APPENDIX F

Ecological Impact Assessment – Addendum

WALLARAH 2 COAL PROJECT

Ecological Impact Assessment - Addendum

For:

Hansen Bailey

June 2016

Final

PO Box 2474
Carlingford Court 2118

Report No. 11084RP9

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

Version	Date Issued	Amended by	Details
1	31/03/2016	GK/DR	Draft 1
2	08/04/2016	GK/DR	Draft2
3	20/04/2016	GK	Final Draft
4	12/05/2016	GK	Final
5	9/06/2016	GK	Final – updated layout
6	14/06/2016	GK	Final – updated Project boundary

Approved by: David Robertson

Position: Director

Signed: David Robertson

Date: *14 June, 2016*

Table of Contents

1 INTRODUCTION

1.1 Background 1.1

1.2 Purpose 1.2

1.3 Location 1.3

1.4 Relevant Legislation 1.4

2 METHODOLOGY

2.1 Desktop Assessments 2.1

2.1.1 Database Searches 2.1

2.1.2 Literature Review 2.2

2.2 Field Surveys 2.2

2.2.1 Weather Conditions 2.4

2.2.2 Vegetation Mapping 2.5

2.2.3 Flora Surveys 2.5

2.2.4 Targeted Threatened Flora Surveys 2.9

2.2.5 Fauna Surveys 2.10

2.2.6 Aquatic Habitat Assessment 2.11

3 RESULTS

3.1 Desktop Assessments 3.1

3.1.1 Database Searches 3.1

3.1.2 Literature Review 3.2

3.2 Vegetation Communities 3.7

3.2.1 Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin 3.12

3.2.2 Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin 3.13

3.2.3 Grasslands 3.17

3.2.4 Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin 3.19

3.3 Aquatic Habitats 3.20

Table of Contents *(Cont'd)*

3.4 Wetlands *3.21*

3.5 Flora of the Study Area *3.22*

3.5.1 Threatened Flora Species *3.22*

3.5.2 Noxious Weeds *3.26*

3.6 Fauna Habitat *3.26*

3.7 Fauna of the Study Area *3.28*

3.7.1 Threatened Fauna Species *3.28*

3.7.2 Migratory Species *3.31*

3.7.3 Potentially Occurring Threatened and Migratory species *3.33*

4 IMPACT ASSESSMENT

4.1 Direct Loss of Vegetation and Habitat *4.1*

4.2 Indirect Impacts *4.5*

4.3 Impacts to Regionally Significant Vegetation and Corridors *4.5*

4.4 Impacts on Aquatic Habitats *4.6*

4.5 Impacts to Endangered Ecological Communities *4.6*

4.6 Impacts to Threatened Flora Species *4.7*

4.7 Impacts to Threatened Fauna Species *4.11*

4.8 Impacts from Key Threatening Processes *4.14*

5 IMPACT ASSESSMENT ON MNES

5.1 Significant Impact Assessments *5.1*

5.2 Commonwealth Offset Calculations *5.7*

6 IMPACT MITIGATION

7 CONCLUSIONS

REFERENCES

List of Appendices

A. LIKELIHOOD OF OCCURRENCE ASSESSMENT

B. RECORDED FLORA SPECIES

C. ASSESSMENT OF SIGNIFICANCE

D. COMMONWEALTH OFFSET ASSESSMENT GUIDE SPREADSHEETS

E. COMMONWEALTH OFFSET ASSESSMENT GUIDE - DATA VALUES AND RATIONALE

List of Tables

2.1	Field Survey Dates	2.4
2.2	Weather conditions during survey periods	2.4
2.3	Braun-Blanquet Scoring System	2.6
3.1	Vegetation Communities within the Study Area	3.3
3.2	Threatened Species previously recorded within the Tooheys Road Site	3.6
3.3	Threatened Flora Species Recorded within the Study Area	3.22
3.4	Tree Hollow densities in impact and offset areas	3.27
3.5	Threatened Fauna Recorded within the Study Area	3.28
3.6	Migratory Species Recorded within the Study Area	3.31
4.1	Comparison of Vegetation Communities within the Original and Alternate Disturbance Footprints	4.3
4.2	Reduction in potential habitat for threatened flora species to be removed	4.9
4.3	Reduction in potential habitat for threatened fauna species to be removed	4.11
5.1	Reduction in potential habitat for threatened MNES flora species to be removed	5.3
5.2	Reduction in potential habitat for threatened MNES fauna species to be removed	5.5
5.3	Summary of Offsets Assessment Guide Calculations for Controlled Action Species – Alternative Disturbance Boundary	5.8
5.4	Improvement of proposed offsets for Controlled Action MNES	5.8
6.1	Improvement in offset ratios for Vegetation Communities	6.3
6.2	Improvement in offset ratio of available habitat for Threatened Flora	6.5
6.3	Improvement in offset ratio of available habitat for Threatened Fauna	6.8
A.1	Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area	A.1

List of Tables

B.1	Flora Species Recorded within the Addendum Study Area and wider Study Area	B.1
E.1	Data Values and Justification for the assessment of Angophora inopina	E.1
E.2	Data Values and Justification for the assessment of Tetratheca juncea	E.8
E.3	Data Values and Justification for the assessment of the Giant Barred Frog	E.15
E.4	Data Values and Justification for the assessment of the Spotted-tailed Quoll	E.20

List of Figures

1.1	Regional locality	1.6
1.2	Conceptual Layout – Tooheys Road Site	1.7
2.1	Layout of Addendum Study Area	2.3
2.2	Flora survey locations within the Study Area – Eastern Area	2.7
2.3	Flora survey locations within the Study Area – Western Area	2.8
2.4	Fauna Survey Locations within the Study Area	2.12
3.1	Vegetation Communities in the Study Area – Eastern Areas	3.9
3.2	Vegetation Communities in the Addendum Study Area (Boral Lands and Crown Lands)	3.10
3.3	Vegetation Communities in the Addendum Study Area (Crown Lands and Rail Corridor)	3.11
3.4	Threatened Flora species recorded in the Study Area (Eastern Area)	3.24
3.5	Threatened and Migratory Fauna species recorded within the Study Area	3.32
4.1	Project Impacts on Vegetation Communities – Tooheys Road Site	4.2
4.2	Locations of Retained Threatened Flor Species within the Tooheys Road Site	4.8
6.1	Vegetation Communities within the Offset Properties	6.12
6.2	Threatened Species recorded within the Offset properties	6.13

List of Photographs

3.1	Paperbark swamp forest within the Crown Road section of the Addendum Study Area	3.12
3.2	Scribbly Gum – Red Bloodwood woodland within the Tooheys Road Disturbance Footprint	3.13

List of Photographs

3.3	Scribbly Gum Woodland on spoil heap in the Boral managed land	3.15
3.4	Black She-Oak variant near Boral fenceline	3.15
3.5	Umbrella sedge infestation in wet depression at base of spoil heap	3.16
3.6	Moist heath variant within the Crown Road	3.16
3.7	Naturally regenerating DNG within the Tooheys Road Southern Offset	3.17
3.8	Exotic grassland within WACJV lands	3.17
3.9	Hairpin Banksia – Slender Tea-tree Heathland adjacent to the Addendum Study Area	3.19
3.10	Emergent sedges/rushes adjacent to existing rail crossing	3.20
3.11	*Gleichenia dicarpa* along banks of Spring Creek	3.21

Glossary of Terms

Addendum Study Area	Areas outside the scope of the 2013 Terrestrial EIA that were ecologically assessed. This encompasses areas within the newly proposed conveyor corridor from the stockpile to the end of the rail spur as well as additional lands adjacent to the corridor and south of Link Road.
Alternate Disturbance Boundary	Boundary within which surface infrastructure is to be located. This includes the Western Shaft, Buttonderry Site and amended Tooheys Road Site layout and conveyor corridor
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
DGRs	Director- General's Environmental Assessment Requirements (NSW DP&I)
DoE	Commonwealth Department of the Environment
DP&I	NSW Department of Planning and Infrastructure
DPI	NSW Department of Primary Industries
Disturbance Footprint	Area of disturbance within the Infrastructure Boundary. The area that will be mechanically altered to implement infrastructure for the Proposal.
EEC	Endangered Ecological Community
EIA	Ecological Impact Assessment
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning & Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	NSW *Fisheries Management Act 1994*
GDE	Groundwater Dependent Ecosystems
Extraction Area	Surface land above the underground longwall mine, contained within the Project Boundary. This forms part of the area of potential surface subsidence
KTP	Key Threatening Process
LEP	Local Environmental Plan.
LGA	Local Government Area
Locality	Land within 10 km radius from the centre of the Project Boundary
MNES	Matters of National Environmental Significance that are listed by the EPBC Act.
NP&W Act	NSW *National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Services

OEH	NSW Office of Environment and Heritage
Original Disturbance Boundary	Boundary within which surface infrastructure areas was initially located. This includes the Western Shaft, Buttonderry Site and original Tooheys Road Site layout and rail loop
Project Boundary	Encompasses all land the Development Consent will apply to, including the Infrastructure Boundaries, the Extraction Area and additional Mining Lease lands
Project Disturbance Area	The total project footprint that will be impacted for mining or construction.
SCA	State Conservation Area.
SEPP	State Environmental Planning Policy.
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities, now the DoE.
SIL	Subsidence Impact Limit. This is the area of land, determined by modelling, subject to potential surface subsidence from longwall mining. This includes areas outside of the Project Boundary.
Study Area	Areas that were ecologically assessed. This encompasses areas within the Project Boundary as well as Offset Lands (Hue Hue Road) and areas potentially subject to subsidence located outside the Project Boundary.
TSC Act	NSW *Threatened Species Conservation Act 1995*

Chapter 1

Introduction

1.1 Background

The Wyong Areas Coal Joint Venture (WACJV) is seeking development consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Wallarah 2 Coal Project (the Project). The key features of the Project include:

- A deep underground longwall mine extracting up to 5 million tonnes per annum (Mtpa) of export quality thermal coal;
- The Tooheys Road Site between the M1 Motorway and the Motorway Link Road, which includes a portal, coal handling facilities and stockpiles, water and gas management facilities, small office buildings, workshop, rail spur, train load out bin and connections to the municipal water and sewerage systems;
- The Buttonderry Site near the intersection of Hue Hue Road and Sparks Road, which includes administration offices, bathhouse, personnel access to the mine, ventilation shafts and water management structures;
- The Western Shaft Site in the Wyong State Forest, which includes a downcast ventilation shaft and water management structures;
- An inclined tunnel (or "drift") from the surface at the Tooheys Road Site to the coal seam beneath the Buttonderry Site;
- Transportation of product coal to the Port of Newcastle by rail; and
- An operational workforce of approximately 300 full time employees.

The Project has been subject to the assessment process under Division 4.1 of Part 4 of the EP&A Act, including a review by the Planning Assessment Commission (PAC). In June 2014, the PAC concluded that *'if the recommendations concerning improved strategies to avoid, mitigate or manage the predicted impacts of the project are adopted, then there is merit in allowing the project to proceed*'.

Following the review by the PAC, the Tooheys Road Site was re-designed to avoid land use conflicts with third parties. The changes to the Project include:

- Removal of the previously proposed rail loop;

- Re-location of the previously proposed rail spur to the eastern side of the Main Northern Rail Line;
- Re-location of the train load out facility to the eastern side of the Main Northern Rail Line;
- A conveyor system to deliver product coal from the stockpile to the new train load out facility; and
- Realignment of the sewer connection.

