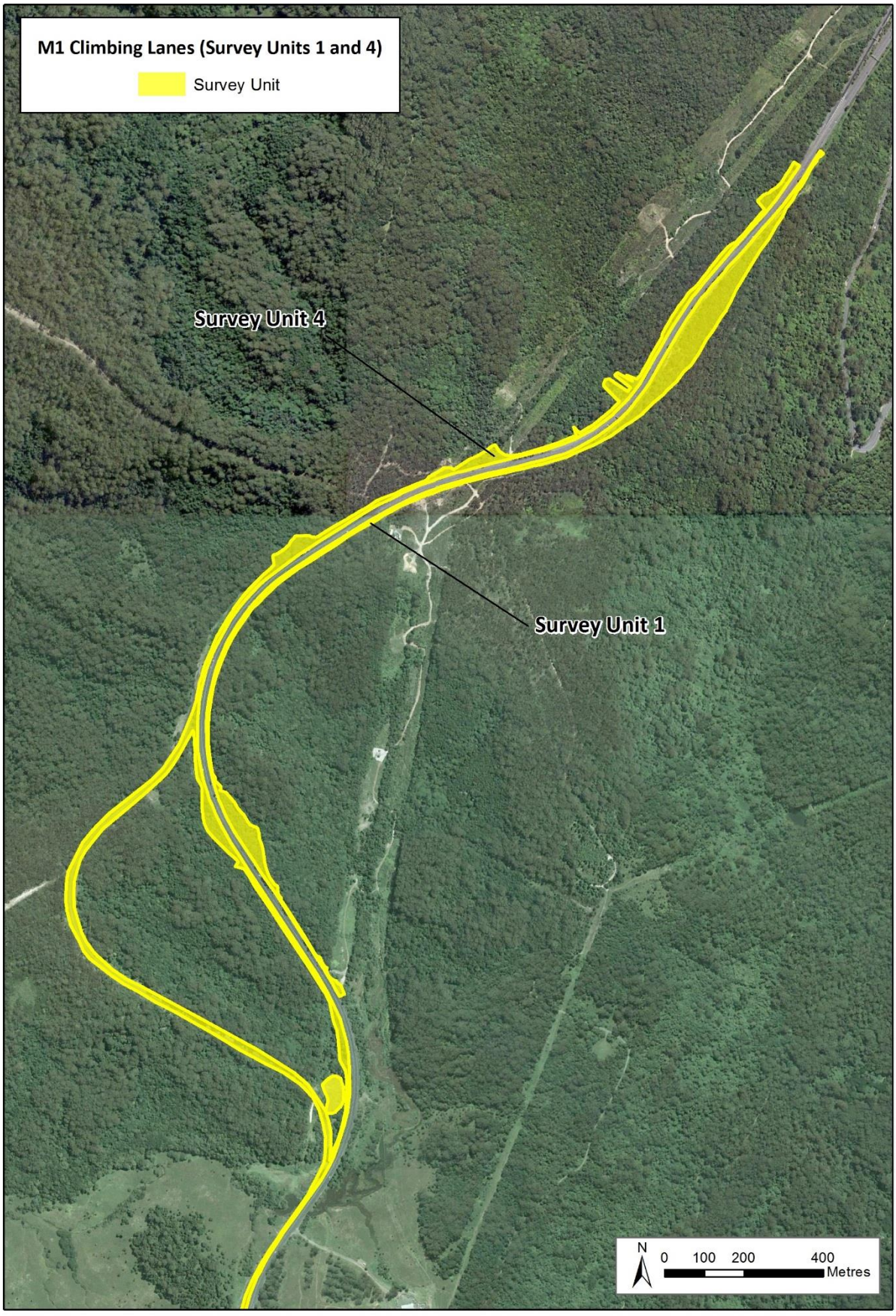
Plate 1: Survey Unit 1 – disturbance and modification associated with motorway, view East.

Plate 2: Survey Unit 1 – transmission line and modified crest associated with motorway, view North.

Plate 3: Survey Unit 1 – outcrops of sandstone in relatively undisturbed area, view East.

Plate 4: Survey Unit 1 – artificial drainage channel incised into sandstone, view Northeast.

Figure 8: Survey units 1 and 4. Background image sourced from Google©2014.



Survey Unit 2 (see Figure 9)

Survey Unit 2 has been extremely disturbed and modified in places from the construction of the M1 Princes Motorway (Plate 5 and Plate 8). Heavy modification and disturbance borders the existing M1 Princes Motorway road alignment with a width of approximately 15 to 50 metres. Some original landforms and native vegetation remain at distances greater than this, though are located outside the proposed works. Disturbances within the survey unit include the installation of overhead transmission lines, embankments, and the construction of stockpile sites (Plate 5 and Plate 8).

Ground surface visibility across the survey unit varied from nil to 40% due to dense vegetation, with overall visibility around 10%. Infrequent exposures were observed along outcrops of sandstone and in areas of roadside disturbance. The main observed landforms include modified crests that border the existing road alignment. Artificial embankments also feature frequently alongside the existing road alignment. At distances greater than 15 to 30 metres from the existing road, natural slopes and crests were observed. Outcrops of sandstone were observed in relatively undisturbed areas. The outcrops of sandstone were found to be void of archaeological material (Plate 6). A rock shelter was observed at 303125 mE 6195635 mN (Plate 7). The floor consists of rock fall with no deposit and no surface artefactual material. The presence of this shelter would have no impact on the current study as it presents no archaeological potential and is located approximately 30 metres east of the proposed road realignment.

Plate 5: Survey Unit 2 – old stockpile site, view North.

Plate 6: Survey Unit 2 – outcropping sandstone, view East.

Plate 7: Survey Unit 2 – Rock shelter, view Northeast.

Plate 8: Survey Unit 2 – steep modified slope and inhibitive vegetation, view Northeast.

Figure 9: Survey unit 2. Background image sourced from Google© 2014.

Survey Unit 3 (see Figure 10)

Survey Unit 3 has been extremely disturbed and modified in places from the construction of the M1 Princes Motorway (Plate 9). Heavy modification and disturbance borders the existing M1 Princes Motorway road alignment with a width of approximately 15 to 50 metres. Some native vegetation has regrown in places (Plate 10). Other disturbances within the survey unit include the old road alignment (Plate 12), installation of overhead transmission lines, embankments, and the construction of stockpile sites.

Ground surface visibility across the survey unit varied from nil to 40% due to dense vegetation (Plate 11) with overall visibility around 10%. Infrequent exposures were observed along outcrops of sandstone and in areas of roadside disturbance. The main observed landforms include modified crests that border the existing road alignment. Artificial embankments also feature frequently alongside the existing road alignment.

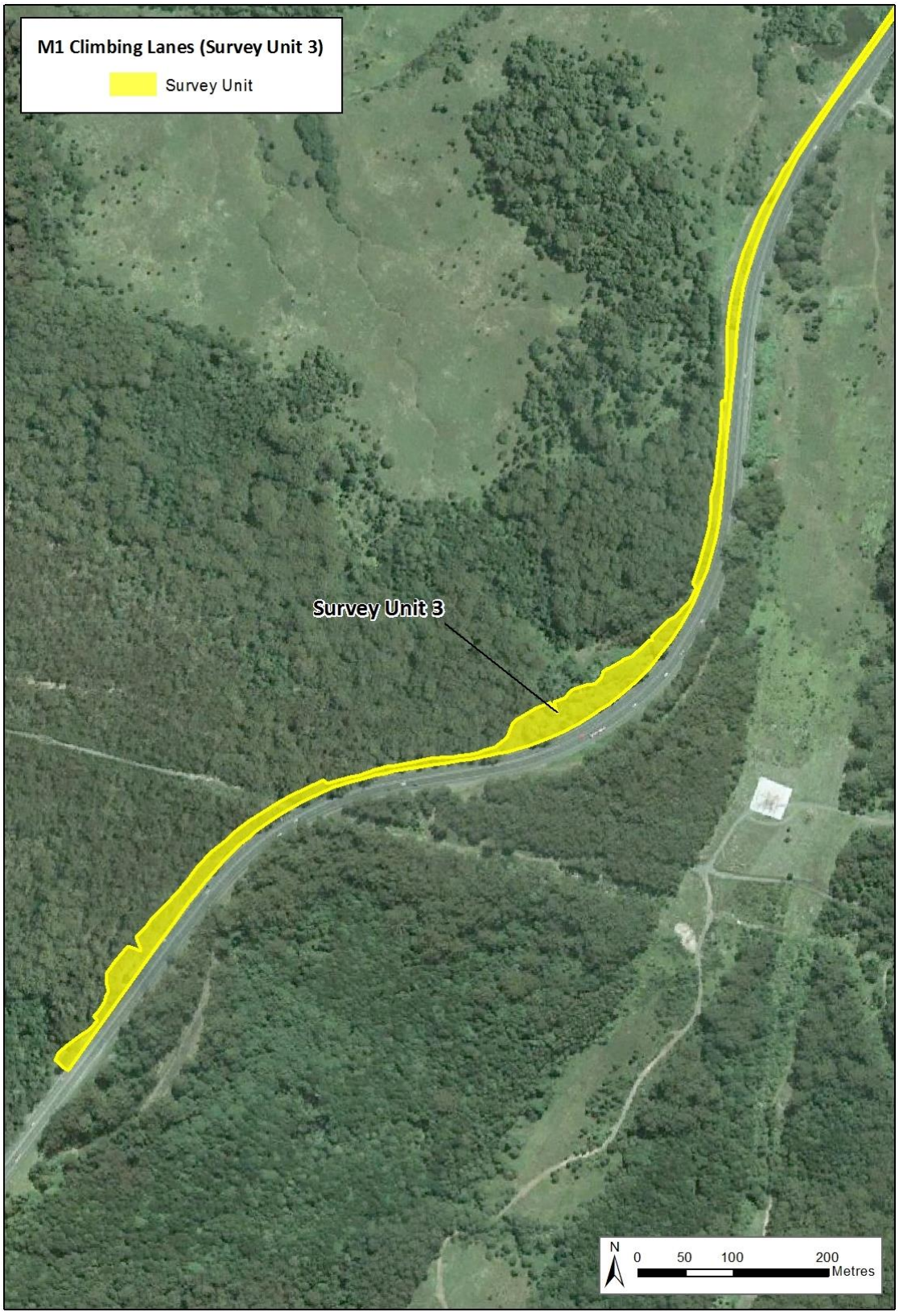
Plate 9: Survey Unit 3 – Modified crest, view South.

Plate 10: Survey Unit 3 – Young growth eucalypt forest, view South.

Plate 11: Survey Unit 3 –Impenetrable vegetation, view North.

Plate 12: Survey Unit 3 – Old road alignment, view North.

Figure 10: Survey unit 3. Background image sourced from Google© 2014



Survey Unit 4 (see Figure 11)

Survey Unit 4 has been extremely disturbed and modified in places from the construction of the M1 Princes Motorway. Heavy modification and disturbance borders the existing M1 Princes Motorway road alignment with a width of approximately 15 metres to 50 metres. Some original landforms and native vegetation remain at distances greater than this (Plate 13). Other disturbances within the survey unit include the old road alignment, installation of overhead transmission lines, embankments, and the construction of stockpile sites and drainage channels (Plate 14, Plate 15 and Plate 16).

Ground surface visibility across the survey unit varied from nil to 40% due to dense vegetation, with overall visibility around 10%. Infrequent exposures were observed along outcrops of sandstone and in areas of roadside disturbance. The main observed landforms include modified crests that border the existing road alignment. Artificial embankments also feature frequently alongside the existing road alignment. The Potential Stockpile site was evidently used in the past for stockpiling purposes as gravel remains beneath the dense grasses that have overgrown throughout the site (Plate 14).

A relatively unmodified slope was observed within Survey Unit 4 (Plate 13). The slope featured large outcrops of sandstone which were inspected and found to be void of archaeological material.

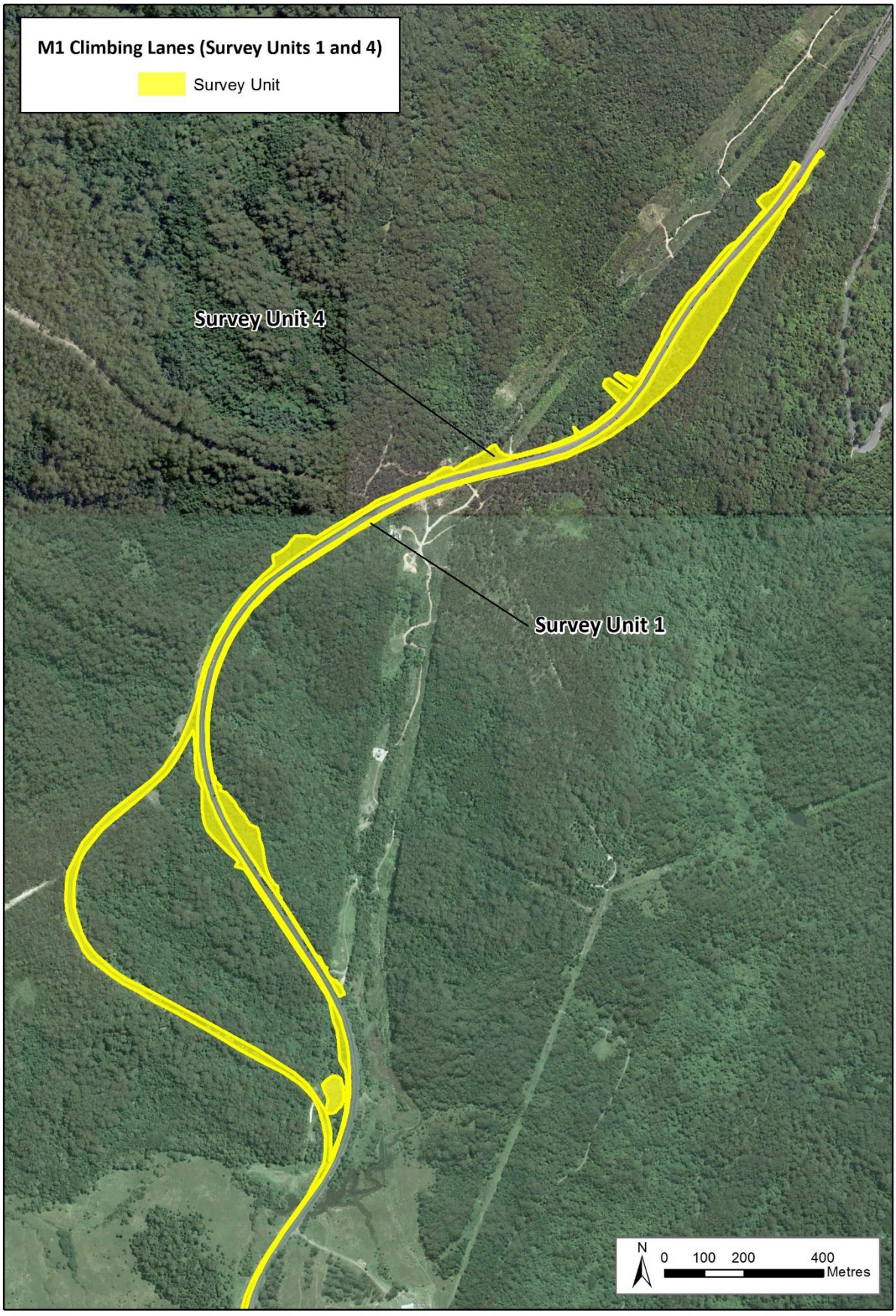
Plate 13: Survey Unit 4 – Outcropping sandstone, unmodified slope, view East.

Plate 14: Survey Unit 4 - Potential Stockpile site, view South.

Plate 15: Survey Unit 4 – Artificial drainage channel, view North.

Plate 16: Survey Unit 4 – Modified slope, view East.

Figure 11: Survey units 1 and 4. Background image sourced from Google© 2014.



6.3 Summary of results

No previously recorded Aboriginal sites were located within the study area. No previously unrecorded Aboriginal sites were detected during the field survey. High levels of disturbance and modification are present throughout most of the study area.

7.0 Analysis and Discussion

7.1 Disturbance levels

Overall the study area features high levels of ground disturbance. The construction of the existing M1 Princes Motorway and associated ground modification has resulted in disturbance along most of the study area. Modification and disturbance generally bordered the existing motorway with a width of 15 to 50 metre throughout the study area. Original landforms and native vegetation were occasionally observed outside of this margin of disturbance.

Survey Unit 1 has been highly disturbed and modified from the construction of the existing M1 Princes Motorway. Survey Unit 1 includes the widest deviation from the existing M1 Princes Motorway road alignment and, as such, features the greatest variability of all the survey units. The extreme modification and disturbance which borders the existing M1 Princes Motorway road alignment is contrasted by the relatively pristine area to the east, within the proposed 600R realignment (see Appendices). It is understood that Roads and Maritime has a variety of options for realignment in Survey Unit 1, the widest of which being the 600R configuration which would effectively cut through pristine bushland.

Survey Units 2, 3 and 4 are all extremely disturbed and modified from the construction of the existing M1 Princes Motorway. Associated infrastructure such as stockpile sites, transmission lines, artificial drainage channels and embankments all occur frequently throughout the study area.

Two areas were identified as relatively undisturbed and unmodified within the study area. The first is located in Survey Unit 1 along the proposed 600R alignment and consists of original bushland, with unmodified slopes and crests. The second is located in Survey Unit 4 and is an unmodified slope. Both areas contained sandstone outcrops. All sandstone outcrops were inspected and found to be void of archaeological material.

Smaller, more fragmented sandstone outcrops were noted throughout the study area. Visibility on sandstone outcrops was slightly increased, ranging from 10-40%. All sandstone was inspected and found to be void of archaeological material.

7.2 Archaeological potential

Archaeological potential is closely related to the levels of ground disturbance in the area. Other factors are also taken into account when assessing archaeological potential, such as whether artefacts were located on the surface, and whether the area is within a sensitive landform unit according to the predictive statements for the area.