These proposed changes are referred to as the 'Amendment'. All other aspects of the Project remain identical to the original proposal.

To give effect to the proposed changes to the Project, WACJV is seeking an amendment to the Development Application (DA) under clause 55 of the *Environmental Planning and Assessment Regulation 2000.* This Ecological Impact Assessment Addendum (Addendum EIA) for the Amendment forms part of the "*Amendment to Development Application SSD-4974"* (Amendment Document) being prepared by Hansen Bailey to support the application to amend the DA.

This report assesses the ecological impacts of the Amendment and where necessary, recommends additional management and mitigation measures to ameliorate these impacts. Aspects of the Project that are unchanged have not been reconsidered. The impacts associated with these aspects of the Project will remain as assessed in the Aquatic and Terrestrial Ecological Impact Assessments (referred to collectively as the 2013 EIA) in the *Wallarah 2 Coal Project Environmental Impact Statement* (Hansen Bailey, 2013) (the 2013 EIS).

1.2 Purpose

The purpose of this Addendum EIA is to describe the current ecological values within the Addendum Study Area, with a focus on sections of the Alternate Disturbance Boundary within this area, and assess the potential ecological impacts of the Amendment, particularly on threatened species, populations and ecological communities protected under the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and aquatic habitats protected under the NSW *Fisheries Management Act 1994* (FM Act).

For the purposes of this Addendum EIA, the Alternate Disturbance Boundary comprises the area within which surface infrastructure is to be located. This includes the Western Ventilation Shaft, Buttonderry Site and amended Tooheys Road Site layout. The Addendum Study Area comprises the newly proposed conveyor corridor at the Tooheys Road Site as well as additional lands adjacent to the corridor and south of the Motorway Link Road that form part of the new Project Boundary.

The specific objectives of this Addendum EIA in relation to the Amendment are to:

- Present and analyse the results of literature and database reviews;
- Present results from recent field surveys and describe the flora, fauna and habitats present or likely to occur within the Addendum Study Area;
- Identify and consider the impacts of the Amendment upon threatened species and ecological communities listed under the EPBC Act and TSC Act as well as aquatic habitats listed under the FM Act recorded within the Alternative Disturbance Boundary or likely to be present therein;
- Present a comparison of the impacts of the Amended Project with the Original Project (as assessed in the 2013 EIS); and
- Confirm the appropriateness of the currently proposed Biodiversity Offset Strategy (BOS) to protect threatened flora and fauna, compensate for the potential residual impacts of the Project (as amended) that cannot be otherwise avoided or mitigated, and provide for a net gain of conserved woodland and forest habitats in the long term.

1.3 Location

The Project is located within the Wyong Local Government Area (LGA), approximately 4.7 km north-west of central Wyong and approximately 45 km south-west of Newcastle. **Figure 1.1** illustrates the location of the Project in relation to the nearest town centres.

The Extraction Area, including the Western Shaft, is located on the western site of the F3 Freeway, just north of the Wyong River. Most of the Wyong State Forest and the south to south-eastern parts of the Jilliby State Conservation Area (Jilliby SCA) lie within this western extent of the Project Boundary. The Amendment does not include any changes to the Extraction Area.

Surface facility areas are located on the eastern and western sides of the F3 Freeway. The Buttonderry Site, on the western side of the F3 Freeway, is bordered by Hue Hue Road to the east and by the Buttonderry waste management facility to the north. There are no changes to the Buttonderry Site.

The Tooheys Road Site is located north-east of the intersection of the F3 Freeway and Motorway Link Road.

The Amendment involves transporting product coal along an alternate route from the Tooheys Road Site to the Main Northern Rail Line via a conveyor system. A train load out facility and rail spur will be constructed adjacent to the Main Northern Rail Line (**Figure 1.2**). The conveyor system and rail spur are located within the Addendum Study Area.

The Addendum Study Area commences within WACJV lands at Tooheys Road, continues eastward through land managed by Boral before turning north onto a Crown road (Nikko Road) and continuing along the Rail Corridor north of Nikko Road. Additional lands within the Addendum Study Area occur to the south of Nikko Road. These areas are contained within

the mining lease application for the Amendment but do not form part of the Alternate Disturbance Boundary.

There are three main areas that are proposed for conservation as biodiversity offsets:

- Hue Hue Road Offset area (HHR offset);
- Tooheys Road Site Northern Offset area (TRN offset); and
- Tooheys Road Site Southern Offset area (TRS offset).

The TRN and TRS offset areas are contained within the main Tooheys Road Site. The HHR offset is located to the west of the Tooheys Road Site and the F3 Freeway.

1.4 Relevant Legislation

A number of Local Council, State and Commonwealth Acts, Policies and Guidelines are relevant to the Project. The primary legislation relevant to this report, as detailed in the 2013 EIA includes:

- NSW *Environmental Planning and Assessment Act 1979* (EP&A Act);
- NSW *Threatened Species Conservation Act 1995* (TSC Act);
- NSW *Fisheries Management Act 1994* (FM Act); and
- Commonwealth *Environmental Protection and Biodiversity Act 1999* (EPBC Act).

Further relevant NSW legislation and planning policies include:

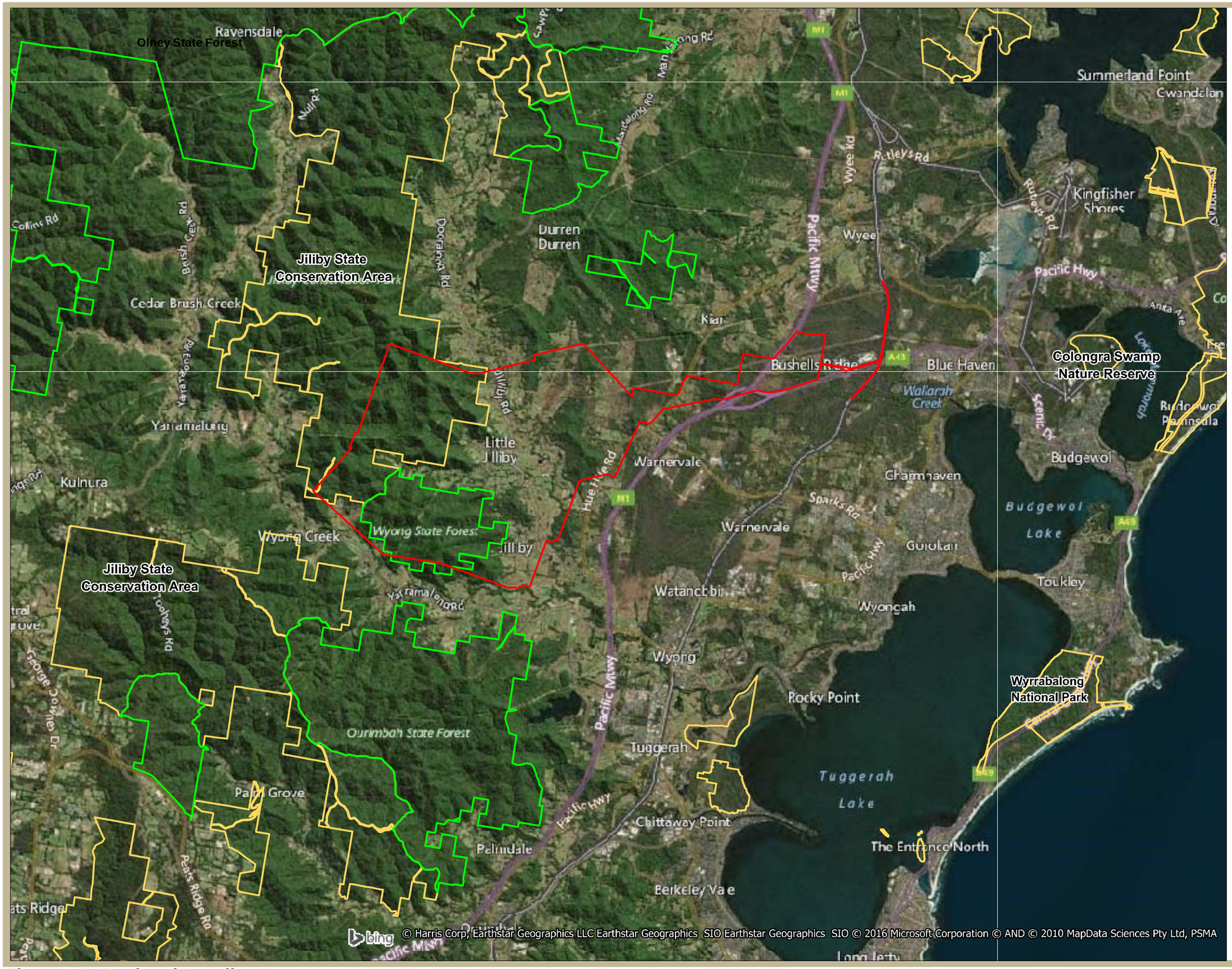
- *Water Act 1912*;
- *National Parks and Wildlife Act 1974*;
- *Water Management Act 2000*;
- *NSW State Groundwater Dependent Ecosystems Policy (DLWC (NSW), 2002)*; and
- SEPPs:
    - *State Environmental Planning Policy No. 14 – Coastal Wetlands;*
    - *State Environmental Planning Policy No. 26 – Littoral Rainforests*;
    - *State Environmental Planning Policy (State and Regional Development)* 2011 (replaces the *State Environmental Planning Policy (Major Projects) 2005* as listed in the 2013 EIA);

- *State Environmental Planning Policy No 44 – Koala Habitat Protection;*
- *State Environmental Planning Policy No 55 – Remediation of Land; and*
- *State Environmental Planning Policy (Infrastructure) 2007.*

For the development of offsetting strategies for the Project, the following documents were considered:

- DEWR (2007) Draft Policy Statement: Use of Environmental Offsets under the Environment Protection and Biodiversity Conservation Act 1999, Department of the Environment and Water Resources, Canberra, ACT; and
- OEH (2011) Principles for the Use of Biodiversity Offsets in NSW, Department of Environment and Climate Change, Hurstville, NSW.