The majority of the study area has been impacted from construction of the M1 Princes Motorway. These disturbances include large artificial embankments, large sandstone cuttings, extensive drainage work adjacent the current road alignment, and previous road alignments. Where intact areas were identified, slope characteristics and distance from water sources suggest that those areas represent limited archaeological potential. Intact sandstone outcrops were observed, but were generally found to be largely fragmented, with no overhang formations or engravings identified.

The crests and slopes of Survey Units 2 and 3 were extremely modified and disturbed and found to have low archaeological potential. Two relatively intact landforms were identified within the study area, in Survey Units 1 and 4. These landforms were inspected for archaeological material and potential and found void.

Dense vegetation prohibited survey in several small areas. However, these areas were predominately steep, heavily modified slopes and as such, present low archaeological potential. Overall, the survey is deemed to have accurately characterised the study area.

No previously recorded Aboriginal sites were identified within the study area. No Aboriginal objects or areas of potential were identified during this survey.

No shell midden or scarred tree Aboriginal sites were observed during the field survey. No specific areas for burials were identified during the field survey. As burials have the potential to occur across the landscape, should human skeletal material be encountered during works, all work must cease immediately and the NSW Police and the OEH must be notified.

8.0 Statutory Requirements

This study has been undertaken in the context of several items of legislation that relate to Aboriginal heritage and its protection in New South Wales.

National Parks and Wildlife Act (1974)

The *National Parks & Wildlife Act 1974*, administered by the OEH provides statutory protection for all Aboriginal 'objects' (consisting of any material evidence of the Aboriginal occupation of NSW) under Section 90 of the Act, and for 'Aboriginal Places' (areas of cultural significance to the Aboriginal community) under Section 84.

The protection provided to Aboriginal objects applies irrespective of the level of their significance or issues of land tenure. However, areas are only gazetted as Aboriginal Places if the Minister is satisfied that sufficient evidence exists to demonstrate that the location was and/or is, of special significance to Aboriginal culture.

The Act was amended in 2010 and, as a result, the legislative structure for seeking permission to impact on heritage items has changed. A section 90 permit is now the only Aboriginal Heritage Impact Permit (AHIP) available and is granted by the OEH. Various factors are considered by OEH in the AHIP application process, such as site significance, Aboriginal consultation requirements, ESD principles, project justification and consideration of alternatives. The penalties and fines for damaging or defacing an Aboriginal object have also recently been increased.

As part of the administration of Part 6 of the Act OEH regulatory guidelines on Aboriginal consultation are in place, which are outlined in the Consultation Requirements. Guidelines are also in place for the processes of due diligence - *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (2010), and for investigation of Aboriginal objects – the Code of Practice in accordance with the 2010 amendment to the Act.

There are no gazetted Aboriginal Places within the study area. The nearest Aboriginal Place to the study area is the Sandon Point Aboriginal Place, located approximately 4.5 kilometres east of the study area. There are two registered Aboriginal sites within the study area which are subject to the provisions of the National Parks and Wildlife Act 1974. All Aboriginal objects, whether recorded or not are protected under the Act.

Heritage Act (1977)

The Heritage Act 1977 is administered by the Department of Premier and Cabinet and protects the natural and cultural heritage of NSW. Generally this Act only pertains to Aboriginal Heritage if it is listed on the State Heritage Register, or subject to an interim heritage order.

There are no Aboriginal heritage items listed on the State Heritage Register within the study area.

Aboriginal Land Rights Act (1983)

The Aboriginal Land Rights Act 1983 is administered by the NSW Department of Human Services - Aboriginal Affairs. This Act established Aboriginal Land Councils (at State and Local levels). These bodies have a statutory obligation under the Act to; (a) take action to protect the culture and heritage of Aboriginal persons in the council's area, subject to any other law, and (b) promote awareness in the community of the culture and heritage of Aboriginal persons in the council's area.

There are no lands held, or currently claimed, by the Local Aboriginal Land Council under the Aboriginal Land Rights Act 1983 within the study area.

Native Title Act (1994)

The Native Title Act 1994 was introduced to work in conjunction with the Commonwealth Native Title Act. Native Title claims, registers and Indigenous Land Use Agreements are administered under the Act.

There are no Native Title claims registered within the study area.

9.0 Significance Assessment

9.1 Assessment criteria

Archaeological significance refers to the archaeological or scientific importance of a landscape, site or area. This is characterised using archaeological criteria such as archaeological research potential, representativeness and rarity of the archaeological resource and potential for educational values. These are outlined below:

- Research potential: does the evidence suggest any potential to contribute to an understanding of the area and/or region and/or state's natural and cultural history?
- Representativeness: how much variability (outside and/or inside the subject area) exists, what is already conserved, how much connectivity is there?
- Rarity: is the subject area important in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- Education potential: does the subject area contain teaching sites or sites that might have teaching potential?

If a Stage 3 PACHCI assessment is required, cultural values and significance would be discussed by the Aboriginal groups during the ongoing consultation, details of which would be contained in the Cultural Heritage Assessment Report of the Roads and Maritime PACHCI.

9.2 Archaeological significance assessment

No Aboriginal sites were previously recorded within the study area. No new Aboriginal sites were identified during the current study. The study area was largely heavily disturbed and modified. The study area was assessed as demonstrating low archaeological significance.

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10.0 Impact Assessment

10.1 Impact assessment

It has been identified that the proposed works will largely be contained within areas that are already highly disturbed and modified. The undisturbed areas that may be impacted were found to have low archaeological significance. No areas were identified as having archaeological potential within the study area.

The impact assessment has therefore found that there will be no impact to known Aboriginal sites and/or places or identified areas of potential under the proposed works.

11.0 Management and Mitigation Measures

11.1 Guiding principles

The overall guiding principle for cultural heritage management is that where possible Aboriginal sites would be conserved. If conservation is not practical, measures would be taken to mitigate against impacts to Aboriginal sites.

The nature of the mitigation measures recommended is primarily based on an assessment of archaeological significance. The final recommendations would also be informed by the comments from ILALC.

11.2 Mitigation measures

In accordance with The Code guidelines and the Roads and Maritime Stage 2 PACHCI guidelines, the current assessment has established that the entire study area has low archaeological significance and no previously recorded Aboriginal sites and/or places are located within the boundaries of the study area. No areas of archaeological potential were identified during the assessment within the proposed study area.

No further Aboriginal archaeological investigation is required for the proposed works.

If unforseen Aboriginal objects are uncovered during development, Roads and Maritime will follow the Roads and Maritime Unexpected Finds procedures (Section 5.8 of the Roads and Maritime PACHCI) which outline that work must cease and an archaeologist, the OEH and the ILALC must be informed. Further, under the Roads and Maritime PACHCI requirements a Stage 3 PACHCI would need to be undertaken and an AHIP would be required under the code of practice (OEH 2010) for works to continue.

If human remains are found, work must cease, the site must be secured and the NSW Police and the Office of Environment and Heritage must be notified.

12.0 Recommendations

The following recommendations were based on consideration of:

- Statutory requirements under the *National Parks and Wildlife Act 1974* as amended.
- The *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* DECCW (24 September 2010).
- The results of the background research, site survey and assessment.
- The interests of the ILALC.
- The likely impacts of the proposed development.

It was found that:

- No Aboriginal sites or places were previously recorded within the study area.
- No new sites or areas of archaeological potential were located within the study area.
- The study area has been subject to high levels of disturbance.

It is therefore recommended that:

- the proposed works are able to proceed without the need for further archaeological and/or Aboriginal heritage assessment;
- if the project design is changed and areas not surveyed are to be impacted, further archaeological assessment would be required.
- if Aboriginal objects are located during works the Roads and Maritime Unexpected Finds procedures must be followed. These procedures state that the OEH, an archaeologist, and the ILALC must be notified; and
- if human skeletal material is encountered during works, all work must cease immediately and the NSW Police and the OEH must be notified. If the skeletal material is found to be Aboriginal, a process of consultation and investigation in accordance with the OEH and Roads and Maritime guidelines must be implemented prior to the re-commencement of works.

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10 November 2016

Julian Watson
Project Development Manager
Roads and Maritime Services
Level 6, 90 Crown Street
Wollongong NSW 2500

Dear Julian,

Re: Addendum to the PACHCI Stage 2 Archaeological Survey Report for the M1 Princes Motorway Improvements Project

Artefact Heritage prepared an archaeological survey report in 2014 as part of Stage 2 of the Roads and Maritime Services (Roads and Maritime) Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) investigation for the proposed M1 Princes Motorway improvements project (Artefact 2014a); located between Bulli Pass, at Bulli Tops, and Picton Road, Mount Ousley, on the Illawarra escarpment. Following the finalisation of the document in October 2014, an addendum Stage 2 PACHI report was prepared to assess an additional three kilometres of road alignment, referred to as Option D4 (Artefact 2014b).

A scope change is proposed which provides for six continuous lanes (three in each direction), between Picton Road and Bellambi Creek (Stage 1), and six lanes in a future Stage 2 between Bellambi Creek and the M1 / Appin Road diverge. These additional work areas are detailed in Figure 1 and Figure 2.

Roads and Maritime have engaged Artefact Heritage to prepare an updated addendum to investigate these additional proposal areas, which had not been assessed by the previous documents. This addendum should be read in conjunction with the original PACHCI Stage 2 investigations (Artefact 2014a and 2014b).

1.0 The Proposal

The M1 Princes Motorway between Picton Road and Bulli Tops is currently two lanes in each direction.

This section of road carries about 37,000 vehicles a day, 15 percent of which are heavy vehicles. Traffic numbers will continue to increase along this route.

Due to the steepness of the road and the tight turns, heavy vehicles have a slow uphill travel speed, which can lead to a large difference in speeds between light vehicles and heavy vehicles.

1.1 Previous scope

The previous scope was for a single stage project for the construction of four climbing lanes predominately on the existing alignment. The lanes were located at various locations between Picton

Road in the south and Bulli Tops (near Bulli Pass) in the north. The project would have provided for various lane combinations.

At the northern end of the project, between Bellambi Creek and Bulli Tops, a six lane arrangement was proposed largely on alignment, with one offline section where a 400m radius curve was to be replaced with a 600m radius curve, and the vertical alignment improved in the realigned extent.

In the southern end of the project, two climbing lanes were proposed, one northbound (between Cataract Creek and Bellambi Creek) and one southbound (between Cataract Creek and near to Picton Road).

1.2 Proposed scope change

A scope change was proposed which provides additional lanes and straighten out the road to improve safety, capacity and efficiency. The project will now be divided into two stages:

Stage one

The first stage of the project will provide an additional lane in each direction of the M1 between Picton Road and Bellambi Creek. The tight curves on the existing M1 north of Picton Road and South of Bellambi Creek will be straightened out to improve safety and traffic efficiency.

Stage two

The second stage of the project will link directly into stage one and will provide an additional lane in each direction between Bellambi Creek and Bulli Tops. The planning and design for stage two will be carried out with stage one.

It is considered that this scope change better meets the project objectives, provides a long term networks solution and allows for significant improvements in Safety in Design, constructability and maintenance capability.

This survey report covers the changes in design that have not be previously surveyed, as well as a number of proposed works sites.

2.0 Objectives of Addendum

This addendum report outlines the following information:

- Assessment of impact within the additional proposal areas
- An updated AHIMS search
- Development of a significance assessment and impact assessment for Aboriginal sites located within the additional proposal areas
- Recommendations for management and mitigation measures for Aboriginal sites within the proposed additional proposal areas.

This addendum report deals solely with the findings of the survey of the additional proposal areas supplied to Artefact Heritage in August 2015. Details of the proposal as a whole, including environmental and archaeological context of the local area, Aboriginal histories of the area, and predictive modelling are outlined in prior reporting (Artefact 2014a and 2014b).

3.0 Investigators and Contributors

This addendum was written by Alexander Timms (Archaeologist). Dr Sandra Wallace (Principal Archaeologist) provided management input and reviewed the report.

4.0 Aboriginal Stakeholder Consultation

Aboriginal stakeholder consultation was conducted by Roads and Maritime as per the PACHCI guidelines.

Representatives of Illawarra Local Aboriginal Land Council (ILALC) were invited to take part in the site survey. Jody Stewart and David Lawrence (ILALC) took part in the survey of the addendum areas on the 8 September and 10 September respectively.

David Lawrence indicated that the area would be part of the hunting grounds available to Aboriginal people. He identified a number of types of native vegetation; including Red Cedar and Cabbage Tree Palms which were useful resource, and have value to the Aboriginal community. He noted that there was a potential scarred tree (fallen over) within survey unit 5; however it has been interpreted as a natural scar (see Section 10.5).

Roads and Maritime forwarded a copy of this report to ILALC for review and comment.

Figure 1: Location and Design of M1 Improvements project – Stage 1

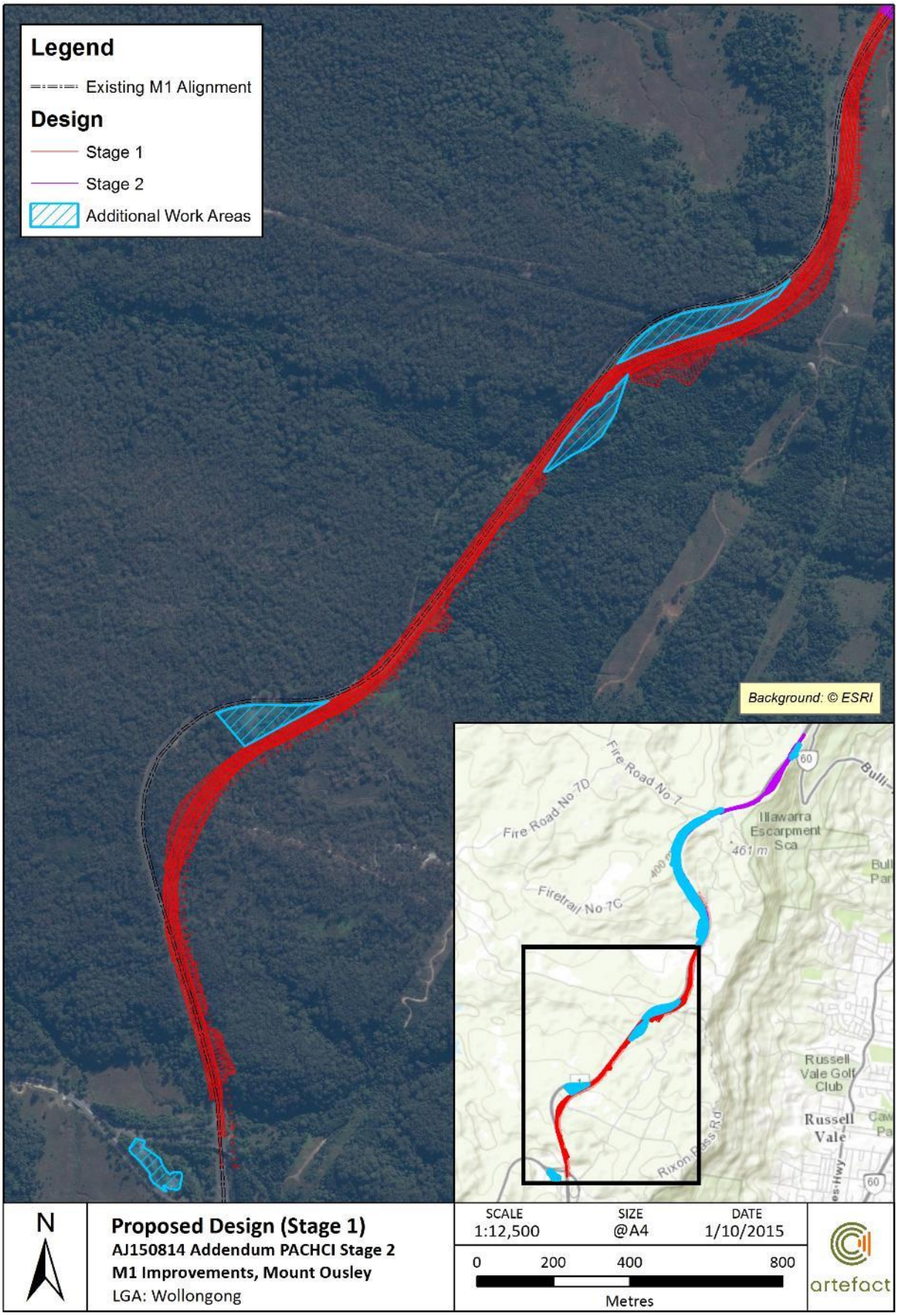
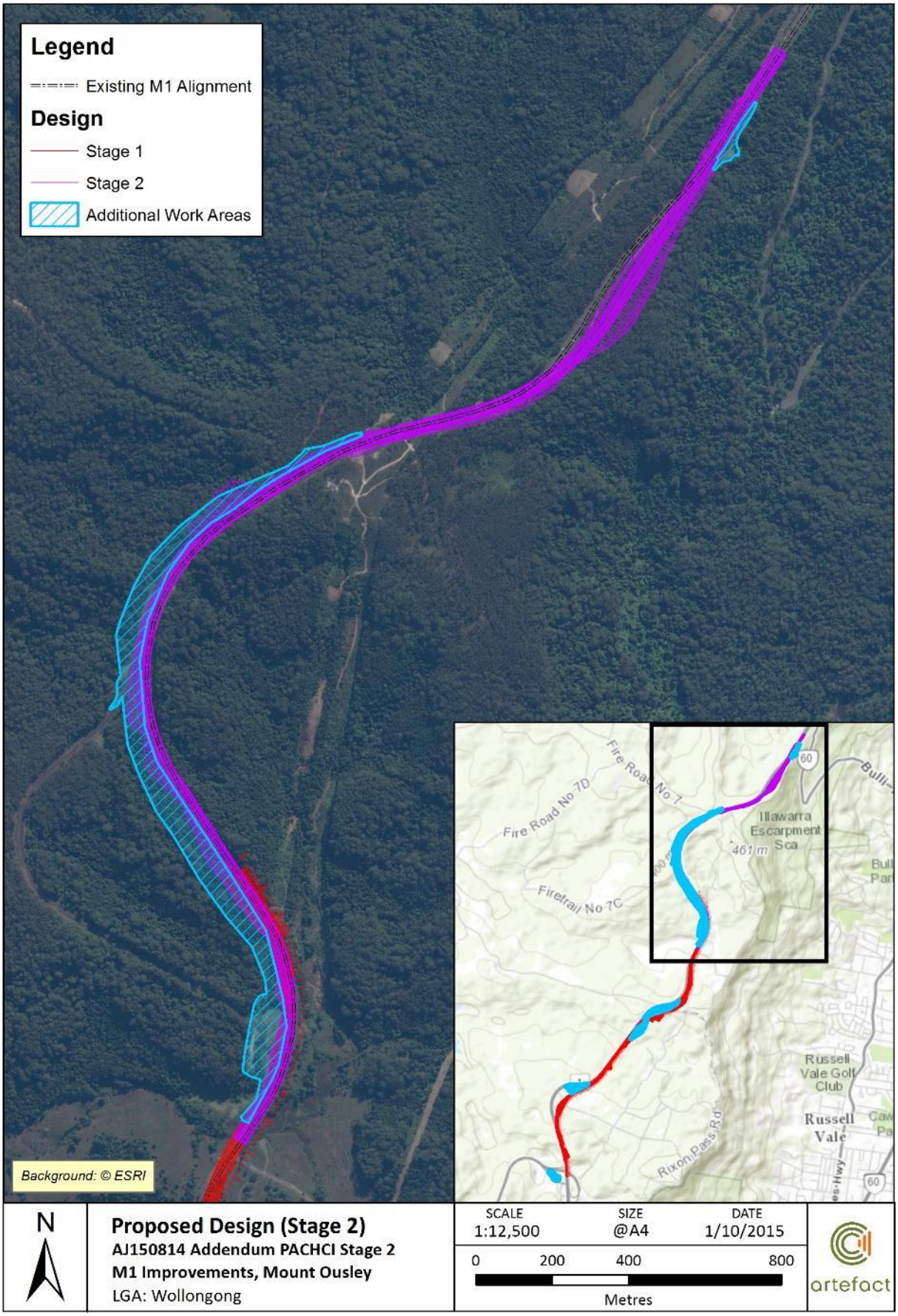