Coordinate System: MGA Zone 56 (GDA 94)



Legend

- Project Boundary
- National Parks and Reserves
- State Forest

Grid North

Data Source:
NPWS, 2010
State Forests NSW 2012
WACJV 2012

cumberland ecology

1 0 1 2 3 4 km

I:\...\11084\Figures\RP9\20160614\Figure 1.1. Regional Locality

Figure 1.1. Regional Locality

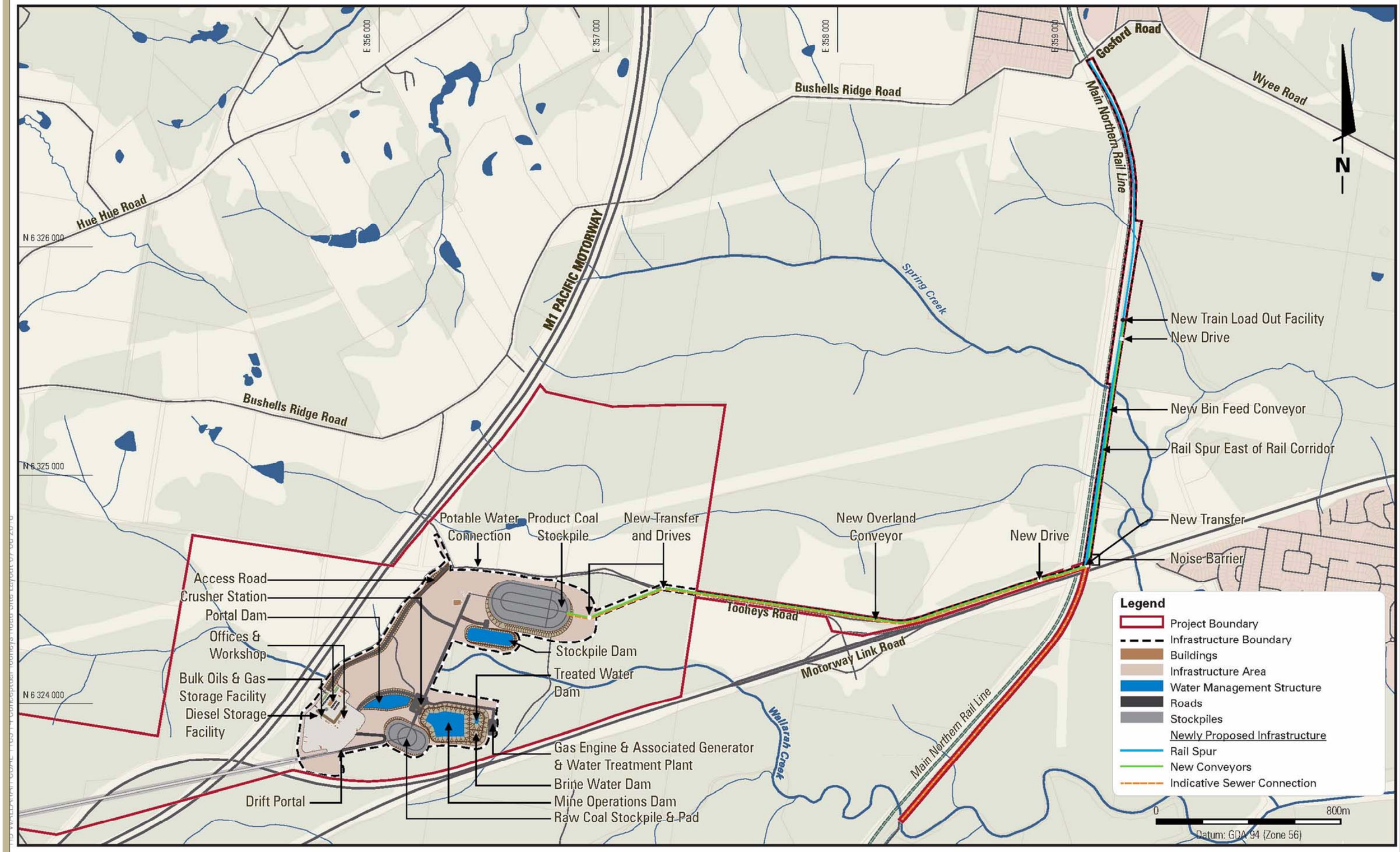


Figure 1.2. Conceptual Layout - Tooheys Road Site

Image Source: Hansen Bailey (2016), Wallarah 2 Coal Project. Conceptual Layout Tooheys Road Site.

I:\...\11084\Figures\RP9\20160614\Figure 1.2. Conceptual Layout_Tooheys Road Site

Chapter 2

Methodology

This chapter presents the methodology utilised in preparing this Addendum EIA. It includes desktop reviews of information from various sources as well as descriptions of the field survey methods used by Cumberland Ecology for the detailed surveys following the exhibition of the 2013 EIS.

The primary focus of this Addendum EIA is on the Addendum Study Area and sections of the Alternate Disturbance Boundary that lie within the Addendum Study Area.

The Addendum Study Area comprises the newly proposed conveyor corridor at the Tooheys Road Site as well as additional lands adjacent to the rail corridor and south of the Motorway Link Road that form part of the new Project Boundary. The Alternate Disturbance Boundary comprises the area within which surface infrastructure is to be located. This includes the Western Ventilation Shaft, Buttonderry Site and updated Tooheys Road Site layout. The wider Study Area comprises areas that are directly and indirectly impacted by all aspects of the Project.

The location of the Addendum Study Area in relation to the disturbance boundary at Tooheys Road and the wider Study area is shown in **Figure 2.1**

2.1 Desktop Assessments

2.1.1 Database Searches

BioNet, the Atlas of NSW Wildlife (OEH, 2015) and the EPBC Protected Matters Search Tool (PMST) (DoE, 2015) were consulted to determine any newly listed species or communities as well as changes in the status of threatened species and communities recorded within the Project Boundary since the submission of the EIS in 2013. A media release by the Department of the Environment (DoE) on amendments to species listed as threatened under the EPBC Act, effective from 5 May 2016, was also consulted.

The PMST search provided a list of MNES that are predicted to occur based on the presence of suitable habitat, within a 10 km radius of the Addendum Study Area. The BioNet search also provided a list of threatened species recorded within a 10 km radius. The BioNet searches were limited to records made after 1 January 1980.

The NSW Department of Primary Industries (DPI) – Fishing and Aquaculture Threatened and Protected Species Records Viewer was also conducted for the Wyong LGA and Hunter

Central Rivers CMA to determine the potential presence of threatened aquatic species listed under the FM Act. Available maps on Key Fish Habitats were also reviewed.

The updated search records were used to reassess the likelihood of occurrence of threatened and migratory species within the Addendum Study Area and the wider Study Area for the Project. Likelihood of occurrence tables for threatened flora, fauna and populations as well as migratory species recorded in the locality are provided in **Appendix A**.

The OEH, DoE and DPI websites were also searched for Key Threatening Processes (KTPs) listed under the TSC Act, EPBC Act and FM Act respectively.

2.1.2 Literature Review

There has been considerable ecological survey effort within the Project Boundary and the locality since 1998 and several documents were reviewed for the 2013 EIA. The review for this Addendum EIA was therefore limited to the following documents:

- Cumberland Ecology (2013) Terrestrial Ecology Impact Assessment;
- Marine Pollution Research (2013) Aquatic Ecology Impact Assessment: and
- Hansen Bailey (2013) Wallarah 2 Coal Project Response to Submissions.

In addition to the above reports, updated general assessment documents and species specific publications relevant to the Wyong area, were also reviewed.

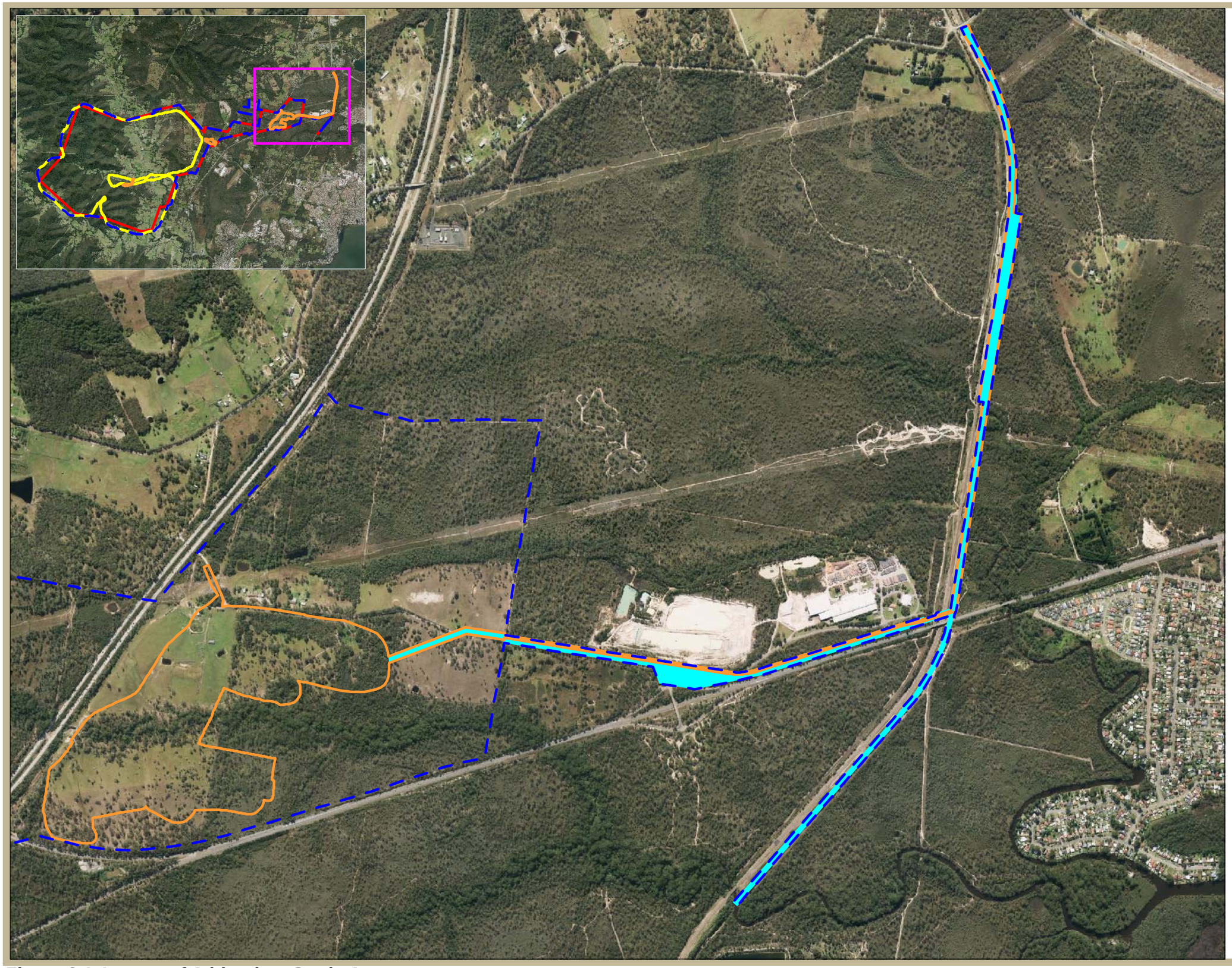
2.2 Field Surveys

Terrestrial Ecology field surveys for the 2013 EIS were conducted by OzArk (and its commissioned sub-consultants) over several seasons and across a wide variety of weather conditions from 2006 to early 2012. Subsequent field surveys were conducted by Cumberland Ecology in mid-late 2012. Aquatic Ecology field surveys were conducted by Marine Pollution Research from 2011 to 2012. The details of these surveys are provided in the 2013 Terrestrial EIA (Cumberland Ecology 2013) and 2013 Aquatic EIA (Marine Pollution Research 2013).

Following exhibition of the 2013 EIS, additional flora surveys were conducted by Cumberland Ecology in July 2013 to fulfil survey adequacy requirements raised by OEH. Targeted surveys for *Corunastylis* sp Charmhaven, an orchid species newly listed in late 2013, were conducted in January 2014. Field surveys within the Addendum Study Area were conducted between 24 November 2015 and 14 January 2016.

A summary of survey dates and tasks completed following exhibition of the 2013 EIS is provided in **Table 2.1** below. The field surveys conducted by Cumberland Ecology complied with relevant standards and guidelines, including minimum survey requirements, provided in the OEH's Biodiversity Survey Guidelines Working Draft (DEC (NSW), 2004) and Field Survey Methods (DECCW (NSW), 2009).

Coordinate System: MGA Zone 56 (GDA 94)



Legend

- Study Area
- Disturbance Boundary
- Addendum Study Area

Grid North

Image Source:
Image © 2016 Aerometrex
(dated 01-04-2014)

cumberland ecology

I:\...\11084\Figures\RP9\20160614\Figure 2.1. Layout_Addendum Study Area

Figure 2.1. Layout of Addendum Study Area

250 0 250 500 750 1000 m

Table 2.1 Field Survey Dates

Year	Dates	Areas Assessed	Tasks Completed
2013	22 – 24 July	Buttonderry, Tooheys Road, Hue Hue Road Offset.	Flora surveys, Targeted threatened flora species surveys, fauna habitat assessments
2014	22 – 24 January	Tooheys Road Site	Orchid surveys,(*Corunastylis* sp Charmhaven)
2015	24 November	Addendum Study Area – Tooheys Road, Nikko Road and areas south of the Nikko Road/Link Road junction	Vegetation mapping, flora surveys, targeted threatened flora surveys, fauna habitat assessments; visual assessments of aquatic habitats
	8 December	Addendum Study Area – Rail Corridor	Vegetation mapping, flora surveys, targeted threatened flora surveys, fauna habitat assessments
2016	14 January	Addendum Study Area – Boral Lands	Vegetation mapping, flora surveys, targeted threatened flora surveys, fauna habitat assessments

2.2.1 Weather Conditions

A summary table of weather conditions, as recorded by the nearest Bureau of Meteorology (BOM) weather station, for each survey date are listed in **Table 2.2** below. Rainfall records were obtained from the Wyong (Jilliby Jilliby Creek) station (Station #061380) while temperature records were obtained from Norah Head AWS (Station #061366).

Table 2.2 Weather conditions during survey periods

Year	Day	Rainfall (mm)	Min Temp (°C)	Max Temp (°C)
2013	22-Jul	0	6.6	17.3
	23-Jul	0	8.1	16.5
	24-Jul	0	10.5	15.6
2014	22-Jan	5	20.9	23.6
	23-Jan	1	19.7	24.2
	24-Jan	1	20.7	24.6
2015	24-Nov	0	19.5	27.4
	8-Dec	0	19.9	27.8

Table 2.2 Weather conditions during survey periods

Year	Day	Rainfall (mm)	Min Temp (°C)	Max Temp (°C)
2016	14-Jan	0	22.2	37.5

2.2.2 Vegetation Mapping

Vegetation mapping following the exhibition of the 2013 EIS was limited to the Addendum Study Area

Previous vegetation mapping for the 2013 EIA and the Wyong Shire Council (OEH, 2008) was used to guide the mapping of the vegetation communities within the Addendum Study Area. Walking meander surveys were conducted across three days between 24 November 2015 and 14 January 2016 to ground-truth the occurrence and extent of vegetation communities within the Addendum Study Area. Records of vegetation units and boundary changes were made using handheld GPS units and photographs were taken at several locations to record the condition of the vegetation. Ground-truthing of the vegetation communities was supplemented by detailed analysis of aerial imagery to determine the extent of the various vegetation communities.

Vegetation mapping also included assessments of the general condition of the different vegetation types within the Addendum Study Area. The assessment of condition of vegetation communities was conducted using the criteria for “moderate to good” condition and “low” condition vegetation in the *Biobanking* guidelines. The condition of each vegetation community is provided within the descriptions of the communities in **Section 3.2**.

The vegetation composition within the Addendum Study Area was subsequently aligned to the corresponding Biometric Vegetation Types (BVTs) utilised for the 2013 EIA and, where applicable, Endangered Ecological Communities (EECs) as listed under the TSC Act and/or EPBC Act. The resultant information was synthesised using Geographical Information Systems (GIS) to create a spatial database.

2.2.3 Flora Surveys

The detailed flora surveys conducted in July 2013 as part of the Response to Submissions (RTS), and between 24 November 2015 and 14 January 2016 for the Addendum EIA consisted of quadrat sampling (20m x 20m) and random meander surveys.

A total of 30 flora quadrats were sampled during the July 2013 surveys with a further five sampled within the Addendum Study Area between November 2015 and January 2016. In each quadrat, the following information was recorded as a minimum:

- All vascular flora species present within the plot;
- The relative abundance of each plant species;

- A waypoint to mark the location of the quadrat, using a handheld GPS;
- Photographs of the vegetation; and
- Geological features such as landform type, soil type, slope and aspect.

Quadrat locations are shown in **Figure 2.2** and the list of recorded flora species is provided in **Appendix B**. Locations of quadrats surveyed between 2005 and 2012 are shown in **Figure 2.2** (Eastern areas) and **Figure 2.3** (Western area).

The relative abundance and cover of each species within the quadrat was approximated using a modified Braun-Blanquet cover abundance scale (Poore, 1955). The scores used are provided in **Table 2.3** below.

Table 2.3 Braun-Blanquet Scoring System

Class	Cover-abundance	Notes
R	Rare (less than 0.1% cover)	Herbs, sedges and grasses: within 1 m^2
		Shrubs and small trees: 1 individual
+	Few Individuals (less than 1% cover)	Herbs, sedges and grasses: within 10 m^2
		Shrubs and small trees: <5 individuals
		Medium - large overhanging tree
1	Many Individuals (less than 5% cover)	Herbs, sedges and grasses: within 50 m^2
		Shrubs and small trees: 5 or more individuals
		One medium - large tree
2	5 - less than 25% cover	-
3	25 - less than 50% cover	-
4	50 - less than 75% cover	-
5	75 - 100% cover	-
(*)	Exotic species; not native to Study Area	

Additional flora species outside the quadrats were recorded during random meander surveys. All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust, 2016)

Coordinate System: MGA Zone 56 (GDA 94)

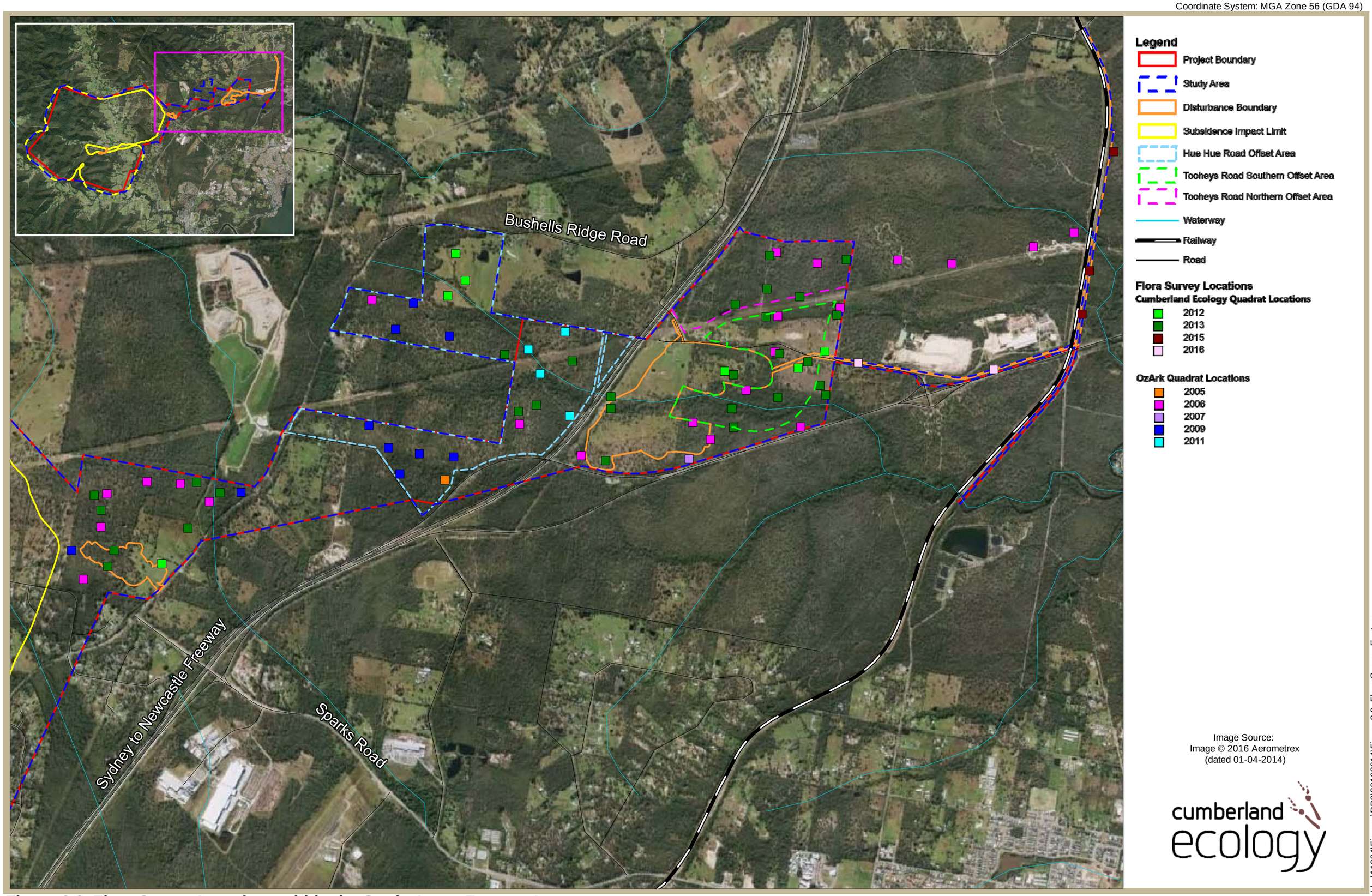


Figure 2.2. Flora Survey Locations within the Study Area - Eastern Area

500 0 500 1000 1500 2000 m

Coordinate System: MGA Zone 56 (GDA 94)

Figure 2.3. Flora Survey Locations within Study Area - Western Area

100 0 100 200 300 400 m

I:\...\11084\Figures\RP9\20160614\Figure 2.3 Flora Survey_Western Area

2.2.4 Targeted Threatened Flora Surveys

Targeted searches for threatened flora were conducted by OzArk in 2006 – 2012 and by Cumberland Ecology in 2012. The methodology for these targeted surveys is described in the 2013 EIA.

Further targeted searches for threatened flora were conducted from 2013 – 2016 as described below.

i. Angophora inopina surveys

The main focus of the *Angophora inopina* surveys was to determine densities of the species within the impact and offset areas of the Project. A total of 11 quadrats (20 m x 20 m) were randomly distributed along the length of the Alternate Disturbance Boundary within the Addendum Study Area. The number of individuals present within each quadrat was recorded and the density of *Angophora inopina* per hectare was then extrapolated utilising mean number of individuals per quadrat. Data from relevant quadrats collected in 2012 and 2013 were utilised in conjunction with the 2015-2016 density quadrats to extrapolate the density of *Angophora inopina* per hectare within the impact and offset areas.