Figure 2: Location and Design of M1 Improvements project – Stage 2



5.0 Legislative Context

This addendum report was prepared in accordance with the following NSW legislation and legislative guidelines:

National Parks & Wildlife Act (1974)

The *National Parks & Wildlife Act 1974* (the NP&W Act) provides statutory protection for all Aboriginal 'objects' (consisting of any material evidence of the Aboriginal occupation of NSW) under Section 90 of the Act, and for 'Aboriginal Places' (areas of cultural significance to the Aboriginal community) under Section 90. Aboriginal objects are afforded automatic statutory protection in NSW whereby it is an offence to:

> *"…damage, deface or destroy Aboriginal sites without the prior consent of the Director-General of the National Parks and Wildlife Service (now the OEH)".*

The Act defines an Aboriginal 'object' as:

> *"…any deposit, object or material evidence (not being a handicraft for sale) relating to indigenous and non-European habitation of the area that comprises New South Wales, being habitation before or concurrent with the occupation of that area by persons of non-Aboriginal European extraction, and includes Aboriginal remains".*

The Act was recently amended (2010), with the legislative structure for seeking permission to impact on heritage items modified. An s90 permit is now the only Aboriginal Heritage Impact Permit (AHIP) available and may only be granted by OEH if the conditions of the 'due diligence guidelines', and/or an 'archaeological investigation' have been met. The penalties and fines for damaging or defacing an Aboriginal object have also increased.

The Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (the EP&A Act) establishes the framework for cultural heritage values to be formally assessed in the land use planning and development consent process. The EP&A Act requires that environmental impact are considered before land development; this includes impact on cultural heritage items and places as well as archaeological sites and deposits. The overall study area falls within the boundary of Wollongong LGA and is covered by the Wollongong Local Environmental Plan (LEP) 2009.

6.0 Background Information

The below is a summary of the background information, as this addendum is designed to be read in conjunction with the original PACHCI Stage 2 investigations (Artefact 2014a and 2014b). Please refer to these documents for full details.

6.1 Environmental Context

The study area is located within the Sydney Basin, a large sedimentary basin extending from Newcastle to Batemans Bay and west to Lithgow. The upper geological layers of the study area are dominated by the Hawkesbury Sandstone unit, the predominant sandstone layer of the Sydney Basin.

The eastern portion of the study area is interspersed with small regions of Narrabeen Group sandstones, including Newport and Garie formations, as well as small regions of Bulga Sandstone (Stroud et al 1985).

The dominant landform feature of the Illawarra, an escarpment comprising a large vertical exposure of Sydney Basin sedimentary units, runs through eastern portion of the study area. The M1 Princes Motorway approximates the contour of the Illawarra Escarpment and is located to its west, atop the associated plateau. The Illawarra Escarpment in this region features an outlying high point called Mt Keira, located south of the study area. The crest of Mt Keira is formed by a remnant layer of Hawkesbury Sandstone that has remained more resistant to erosional processes than surrounding sandstone.

The study area is generally located across the higher portions of the Illawarra Escarpment, a landform feature which forms the watershed between drainage to the east across the Illawarra Plain, and drainage to the west and inland to the Nepean / Hawkesbury River system. The study area is therefore generally associated with unnamed ephemeral headwaters, with two more significant water crossings including Bellambi Creek and Cataract Creek.

6.2 Land Use History

Present day Wollongong was an attractive region in early colonial history due to its proximity to Sydney, fertile land and the presence of woodland and natural mineral resources. The Illawarra Escarpment, however, has been notoriously difficult to traverse. Historic and modern land use in the study area predominately concerns transport and access to the Wollongong region. In 1821 Cornelius O'Brien found a pass from Mt Nebo to Figtree and utilized it as a private toll road (Hagan & Wells 1997). Numerous alternative and precarious routes were found over the following years as the need for overland transport increased until 1868 when wheeled vehicles were able to use the Bulli Pass (Bayley 1989). Mount Ousley Road was built as an alternative route to Bulli Pass, traversing the Illawarra Escarpment further south and entering Wollongong just north of the city (Kass 2010).

6.3 Aboriginal Ethno-Historic Context

Aboriginal people traditionally lived in small family or clan groups that were associated with particular territories or places. The study area is located within the Dharawal language group area (Attenbrow 2010: 34). The Dharawal language group was largely coastal and is thought to have extended from the Shoalhaven River in the south, to Botany Bay in the north and then inland to Camden (Attenbrow 2010: 34). The study area falls within the territory of the Dharawal-speaking Wodi Wodi people. Tindale (1974) described the territory of the Wodi Wodi as extending from north of the Shoalhaven River at Nowra to Wollongong and inland to Moss Vale.

7.0 Aboriginal Heritage Information Management System (AHIMS) search

An area of approximately 7 km (east-west) by 10 km (north-south) was searched to gain information on the archaeological context of the study area, and to ascertain whether there are any previously recorded Aboriginal sites within the study area. An extensive search of the Aboriginal Heritage Information System (AHIMS) database was undertaken on the 10 November 2016 for sites registered within the following coordinates:

GDA 1994 MGA 56	301934 – 307267
	6193959 – 6202028
Buffer	1000 m
Number of sites	62
AHIMS Search ID	253472

A total of 62 sites were identified by the extensive AHIMS search. The frequency of recorded site types is summarised in Table 1 below. The distribution of recorded sites within the AHIMS search area is shown in Figure 3.