In addition to the density quadrats, locations of *Angophora inopina* individuals located during random meanders of suitable habitat, floristic surveys and targeted *Corunastylis* sp Charmhaven surveys were recorded.

ii. Corunastylis sp Charmhaven surveys

Targeted surveys for *Corunastylis* sp. Charmhaven were conducted from 22 - 24 January 2014. The targeted surveys were restricted to the Tooheys Road area as this area is dominated by the Scribbly Gum heathy woodland which is likely to support *Corunastylis* sp Charmhaven. Additional vegetation communities bordering the Scribbly Gum heathy woodland areas within the Tooheys Road Site were also assessed. These include:

- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC); and
- Derived Native Grassland.

Initial driving and walking reconnaissance was conducted across the Tooheys Road Site to determine areas likely to support *Corunastylis* sp Charmhaven and related *Genoplesium* species.

Targeted meander transects, lasting 30 minutes each, were walked by two people at a slow pace and coordinates of all orchid species detected (including common species) were recorded using a handheld GPS. Meanders were not restricted to areas currently under natural vegetation, but included power line easements and previously cleared grassland areas where direct impacts from development were likely. In addition to the targeted

meanders, opportunistic sightings of orchids between meanders and during reconnaissance were also noted.

A total of 18 hours of targeted meander searches (18 meanders x 2 people x 0.5 hr/meander/person), covering a total distance of approximately 18km (9 km/person), were conducted.

Targeted searches for *Corunastylis* sp. Charmhaven were incorporated into the random meander surveys for the Addendum Study Area.

iii. Other threatened flora

Targeted searches for threatened flora species known or considered likely to occur within the study area were incorporated into the 2013 – 2016 targeted surveys for *Angophora inopina* and *Corunastylis* sp. Charmhaven. These include:

- *Acacia bynoeana;*
- *Callistemon linearifolius*
- *Cryptostylis hunteriana;*
- *Grevillea parviflora ssp parviflora;*
- *Melaleuca biconvexa;* and
- *Tetratheca juncea*.

2.2.5 Fauna Surveys

Detailed fauna surveys were conducted from 2006 to 2012. The locations of fauna surveys are shown in **Figure 2.4** and are described in the 2013 EIA. Fauna surveys for this Addendum EIA are limited to fauna habitat assessments and tree hollow counts only.

i. Fauna Habitat Assessment

The fauna habitat assessment was conducted in conjunction with the vegetation mapping during the 2015-2016 survey and included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, fallen logs, bush rock and wetland areas such as creeks and soaks. Structural features considered included the nature and extent of the understorey and ground stratum and extent of canopy. Tree hollows were used as a general indication of habitat quality for arboreal fauna, hollow dwelling birds and bats. Tree hollows observed during surveys were noted and the general vegetation condition and tree maturity was used to predict whether trees on site were likely to contain hollows.

ii. Tree Hollow Assessment

Hollows were used as a general indication of habitat quality for arboreal fauna, and hollow-dependent birds and bats. Tree Hollow surveys were conducted in the Addendum Study Area during the 2015 - 2016 survey period.

A total of five 20m x 50m quadrats were randomly placed in the Alternate Disturbance Boundary section within the Addendum Study Area. The total number of hollows present within each randomly placed 20m x 50m quadrat was counted and hollows were classified into three size categories:

i. Small: Hollow opening diameter ≤ 50 mm;

ii. Medium: Hollow opening diameter >50 mm – 300 mm; and

iii. Large: Hollow opening diameter >300 mm.

The density of hollows per hectare (total, small, medium and large) was then extrapolated utilising the mean number of individuals per quadrat. Data from relevant quadrats collected in 2012 was also utilised to extrapolate the density of tree hollows within the impact and offset areas respectively. In addition to the quadrats, opportunistic sightings of hollow bearing trees within the Addendum Study Area were also recorded.

2.2.6 Aquatic Habitat Assessment

Aquatic surveys for the Addendum EIA were largely limited to visual assessment of the sections of Spring Creek present within the Addendum Study Area. The following observations were recorded during the aquatic habitat assessment:

- Riparian vegetation up to a distance of 3m from the bank edge;
- Presence of macrophytes (aquatic plants);
- Bank stability and erosion:
- Water clarity;
- Presence of slicks or plumes on the water surface; and
- Anthropogenic structures.

Photographs facing upstream and downstream were taken at the crossing point to record stream conditions.

Coordinate System: MGA Zone 56 (GDA 94)

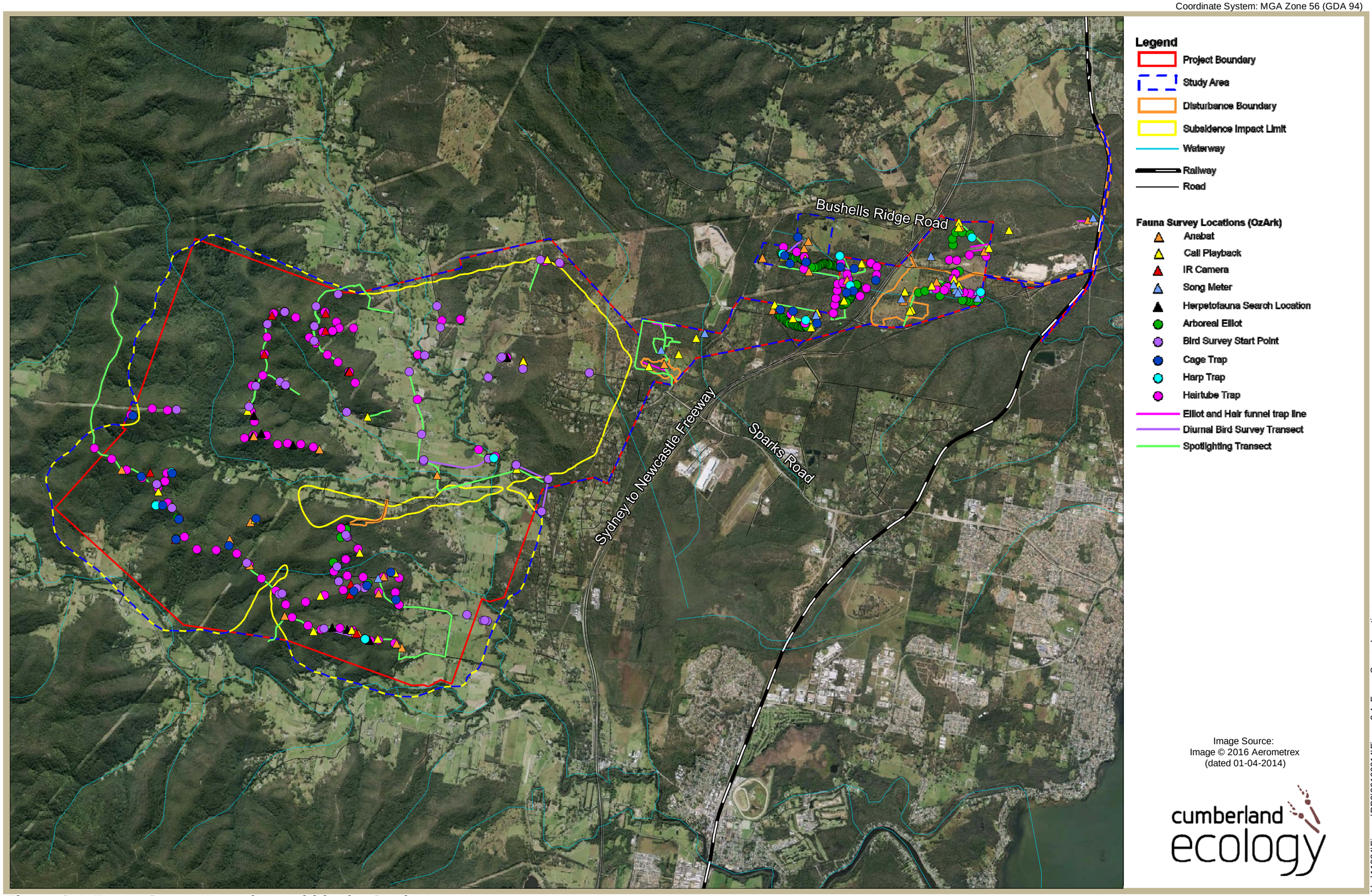


Figure 2.4. Fauna Survey Locations within the Study Area

1000 0 1000 2000 3000 4000 m

Chapter 3

Results

This chapter presents the results of the desktop and field investigations completed for the Addendum Study Area. It also discusses the results with respect to the 2013 EIA and other studies conducted in the locality to provide a comprehensive overview of flora and fauna biodiversity.

3.1 Desktop Assessments

3.1.1 Database Searches

The Atlas of NSW database search indicates that two additional threatened species, *Corunastylis* sp. Charmhaven and the Eastern Chestnut mouse (*Pseudomys gracilicaudatus*) have been recorded in the locality since the 2013 EIA.

Corunastylis insignis (formerly *Genoplesium insignis*), an orchid species with some potential to occur within the Study Area has been up-listed from Endangered to Critically Endangered under the TSC Act and has also been listed as Critically Endangered under the EPBC Act.

Another orchid species, *Thelymitra* sp. *adorata* has also been listed as Critically Endangered under EPBC Act while the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*) have been up-listed to Critically Endangered under EPBC Act. The TSC Act status for these three species remains unchanged.

The listings under the TSC Act and/or EPBC Act for all other threatened and migratory species assessed in the 2013 EIA remains unchanged. An updated assessment of the likelihood of threatened species or communities occurring within the Addendum Study Area and wider Study Area, based on the latest available records, is provided in **Appendix A.**

The DPI Fisheries Species Records Viewer yielded no records for threatened or protected aquatic species within the Wyong LGA or Hunter Central Rivers CMA. However the review of Key Fish Habitat maps for the Wyong LGA determined that the lower reaches of Spring Creek are listed as Key Fish Habitat.

The OEH has 38 key threatening processes (KTPs) listed under the TSC Act, DoE has 21 KTPs listed under the EPBC Act and DPI Fisheries has 8 KTPs listed under the FM Act. KTPs of direct relevance to the Project include:

- Clearing of native vegetation (TSC Act, EPBC Act);

- Alteration of habitat following subsidence due to longwall mining (TSC Act);
- Alteration of natural flow regimes (TSC Act, FM Act);
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (TSC Act, EPBC Act);
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (TSC Act); and
- Anthropogenic climate change (TSC Act, EPBC Act, FM Act).

3.1.2 Literature Review

i. Vegetation nomenclature

Previous studies in the Wyong LGA have used different nomenclature to describe the vegetation communities present in the Study Area. The 2013 EIA for the Project described the vegetation communities as per the Biometric nomenclature and aligned the Biometric Vegetation Types (BVTs) with the equivalent local vegetation units as described in the vegetation mapping for Wyong Shire Council. **Table 3.1** below aligns each Biometric community, as described in the 2013 EIA, with the equivalent local (Wyong LGA) vegetation community (Bell, 2002a; Bell, 2002b), definitions of Endangered Ecological Communities (EECs) listed under the TSC Act/EPBC Act and the relevant vegetation formation.

Table 3.1 Vegetation Communities within the Study Area

Biometric Community	Vegetation Formation	Wyong LGA Communities	NSW EEC
Blackbutt - Turpentine open forest of the foothills of the North Coast	Wet Sclerophyll Forests	Alluvial Riparian Blackbutt Forest	River Flat Eucalypt Forest on Coastal Floodplains
Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin	Rainforests	Riverine Alluvial Gallery Rainforest-Moist Forest Narrabeen Warm Temperate-Subtropical Rainforest	Lowland Rainforest
Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin	Heathlands	Narrabeen Impeded Wet Heath	n/a
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	Wet Sclerophyll Forests	Coastal Ranges Moist Layered Forest	n/a
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	Forested Wetlands	Narrabeen Alluvial Drainage Line Complex (Melaleuca thicket variant)	Swamp Sclerophyll Forest on Coastal Floodplains
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin	Coastal Freshwater Lagoons	Freshwater Wetlands	Freshwater Wetlands on Coastal Floodplains
Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin	Forested Wetlands	Alluvial Footslopes Redgum Forest	River Flat Eucalypt Forest on Coastal Floodplains
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Dry Sclerophyll Forests	Narrabeen Doyalson Coastal Woodland (includes Frequent Fire variant, Black She-Oak variant and Moist Heath variant) Narrabeen Snappy Gum Forest	n/a
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Dry Sclerophyll Forests	Narrabeen Buttonderry Footslopes Forest	n/a

Table 3.1 Vegetation Communities within the Study Area

Biometric Community	Vegetation Formation	Wyong LGA Communities	NSW EEC
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin	Dry Sclerophyll Forests	Narrabeen Dooralong Spotted Gum-Ironbark Forest	Lower Hunter Spotted Gum-Ironbark Forest
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	Dry Sclerophyll Forests	Coastal Ranges Moist Layered Forest (dry variant)	n/a
		Narrabeen Dooralong Spotted Gum-Ironbark Forest	
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Forested Wetlands	Alluvial Floodplain Shrub Swamp Forest (includes sedge-scrub variant)	Swamp Sclerophyll Forest on Coastal Floodplains
		Narrabeen Alluvial Drainage Line Complex (shallow drainage line variant and sedge woodland variant)	
Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin	Forested Wetlands	Alluvial Woollybutt-Melaleuca Sedge Forest	Swamp Sclerophyll Forest on Coastal Floodplains

ii. Rail Loop Vegetation

The review of the 2013 EIA report determined that the vegetation within the footprint of the previously proposed rail loop is dominated by the community known as Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin (Scribbly Gum woodland). Other communities present in the footprint of the previously proposed rail loop include:

- Blackbutt - Turpentine open forest of the foothills of the North Coast (Blackbutt Forest);
- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (Paperbark Swamp forest);
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin (Smooth-barked Apple forest);
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (Swamp Mahogany forest);
- Derived Native Grassland (DNG); and
- Exotic/Agricultural/Low Diversity Grassland (Exotic grassland).

Of these communities, Paperbark Swamp Forest and Swamp Mahogany Forest are equivalent to the TSC Act listed EEC Swamp Sclerophyll Forest on Coastal Floodplains. Both communities are also considered to be obligate Groundwater Dependent Ecosystems (GDEs).

While the Biometric community, Blackbutt-Turpentine, is not associated with any State listed EEC, due to the regional significance of the local vegetation community, a conservative approach was taken and this community was assessed as the TSC Act listed EEC River Flat Eucalypt Forest on Coastal Floodplains. This community was also assessed as a probable GDE.

iii. Addendum Study Area vegetation

A review of the 2013 EIA report determined that vegetation in the part of the Addendum Study Area on WACJV lands consists of a mix of Scribbly Gum Woodland, Derived Native Grassland (from Scribbly Gum Woodland) and Exotic Grassland. The part of the Addendum Study Area on WACJV lands passes through the Tooheys Road Southern Offset area (TRS offset area). The vegetation within the TRS offset area consists of Scribbly Gum Woodland and Derived Native Grassland in areas to the south of Tooheys Road and Exotic Grassland in areas immediately north of Tooheys Road.

A review of available vegetation mapping prepared for Wyong Shire Council determined that the following vegetation communities are present within the remainder of the Addendum Study Area:

- Narrabeen Doyalson Coastal Woodland;
- Narrabeen Alluvial Drainage Line Complex; and
- Narrabeen Impeded Wet Heath.

As outlined in **Table 3.1**, Narrabeen Doyalson Coastal Woodland, including several variants, is equivalent to the community Scribbly Gum woodland while different local variants of Narrabeen Alluvial Drainage Line Complex are equivalent to either Paperbark Swamp Forest or Swamp Mahogany Forest.

The Wyong LGA community Narrabeen Impeded Wet Heath was not previously recorded within the Study Area for the Project. Based on available descriptions and field data, this community has been aligned with the BVT Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin (Hairpin Banksia heath). This community does not conform to any EECs under the TSC Act or EPBC Act.

iv. Threatened and Migratory Species

A total of four threatened flora species, nine threatened fauna species and two migratory fauna species have previously been recorded within the Tooheys Road Site. Of these, three threatened flora, two threatened fauna and one migratory fauna species have been recorded within the footprint of the previously proposed rail loop. A summary of the species recorded within the Tooheys Road Site, specifically within the previously proposed rail loop, is provided in **Table 3.2** below.

Table 3.2 Threatened Species previously recorded within the Tooheys Road Site

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Recorded within Rail Loop footprint
Acacia bynoeana	Bynoe's Wattle	E1	V	Yes
Angophora inopina	Charmhaven Apple	V	V	Yes
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	No
Tetratheca juncea	Black-eyed Susan	V	V	Yes
Crinia tinnula	Wallum Froglet	V		Yes
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		No
Daphoenositta chrysoptera	Varied Sittella	V		No
Glossopsitta pusilla	Little Lorikeet	V		No
Ninox strenua	Powerful Owl	V		No
Tyto novaehollandiae	Masked Owl	V		No
Haliaeetus leucogaster	White-bellied Sea-Eagle		M,C	Yes

Table 3.2 Threatened Species previously recorded within the Tooheys Road Site

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Recorded within Rail Loop footprint
Hirundapus caudacutus	White-throated Needletail		M,C,J,K	No
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		Yes
Myotis macropus	Southern Myotis	V		No
Petaurus norfolcensis	Squirrel Glider	V		No

v. Aquatic Habitats

The two primary waterbodies flowing through the Tooheys Road Site are Wallarah Creek and Spring Creek. The primary impacts to aquatic habitats from the original layout of the Tooheys Road Site include removal of riparian vegetation along Wallarah Creek for surface infrastructure and creek crossings.

The layout for the previously proposed rail loop required two crossings across the main channel of Wallarah Creek as well as an additional crossing across the main channel of Spring Creek before joining up the Main Northern Rail Line.

The section of Wallarah Creek affected by the Tooheys Road infrastructure and the previously proposed rail loop crossings is considered Class 3 fish habitat as it provides permanent to semi-permanent wetland habitat with good aquatic habitat complexity but is unlikely to provide fish passage.

The section of Spring Creek affected by the previously proposed rail loop crossing is considered Class 2 fish habitat as it is a permanent creek with good connection to the estuary. This section of Spring Creek is also designated Key Fish Habitat (KFH) due to the presence of more or less permanent pools with reasonable fish passage.

3.2 Vegetation Communities

The major vegetation communities that occur within the Tooheys Road and Buttonderry Areas and their distribution are shown in **Figure 3.1**. The extent of occurrence of each community has been mapped using a combination of information derived from Wyong LGA mapping conducted by Bell (2002a; 2002b; OEH, 2008) and results from ground-truthing by OzArk (2006 – 2011) and Cumberland Ecology (2011 – 2016).

Detailed descriptions of the vegetation communities present across the wider Study Area for the Project are provided in Chapter 5 of the 2013 Terrestrial EIA. This Addendum EIA, therefore, focuses on descriptions of the vegetation communities found within the Addendum

Study Area during the 2015 – 2016 surveys. Mapping of the vegetation communities within the Addendum Study Area is shown in **Figures 3.2** and **3.3**.

Coordinate System: MGA Zone 56 (GDA 94)

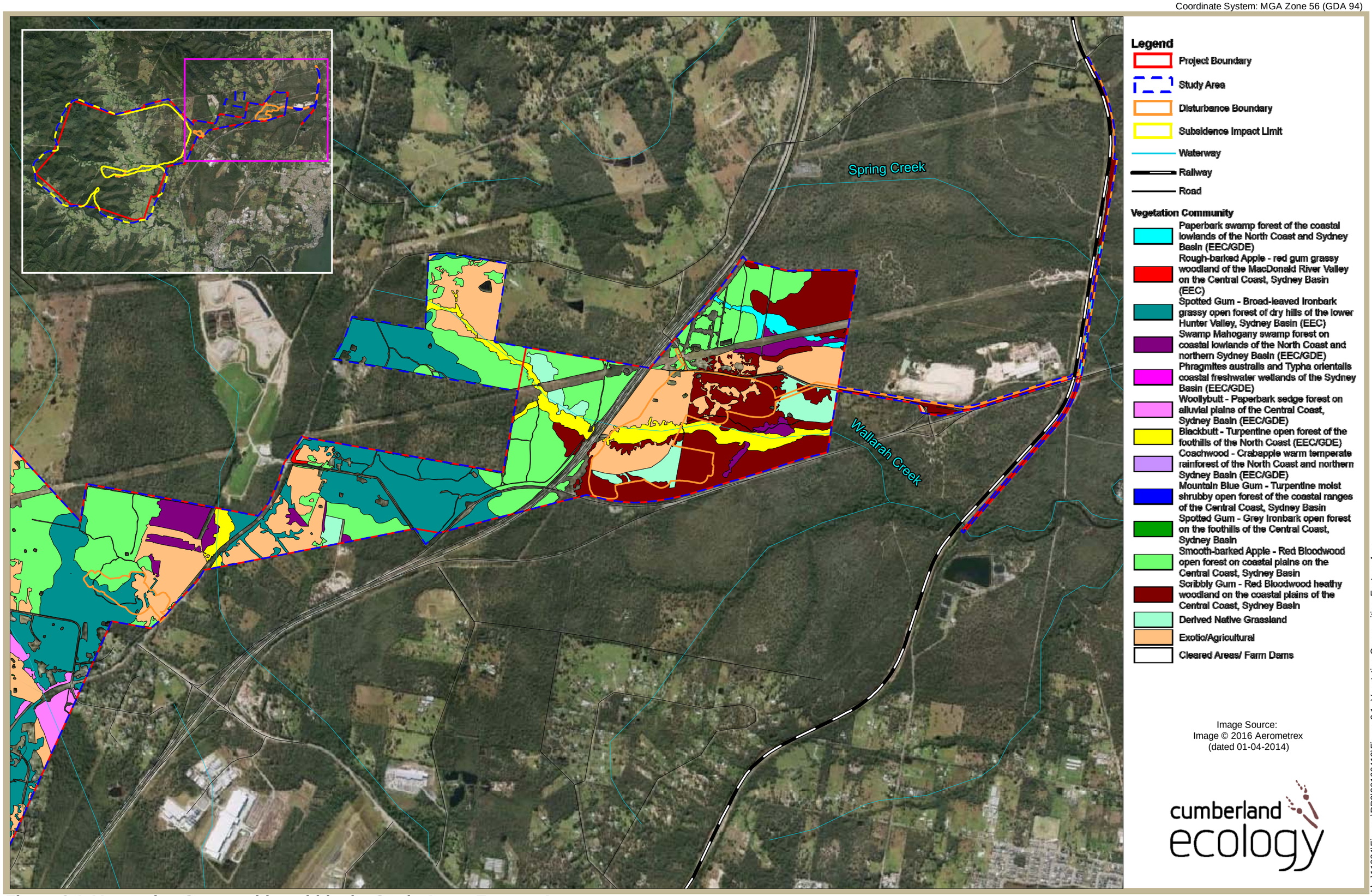


Figure 3.1. Vegetation Communities within the Study Area - Eastern Area

500 0 500 1000 1500 2000 m

Coordinate System: MGA Zone 56 (GDA 94)

Figure 3.2. Vegetation Communities in the Addendum Study Area (Boral Lands and Crown Road)

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)

Figure 3.3. Vegetation Communities in the Addendum Study Area (Crown Road and Rail Corridor)

I:\...\11084\Figures\RP9\20160614\Figure 3.3. Vegetation Communities_Addendum Study Area

3.2.1 Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin

Photograph 3.1 Paperbark swamp forest within the Crown Road section of the Addendum Study Area

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Disturbance Footprint: 0.55 ha

Paperbark Swamp Forest occurs as small, discrete patches in poorly drained areas within the Addendum Study Area, mainly within the Crown Road (Nikko Road).