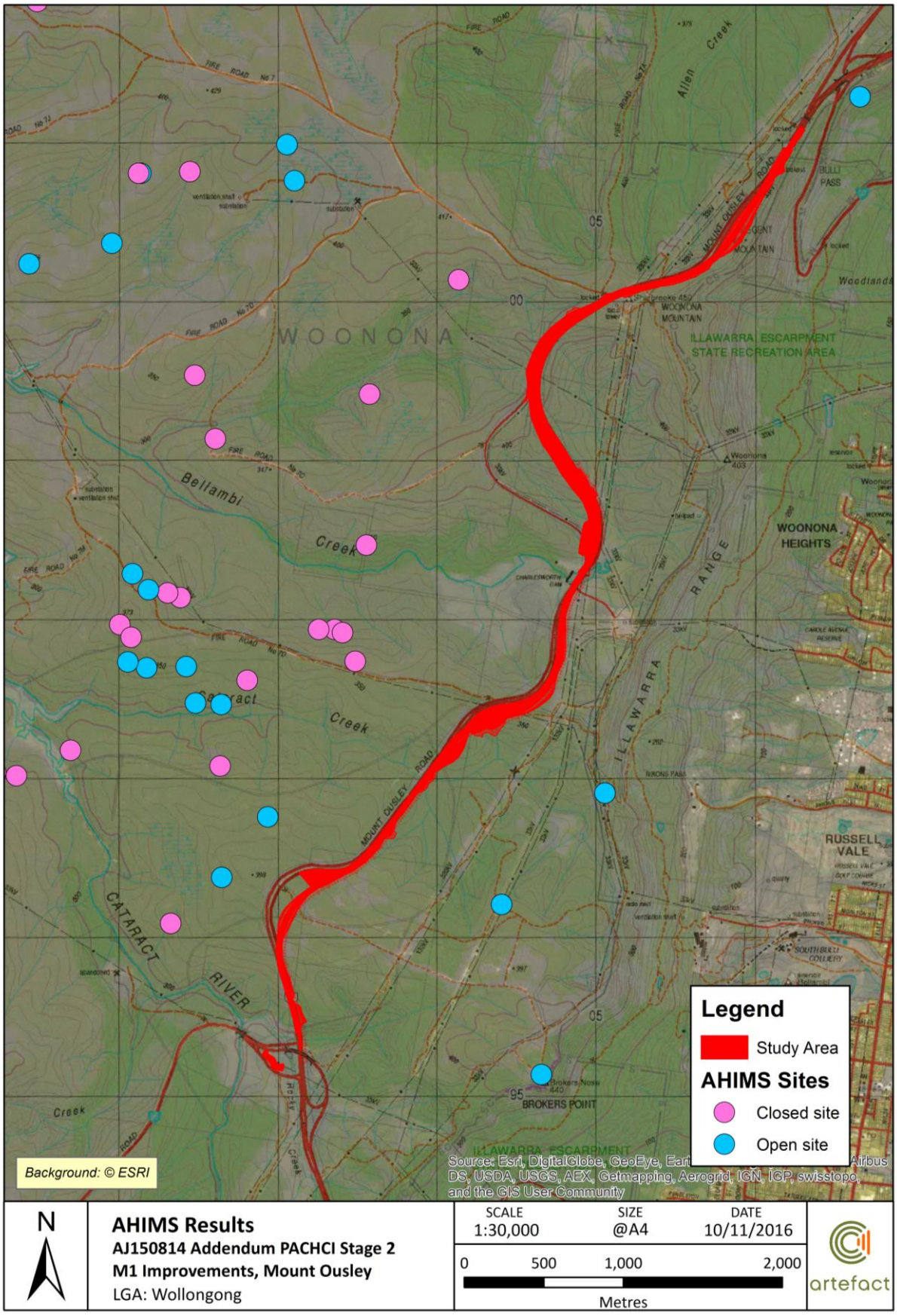
The location of Aboriginal sites is considered culturally sensitive information. It is advised this information, including the AHIMS data appearing on the heritage map for the proposal be removed from this report if it is to enter the public domain.

Table 1: Frequency of site features from AHIMS data

Site Feature	Frequency	Percentage
Artefact	17	27
Grinding Groove	13	21
Artefact, Art (Pigment or Engraved)	12	19
Art (Pigment or Engraved)	10	16
Grinding Groove, Artefact, Art (Pigment or Engraved)	3	5.5
Artefact, Potential Archaeological Deposit (PAD)	3	5.5
Grinding Groove, Art (Pigment or Engraved)	1	1.5
Burial	1	1.5
Artefact, Grinding Groove	1	1.5
Aboriginal Resource and Gathering, Stone Arrangement	1	1.5

The predominant site type located within the AHIMS search area is artefact sites (n=17, 27%), followed by grinding grooves (n=13, 21%), artefact and art sites (n=12, 19%), and art (pigment or engraved) sites (n=10, 16%). The remaining sites types include grinding groove, artefact and art sites (n=3, 5.5%), artefact, potential archaeological deposit (n=3, 5.5%), grinding groove, art (n=1, 1.5%), burial (n=1, 1.5%), artefact and grinding groove (n=1, 1.5%), Aboriginal resource and gathering, stone arrangement (n=1, 1.5%).

Figure 3: AHIMS Results



8.0 Survey Methodology

Pedestrian survey of the additional proposal areas was conducted on the 8 September and 10 September 2015 by Alexander Timms and Duncan Jones (Artefact Heritage). Jody Stewart (ILALC) took part in the survey on the 8 September 2015. David Lawrence (ILALC) took part in the survey on the 10 September 2015.

Survey units were defined by areas of additional impact (Figure 4 and Figure 5). Each survey unit was given an arbitrary number (1 to 6) to assist in identification and description.

A sample survey of the additional areas was carried out. A sample survey is acceptable under the OEH *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* 2010 (Code of Practice) with justification. Sample survey was utilised as most survey units contained very small proportions of ground surface exposure. Grass and vegetation coverage was dense in all survey areas, resulting in poor visibility throughout the study area. All exposures within the addendum areas were targeted however, and investigated for Aboriginal cultural material. Old growth native trees were similarly targeted for evidence of cultural modification. Local landforms, evidence of land use history and previous research were used to inform assessments of archaeological potential.

Figure 4: Addendum Survey Units (Stage 1)

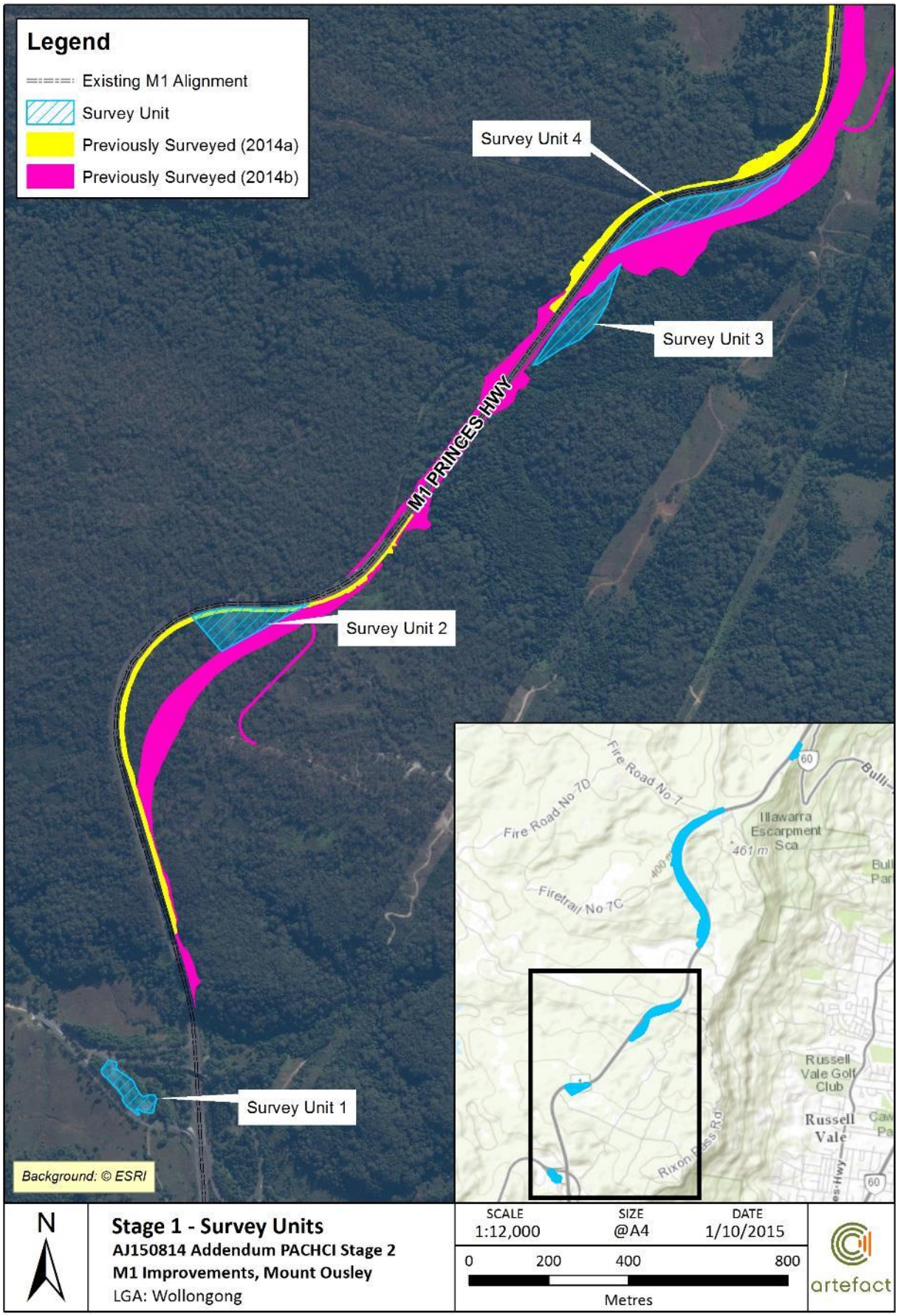
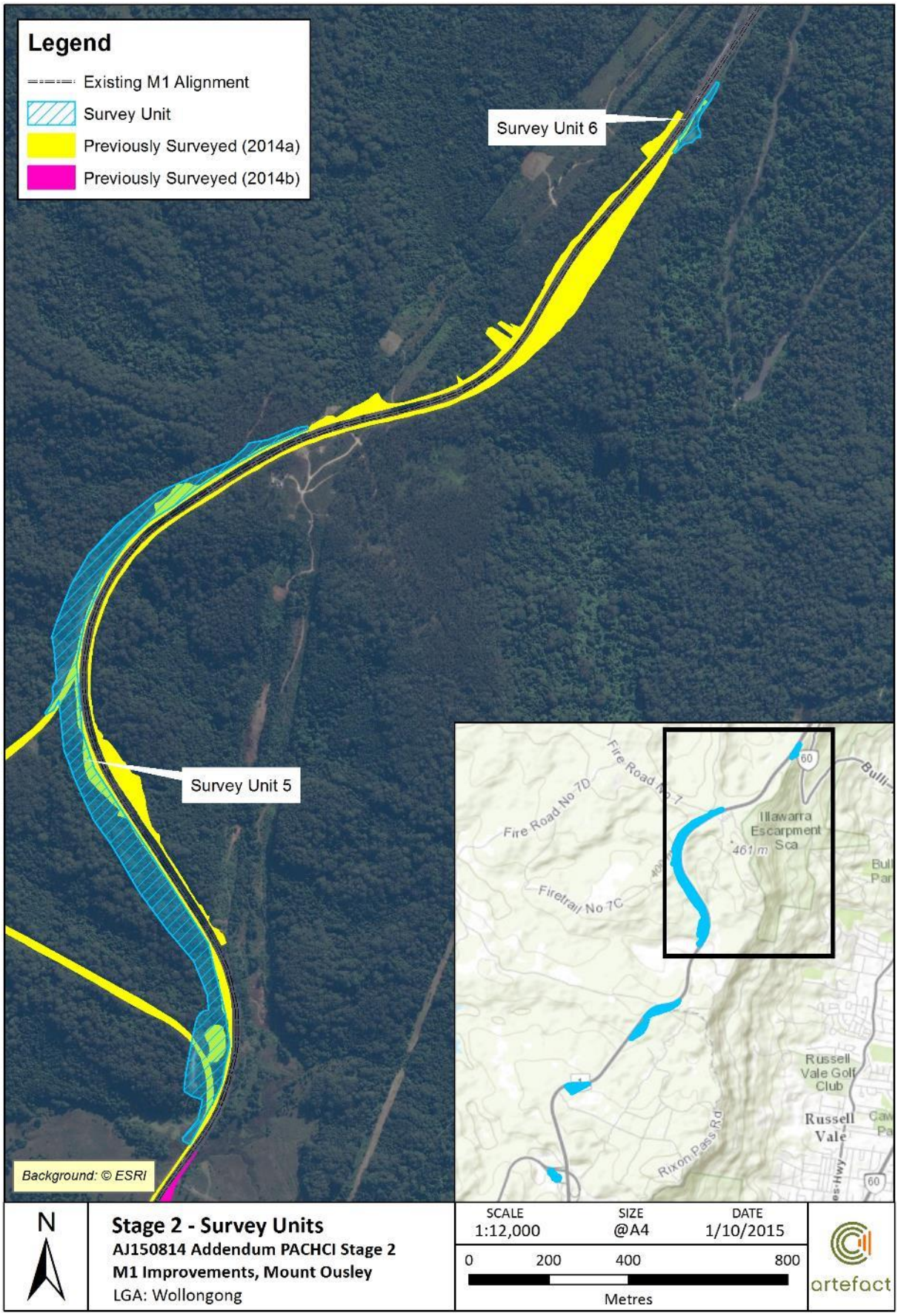


Figure 5: Addendum Survey Units (Stage 2)



9.0 Survey Results

9.1 Survey coverage

The survey area is made up of units within or near the M1 Princes Motorway corridor which has been partially cleared of original vegetation. A majority of survey units comprised dense vegetation coverage with limited ground surface visibility. However, infrequent areas of ground surface exposure were observed in vehicle tracks, erosion scours around tree bases and exposures associated with disturbance. A number of survey units appear to be heavily modified. The survey coverage and landforms are summarised in Table 2 and Table 3.

Table 2: Survey coverage

Survey Unit	Landform	Survey unit area (m2)	Visibility (%)	Exposure (%)	Effective Survey Coverage (m2)	Effective Coverage (%)
1	Modified flat	7076	70%	80%	3963	56
2	Modified flat, slope	15078	40%	40%	2412	16
3	Crest, slope	13128	30%	20%	788	6
4	Crest, slope	19139	20%	10%	383	2
5	Crest, slope, open depression	119567	10%	10%	1196	1
6	Flat, slope	3739	20%	30%	224	6

Table 3: Landform Summary

Landform	Landform area (m2)	Area effectively surveyed	% of landform effectively surveyed	Number of sites
Modified flat	12136	6068	50	0
Flat	3229	1292	40	0
Slope	150217	15022	10	0
Crest	11045	4418	40	0
Open depression	1100	110	10	0

10.0 Survey Observations

10.1 Survey Unit 1 (Stage 1)

Survey Unit 1 is located within the southern portion of the study area, within the Stage 1 project area (Figure 4). The survey unit is located between the entry and exit ramps for Picton Road.

Survey Unit 1 is currently utilised as a storage compound and site office. It is visually evident the area has been significantly disturbed to create a flat compound area (Photo 1). There are large windrows of fill material surrounding the main compound area. The entire survey unit had been cleared of vegetation and the exposed ground surface consists of introduced fill material.

No artefacts were identified within Survey Unit 1. The area was assessed as demonstrating low archaeological potential.

Photo 1: Modified flat area used as compound, SW aspect

Photo 2: Windrows around edges of area, NE aspect

10.2 Survey Unit 2 (Stage 1)

Survey Unit 2 is located within the south portion of the study area, within the Stage 1 project area (Figure 4). Survey Unit 2 is located on the southern side of the M1 Princes Motorway within a former compound site. Portions of this area have been surveyed during previous investigations (Artefact 2014a and 2014b).

A majority of Survey Unit 2 is situated on flat land, covered with bitumen surfaces (Photo 3). The area most likely modified to utilise as a compound/stockpile area during previous works to the M1 Princes Motorway. The modified flat compound area is located on a slope landform, with a northeast aspect.

Vegetation within Survey Unit 2 primarily consists of low dense grass growing through the bitumen (Photo 3). Dense vegetation is located along the western and southern edges of the survey unit; based on the context and immaturity of observed trees, much of the vegetation may represent regrowth from previous vegetation clearance (Photo 4).

No artefacts were identified within Survey Unit 2. The area was assessed as demonstrating low archaeological potential.

Photo 3: Bitumen surface with grass taking over the area, NE aspect

Photo 4: Example of dense vegetation at west and south edges of survey unit, W aspect

10.3 Survey Unit 3 (Stage 1)

Survey Unit 3 is located within the south central portion of the study area, within the Stage 1 project area (Figure 4). Survey Unit 3 is between the current alignment of M1 Princes Motorway and a portion of the old alignment of the motorway (Mount Ousley Road). Portions of this area have been surveyed during previous investigations (Artefact 2014a and 2014b).

Survey Unit 3 was found to have visual evidence of significant ground disturbance. It appears the whole eastern portion has been modified and built up for the construction of the former motorway alignment. The area was covered in bitumen surfaces and regrowth vegetation (Photo 5).

The western portion of the study area is located on a sandstone crest and associated slopes (Photo 6). A number of sandstone exposures were encountered, however no grinding features were identified. This area was densely vegetated by eucalypt trees and shrubs.

No artefacts were identified within Survey Unit 3. The area was assessed as demonstrating low archaeological potential.

Photo 5: Former alignment of Princes Motorway, NE aspect

Photo 6: Sandstone outcrop on western edge of Survey Unit 3, SW aspect

10.4 Survey Unit 4 (Stage 1)

Survey Unit 4 is located within the south central portion of the study area, within the Stage 1 project area (Figure 4). Survey Unit 4 is located on the south side of the M1 Princes Motorway. Portions of this area have been surveyed during previous investigations (Artefact 2014a and 2014b).

Visual inspection of ground surfaces suggest high amounts of disturbance along land bordering the M1 Princes Motorway. The northern portion of the survey unit has been modified and bitumen surfaces and cuttings were observed (Photo 7).

Rixsons Pass Road and a transmission line easement cut through the centre of Survey Unit 4; on an east-west orientation. High amounts of disturbance as a result of vegetation clearance are associated with these features (Photo 8).

A low sandstone escarpment is located within the southwest portion of the survey unit, roughly running parallel with the Princes M1 Princes Motorway alignment. No grinding features were identified on inspected sandstone exposures. A rock shelter was identified along the sandstone escarpment, which measured approximately 8 metres wide, 3 metres deep and 1.5 metres high; with a southeast aspect. The mixed rock and silt ground surface of the shelter offered good visibility (Photo 9). No Aboriginal objects or features were identified within the shelter. During the time of inspection, there was a moderate amount of water seepage from the roof and rear wall of the shelter; resulting in a wet muddy shelter floor. Due to the moisture encountered within the overhang, it is unlikely to have been used as a habitation shelter.

The area surrounding the escarpments was frequently steep and densely vegetated, greatly reducing ground surface visibility (Photo 10). However the terrain was not conducive to sustained Aboriginal occupation.

No artefacts were identified within Survey Unit 4. The area was assessed as demonstrating low archaeological potential.