The vegetation consists largely of relatively young, vegetation composed of thickets of *Melaleuca* species, predominantly *Melaleuca nodosa* (Prickly-leaved Paperbark) and *Melaleuca sieberi*. Other common mid-storey species include *Leptospermum polygalifolium* (Tantoon). *Allocasuarina littoralis* (Black She-oak) and scattered emergents, mainly *Angophora costata* (Smooth-barked Apple) occur along the outer fringes where the swamp community starts intergrading with adjacent patches of drier vegetation.

The understorey is largely dominated by *Gahnia clarkei* (Tall Saw-sedge) and *Carex inversa* while the vine *Parsonsia straminea* (Common Silkpod) is common amongst the mid-storey species. Exotic species recorded within the community include *Andropogon virginicus*

(Whiskey Grass), *Paspalum dilatatum* (Paspalum), *Cortaderia selloana* (Pampas Grass), and *Cyperus eragrostis* (Umbrella sedge).

This community is considered to be part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC.

3.2.2 Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin

Photograph 3.2 Scribbly Gum – Red Bloodwood woodland within the Tooheys Road Disturbance Footprint

Status: Not listed

Predominant Condition: Moderate to good

Area of Occupancy within Disturbance Footprint: 27.5 ha

This community occurs predominantly in the Tooheys Road Site, with a small area occurring in the Hue Hue Road offset site. This community is the dominant community across the majority of the Addendum Study Area.

Scribbly Gum - Red Bloodwood heathy woodland is characterised by a canopy of *Eucalyptus haemastoma* (Scribbly Gum) and *Corymbia gummifera* (Red Bloodwood) with frequent occurrences of *Eucalyptus capitellata* (Brown Stringybark) and *Angophora costata* (Smooth-baked Apple). The understorey includes *Lambertia formosa* (Mountain Devil), *Hakea*

teretifolia (Needlebush), *Persoonia levis* (Broad-leaved Geebung), *Leptospermum trinervium* (Flaky-barked Tea-tree), *Epacris pulchella* (Wallum Heath), *Pimelea linifolia* subsp. *linifolia* (Slender Rice Flower), *Isopogon anemonifolius* (Broad-leaved Drumstick), *Entolasia stricta* (Wiry Panic), and *Xanthorrhoea media. Angophora inopina* (Vulnerable – TSC & EPBC Acts) is often present as a mid storey species in this community, generally in areas where the canopy is open.

Several local variants, as described in the Wyong LGA mapping occur within the Addendum Study Area. These include:

- Black She-oak variant – This variant is characterised by dense thickets of *Allocasuarina littoralis* (Black She Oak) under a scattered canopy of *Eucalyptus haemastoma, Angophora costata* and *Eucalyptus capitellata*. It occurs in response to past clearing and under-scrubbing for grazing activities, which has then been left to regenerate.

- Moist heath variant - This variant is similar to its parent community except for a greater proportion of sedges and other moisture loving shrubs (e.g. *Hakea teretifolia, Melaleuca sieberi*) in the understorey.

The condition of this vegetation community varies across the length of the Addendum Study Area. Large sections within the Boral managed land, particularly towards the western extent, consist of regrowth vegetation on spoil heaps from the current land uses (**Photograph 3.3**). The Black-She Oak variant is common in disturbed areas within the Boral lands, particularly adjacent to wet depressions at the base of spoil heaps (**Photograph 3.4**). One depression at the base of the spoil heap is dominated by a monoculture of *Cyperus eragrostis* (Umbrella sedge) (**Photograph 3.5**). However due to the small area of this monoculture, it has been incorporated into the Scribbly-Gum community instead of being mapped as a separate unit.

Although the condition of the Scribbly Gum Woodland community progressively improves towards the eastern extent of the Boral managed land, there is still a high proportion of weeds in the understorey, including noxious weeds such as *Lantana camara* (Lantana). However the community is still considered to be in moderate to good condition as per the *Biobanking* guidelines due to the presence of both canopy and understorey species.

The vegetation within the Crown Road and Rail Corridor is intersected by several tracks and has a high component of weeds, particularly in areas immediately adjacent to the rail corridor. Despite these disturbances, the vegetation within the Crown Road and Rail Corridor is generally denser and in better overall condition compared to the vegetation in the land managed by Boral. The Black She-Oak variant is largely absent from the Crowns Road and Rail Corridor. However patches of the Moist Heath variant are present, particularly near patches of Paperbark Swamp community and Spring Creek (**Photograph 3.6**).

Photograph 3.3 Scribbly Gum Woodland on spoil heap in the Boral managed land

Photograph 3.4 Black She-Oak variant near Boral fenceline

Photograph 3.5 Umbrella sedge infestation in wet depression at base of spoil heap

Photograph 3.6 Moist heath variant within the Crown Road

3.2.3 Grasslands

Photograph 3.7 **Naturally regenerating DNG within the Tooheys Road Southern Offset**

Photograph 3.8 **Exotic grassland within WACJV lands**

Status: Not listed.

Predominant Condition: Low

Area of Occupancy within Disturbance Footprint: Derived Native Grassland – 6.01 ha; Exotic/Agricultural/Low Diversity Grassland – 25.6 ha

Grassland communities can be broadly divided into two types – DNG and Exotic/Agricultural/Low Diversity Grasslands.

DNGs occur at the Tooheys Road Site and the Hue Hue Road offset sites. DNG at Tooheys Road occurs adjacent to Scribbly Gum – Red Bloodwood woodland and is dominated by grasses and sedges such as *Ptilothrix deusta, Cyathochaeta diandra* and *Microlaena stipoides,* as well as herbs such as *Goodenia bellidifolia*. The DNG within Tooheys Road is in a moderately good condition and shows signs of naturally occurring regeneration of canopy species such as *Corymbia gummifera*.

Exotic, Agricultural and Low Diversity Grasslands are distributed across the entire Project Boundary. These grassland areas are largely a mix of pasture/paddocks and turf farms which formerly also included scattered fruit orchards.

The exotic and low diversity grasslands within the Tooheys Road Site are dominated by *Axonopus fissifolius* (Narrow leaved Carpet grass). Other widespread exotic species include *Senecio madagascariensis* (Fireweed), *Hypochaeris radicata* (Flatweed), *Gamochaeta purpurea* (Purple Cudweed), *Paspalum dilatatum* (Paspalum) and *Juncus cognatus*, with scattered occurrences of native species such as *Microlaena stipoides* and *Themeda australis*.

This vegetation community is not considered to be equivalent to any State or Commonwealth listed EEC.

3.2.4 Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin

Photograph 3.9 Hairpin Banksia – Slender Tea-tree Heathland adjacent to the Addendum Study Area

Status: Not listed

Predominant Condition: Moderate to good

Area of Occupancy within Disturbance Footprint: 0 ha

The Hairpin Banksia – Slender Tea-tree heath community is equivalent to the Impeded Wet Heath community of the Wyong LGA mapping. This community is not present within the Addendum Study Area or the Project Boundary. However a small patch of this community is present near the rail corridor portion of the Addendum Study Area.

Emergent canopy species are absent and the mid-storey layer is dominated by species such as *Banksia oblongifolia, Hakea teretifolia, Leptospermum trinervium* and *Petrophile pulchella*. Groundcover species include *Cyathochaeta diandra, Dampiera stricta, Lepyrodia scariosa* and *Xanthorrhoea* species.

This vegetation community is not considered to be equivalent to any State or Commonwealth listed EEC.

3.3 Aquatic Habitats

The Addendum Study Area crosses the main channel of Spring Creek at one location, directly adjacent to the current crossing for the Main Northern Rail Line (**Photograph 3.10**). The vegetation along the banks of the creek is dominated by a dense band of the fern *Gleichenia dicarpa* (**Photograph 3.11**).

Floating macrophytes are absent and emergent vegetation is largely limited to sedges such as *Gahnia clarkei, Typha orientalis* and *Juncus* species along the edge of the existing rail crossing. The water was highly discoloured and turbid. However no unusual odours, oil slicks or plumes were detected. No erosion of banks was observed within the Addendum Study Area.

Photograph 3.10 Emergent sedges/rushes adjacent to existing rail crossing

Photograph 3.11 *Gleichenia dicarpa* along banks of Spring Creek

3.4 Wetlands

No large areas of wetland habitat occur within the Addendum Study Area.

An area of zone E2 'Environmental Conservation', containing EEC listed Paperbark and Swamp Mahogany vegetation, occurs near the Tooheys Road Site which is subject to specific provisions which are outlined in *Wyong Development Control Plan 2013 (Chapter 30)* and the *Wyong Local Environmental Plan 2013*. The majority of the area zoned as E2 'Environmental Conservation' falls within the proposed Tooheys Road Southern Offset and is unaffected by the altered layout. Therefore the assessment for the area of zone E2 (formerly known as 7(g) under the *Wyong Local Environment Plan 1991*) outlined in the 2013 EIA remains valid.

3.5 Flora of the Study Area

Over 550 plant species including threatened species listed under the EPBC Act and TSC Act were recorded within the wider Study Area for the Project. Of these, approximately 210 species were recorded within the Addendum Study Area. The dominant plant families recorded include Myrtaceae, Poaceae, Cyperaceae and Asteraceae.

A comprehensive species list has been compiled from data collected from surveys of the Study Area and is presented in **Appendix B**.

3.5.1 Threatened Flora Species

i. Recorded Threatened Flora Species

Six threatened flora species, listed under the TSC Act and EPBC Act, have been recorded within the Study Area (**Table 3.3, Figure 3.4**). Detailed descriptions of these species are provided in **Section 5.5.1** of the 2013 Terrestrial EIA.

Table 3.3 Threatened Flora Species Recorded within the Study Area

Scientific name	Common name	TSC status	EPBC status	Buttonderry Site	Hue Hue Road Offset Site	Tooheys Road Site	Original Rail Loop	Addendum Study Area
Acacia bynoeana	Bynoe's Wattle	E	V			+	+	
Angophora inopina	Charmhaven Apple	V	V			+	+	+
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V			+		
Grevillea parviflora ssp. parviflora	Small-flower Grevillea	V	V		+			
Melaleuca biconvexa	Biconvex Paperbark	V	V	+				
Tetratheca juncea	Black-eyed Susan	V	V		+	+	+	

Key: E/E1 = Endangered; V = Vulnerable

Of these six species, only *Angophora inopina* was recorded within the Addendum Study Area and is discussed in more detail below. *Tetratheca juncea, Acacia bynoeana* and *Cryptostylis hunteriana* are considered likely to occur within the Addendum Study Area as

these species have previously been recorded within Scribbly Gum woodland, which is the dominant community within the Addendum Study Area.