Photo 7: Old modified flat adjacent road, now overgrown, SW aspect

Photo 8: Rixons Road clearing, E aspect

Photo 9: Sandstone rock shelter, 2m range pole in foreground, NW aspect

Photo 10: Steep terrain and dense vegetation within south portion of survey unit, N aspect

10.5 Survey Unit 5 (Stage 2)

Survey Unit 5 runs through the central and northern portions of the study area, within the Stage 2 project area (Figure 4). The boundary of Survey Unit 5 includes two work areas and the proposed upgrade to the western lanes of the M1 Princes Motorway. Portions of this area have been surveyed during previous investigations (Artefact 2014a and 2014b).

The southern portion of Survey Unit 5 displays high amounts of disturbance, as it is located on the former Princes Highway alignment and a large area that has been cleared/modified for the transmission line (Photo 11).

The central portion of Survey Unit 5 displays intact crest and slope landforms, with some sandstone outcropping. Areas bordering the M1 Princes Motorway display modification associated with drainage. A number of large tree stumps were identified that suggest logging activities were undertaken in the area. A tributary of Bellambi Creek also runs through this portion of the survey unit (Photo 12).

This portion of the study area is dominated by eucalypt trees with dense canopy cover, and minimal understorey vegetation. David Lawrence (ILALC) identified a potential scared tree within this area. However based on observations, it appears to be natural scarring. Natural tree scarring can be caused by trauma; including, bushfire, drought, lightning, faunal damage, impact/abrasion or a branch tearing off the trunk (Long 2005: 36). The scarred tree was identified on its side (Photo 15); the heartwood was heavily deteriorated and no cut marks were identified on the cambium. Another natural scar was identified nearby (Photo 16), which featured a curved top and scarring down into the base of the tree; which is typical of scarring caused by fire or lightning (Long 2005: 39).

A large part of the northern portion of Survey Unit 5 has been disturbed by the construction of the former and existing Princes Motorway (Photo 13). The terrain immediately to the west of the disturbed area is situated on a very steep gradient, with a west aspect (Photo 14). The steep slope presents low archaeological potential, due to the difficulty accessing the area.

No artefacts were identified within Survey Unit 5. The area was assessed as demonstrating low archaeological potential.

Photo 11: Cleared area, associated with transmission line, E aspect

Photo 12: Dense vegetation and tributary, NW aspect

Photo 13: Former and current Princes Motorway alignment, NE aspect

Photo 14: Very steep, densely vegetated terrain, N aspect

Photo 15: Fallen tree with natural scarring, timber heavily degraded, E aspect

Photo 16: Natural scar, most likely lightning or fire scarring, SE aspect

10.6 Survey Unit 6 (Stage 2)

Survey Unit 6 is located within the northern portion of the study area, within the Stage 2 project area (Figure 4). Survey Unit 6 is on the eastern side of the M1 Princes Motorway, to the south of the Bulli Pass exit.

Survey Unit 6 consists of a compound/stockpile site and transmission line easements. The area has been modified within the central portion to create a flat area of land (Photo 17). The remaining portions of the survey unit have been disturbed as a result of vegetation clearance and the construction of access tracks associated with the transmission line (Photo 18).

Vegetation within the study area was dominated by grasses and weeds. However there were frequent ground exposures within the area due to vehicle movement and erosion.

No artefacts were identified within Survey Unit 6. The area was assessed as demonstrating low archaeological potential.

Photo 17: Modified flat within survey unit, E aspect

Photo 18: Access track underneath transmission line, NE aspect

11.0 Analysis and Discussion

No previously recorded Aboriginal sites were located within the additional survey units. No previously unrecorded Aboriginal sites were identified during the field survey. High levels of disturbance and modification are present throughout most of the study area.

11.1 Disturbance Levels

The portions of the additional survey units within the current and former road easements are significantly disturbed. Those portions of the study area (including the Survey Unit 1, Survey Unit 2 and Survey Unit 6) have been modified through the construction of compound/stockpiling sites.

Portions of Survey Unit 3, Survey Unit 4 and Survey Unit 5, in areas away from the road corridor were identified as relatively undisturbed. Those portions of the study area included an unmodified tributary, slope and crest landforms, with outcropping sandstone and a variety of vegetation types. All observed sandstone outcrops and old growth trees were inspected for evidence of archaeological material, art, grinding grooves and cultural scarring. No Aboriginal objects were identified.

11.2 Archaeological Potential

Survey Unit 1, Survey Unit 2 and Survey Unit 6, and those portions of Survey Unit 3, Survey Unit 4 and Survey Unit 5 bordering the current road alignment are significantly disturbed and demonstrate low archaeological potential.

The relatively undisturbed portions of Survey Unit 3, Survey Unit 4 and Survey Unit 5 were inspected and no Aboriginal objects were identified. The high elevation terrain, steep slopes, relatively infrequent outcropping sandstone and high energy ephemeral watercourses demonstrate low archaeological potential.

No Aboriginal objects or areas of archaeological potential have been identified within the additional proposal area.

12.0 Significance Assessment

12.1 Assessment Criteria

Archaeological significance refers to the archaeological or scientific importance of a landscape or area. This is characterised by using archaeological criteria such as archaeological research potential, representativeness and rarity of the archaeological resource and potential for educational values. These are outlined below:

- Research potential: does the evidence suggest any potential to contribute to an understanding of the area and/or region and/or state's natural and cultural history?
- Representativeness: how much variability (outside and/or inside the subject area) exists, what is already conserved, how much connectivity is there?
- Rarity: is the subject area important in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- Education potential: does the subject area contain teaching sites or sites that might have teaching potential?

If a Stage 3 PACHCI assessment is required, cultural values and significance would be discussed by the Aboriginal groups during the ongoing consultation, details of which would be contained in the Cultural Heritage Assessment Report required under the Roads and Maritime PACHCI.

12.2 Archaeological significance assessment

Archaeological significance of the additional proposal areas has been determined based on both the findings of the original investigations and observations made during field survey, as well as the landscape and archaeological context of the project area.

All of the additional proposal areas are assessed as having low representative and rarity values for Aboriginal archaeological material and / or sites. Aboriginal objects may be present in areas of low archaeological significance, but are likely to be in disturbed contexts and / or associated with transient Aboriginal occupation and identified as low density background scatters. The study area is assessed as having low levels of both scientific and research potential and as demonstrating overall low archaeological significance.

13.0 Impact assessment

It has been identified that the proposed works will be contained within areas that are already highly disturbed and modified and undisturbed areas that may be impacted were found to have low archaeological significance. No areas were identified as having archaeological potential within the study area.

The impact assessment has therefore found that there will be no impact to known Aboriginal sites and/or places or identified areas of archaeological potential within the additional proposal areas.

14.0 Management and mitigation measures

14.1 Guiding Principles

The overall guiding principle for cultural heritage management is where possible Aboriginal sites should be conserved. If conservation is not practicable, measures should be taken to mitigate against impact to Aboriginal sites.

The nature of the mitigation measures recommended is based on the assessed significance of the site or sites. The recommendations are also informed by cultural significance. The ILALC were sent a draft version of this report by Roads and Maritime for review and comment.

14.2 Mitigation Measures

The current assessment has established the additional work areas demonstrate low archaeological potential and low archaeological significance. The assessment confirmed no previously recorded Aboriginal sites and/or places and no areas of archaeological potential are located within the boundaries of the additional work areas (Survey Units 1 to 6).

No further Aboriginal archaeological investigation is required for the study area.

If unforeseen Aboriginal objects or suspected human remains are uncovered once work commences, work in the vicinity of the find must cease until further advice/approvals have been obtained. For any unexpected finds during project implementation, please refer to the Roads and Maritime *Standard Management Procedure for Unexpected Heritage Items* (2015).

15.0 Conclusion and Recommendations

The below conclusions and recommendations address the additional proposal areas which form the focus of this addendum PACHCI Stage 2 report (Figure 4 and Figure 5). The recommendations do not address the road alignment and main work associated with the M1 Improvements project. For a full assessment and recommendations for the wider M1 Improvements project, please refer to the PACHI Stage 2 report (Artefact 2014a) and addendum report (2014b).

The following recommendations were based on consideration of:

- Statutory requirements under the *National Parks and Wildlife Act 1974*
- The results of the site survey and assessment
- The interests of Aboriginal stakeholder groups
- The likely impact of the proposed development.

It was found:

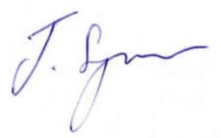
- No Aboriginal sites and/or places were located within the additional impact areas
- The additional proposal areas were assessed as demonstrating low archaeological potential

It is therefore recommended:

- The proposed work within the additional proposal areas are able to proceed without the need for further archaeological and/or Aboriginal heritage assessment
- If the project design should change or if areas not surveyed are added to the scope of proposed work, further archaeological assessment would be required
- If unforeseen Aboriginal objects or suspected human remains are uncovered once work commences, work in the vicinity of the find must cease until further advice/approvals have been obtained. For any unexpected finds during project implementation, please refer to the Roads and Maritime Standard *Management Procedure for Unexpected Heritage Items* (2015).

If you have any queries regarding this assessment and recommendations, please do not hesitate to contact me.

Kind Regards,



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