Melaleuca biconvexa and *Grevillea parviflora ssp parviflora* have not been recorded within the Tooheys Road Site. However the Paperbark Swamp Forest community constitutes potential habitat for *Melaleuca biconvexa* while the Scribbly Gum woodland community constitutes potential habitat for *Grevillea parviflora ssp parviflora*.

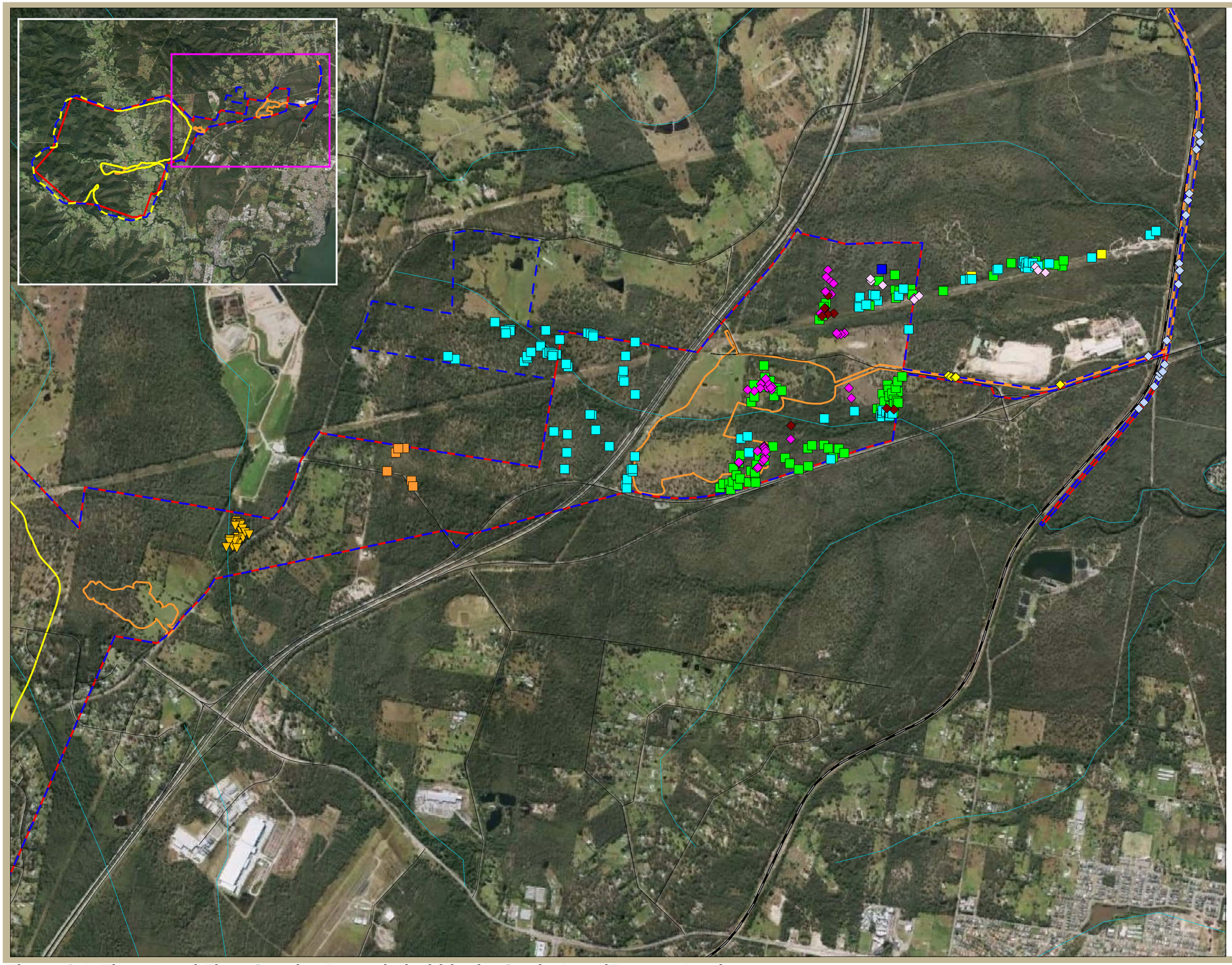
a. Angophora inopina (Charmhaven Apple)

Large numbers of this small tree occur within the Tooheys Road Site. Although this species is predominantly found in the Scribbly Gum woodland community, scattered individuals are found in Smooth-barked Apple forest, Swamp Mahogany forest, Paperbark Swamp forest and edges of DNG.

Although individual trees are found scattered across the different communities, large clusters of individuals were concentrated in some locations. In particular >100 individuals were recorded within a patch (<1 ha) near the power easement that runs through the Tooheys Road Site.

Density estimates for *Angophora inopina* within the updated impact area of Tooheys Road was calculated at approximately 56 individuals per hectare whereas density for the Offset areas was calculated at approximately 83 individuals per hectare (approximately 114 and 40 individuals per hectare in the Tooheys Road North and Tooheys Road South offsets respectively). While these calculations are likely to have overestimated the actual number of *Angophora inopina* individuals present per hectare in the impact and offset areas, they indicate that higher numbers of individuals are present in the offset areas compared to the impact areas.

Coordinate System: MGA Zone 56 (GDA 94)



Legend

- Project Boundary
- Study Area
- Disturbance Area
- Subsidence Impact Limit
- Waterway
- Railway
- Road

Threatened Flora

Cumberland Ecology

- Meleuca biconvexa (2012)
- Angophora inopina (2012)
- Angophora inopina (2013)
- Angophora inopina (2014)
- Angophora inopina (2015)
- Angophora inopina (2016)

OzArk

- *Acacia bynoeana*
- *Angophora inopina*
- *Tetratheca juncea*
- *Cryptostylis hunteriana*
- *Grevillea parviflora subsp parviflora*

Image Source:
Image © 2016 Aerometrex
(dated 01-04-2014)

cumberland ecology

Grid North

I:\...\11084\Figures\RP9\20160614\Figure 3.4. Threatened Flora_Study Area

Figure 3.4. Threatened Flora Species Recorded within the Study Area (Eastern Area)

500 0 500 1000 1500 2000 m

ii. Potentially Occurring Threatened Flora Species and Populations

The following threatened flora species and threatened flora populations were assessed in the 2013 Terrestrial EIA as having potential to occur within the Study Area for the Project based on a combination of suitable habitat, distribution and frequency as indicated by the Atlas records and PMST search, and confirmed sightings in the locality from other commissioned studies.

- *Asterolasia elegans;*
- *Caladenia tessellata* (Thick Lip Spider Orchid);
- *Callistemon linearifolius* (Netted Bottle Brush);
- *Corunastylis insignis* (formerly *Genoplesium insignis*) (Variable Midge Orchid);
- *Eucalyptus camfieldii* (Camfield's Stringybark);
- *Maundia triglochinoides;*
- *Rhizanthella slateri* (Eastern Underground Orchid);
- *Rutidosis heterogama* (Heath Wrinklewort);
- *Syzygium paniculatum* (Magenta Lilly Pilly);
- *Thelymitra sp. adorata* (Wyong Sun Orchid); and
- *Eucalyptus parramattensis subsp. parramattensis* (*Eucalyptus parramattensis* C. Hall. *subsp. parramattensis* in Wyong and Lake Macquarie local government areas).

Detailed descriptions of these species are provided in **Section 5.5.4** of the 2013 Terrestrial EIA and an updated assessment of the Likelihood of Occurrence within the updated Project Boundary is provided in **Appendix A**.

Of the species listed above, the following are considered as having potential to occur within the Addendum Study Area due to the presence of suitable habitat

- *Callistemon linearifolius* (Netted Bottle Brush)*;*
- *Corunastylis insignis (*formerly *Genoplesium insignis*) (Variable Midge Orchid);
- *Eucalyptus camfieldii* (Camfield's Stringybark);
- *Rhizanthella slateri* (Eastern Underground Orchid) and
- *Eucalyptus parramattensis subsp. parramattensis* (*Eucalyptus parramattensis* C. Hall. *subsp. parramattensis* in Wyong and Lake Macquarie local government areas).

a. *Corunastylis* sp. Charmhaven

Corunastylis sp. Charmhaven is a species of terrestrial orchid discovered in 2012 at a single location in the Gorokan/Charmhaven area within the Wyong Local Government Area (LGA). This species was not assessed in the 2013 EIA as this species was listed under the TSC Act and EPBC Act after publication of the 2013 EIS (NSW Scientific Commitee, 2013) .

The species is described as having a 1.4 cm long inflorescence bearing 6-9 flowers in a well-spaced spike. The flowers are described as being about 8.5 mm between the tip of dorsal sepal and tips of lateral sepals, 6 mm between tips of lateral petals, green and cream with deep maroon markings(OEH, 2014).

It occurs in low woodland to heathland with a shrubby understory dominated by species such as Black She-oak (*Allocasuarina littoralis*), Prickly Tea-tree (*Leptospermum juniperinum*), Prickly-leaved Paperbark (*Melaleuca nodosa*), Narrow-leaved Bottlebrush (*Callistemon linearis*) and Zigzag Bog-rush (*Schoenus brevifolius*) (OEH, 2014).

Although targeted surveys did not detect this species within the Tooheys Road Site, it is considered as having potential to occur within the Addendum Study Area and the Tooheys Road Site more generally. This is due to the presence of suitable habitat, in particular the Scribbly Gum woodland community.

3.5.2 Noxious Weeds

Thirty-two exotic flora species were recorded within the Addendum Study Area. Of these, four species, *Ageratina adenophora* (Crofton Weed), *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush), *Lantana camara* (Lantana) and *Senecio madagascariensis* (Fireweed) are declared as noxious under the *Noxious Weeds Act 1993* for the Wyong LGA. *Chrysanthemoides monilifera* subsp. *rotundata*, *Lantana camara* and *Senecio madagascariensis* are also declared Weeds of National Significance (WONS) under the *National Weed Strategy 1997*. All four species are Class 4 Noxious weeds, meaning their growth must be managed in a manner that reduces their numbers and spread, and continuously inhibits their reproduction. The sale, propagation or the intentional distribution of these species are also prohibited.

3.6 Fauna Habitat

Fauna habitats within the original Project Boundary have largely been described in **Section 5.6** of the 2013 Terrestrial EIA and included:

- Remnant forest and woodland;
- Riparian habitats;
- Swamp forests and open wetlands;
- Regenerating vegetation;

- Pasture/exotic grassland areas; and
- Tree hollows.

Of these, the following habitats are present within the Addendum Study Area:

- Remnant forest and woodland;
- Swamp forests;
- Regenerating vegetation;
- Pasture/exotic grassland areas; and
- Tree hollows.

The vegetation within the Addendum Study Area is similar to that in the wider Study Area in that it has either regenerated from past clearing and is very young and structurally simple; or has been modified from its original state through degradation from current land uses. Therefore the descriptions of fauna habitat provided in the 2013 EIA remain valid for the wider Study Area and are also relevant to the Addendum Study Area.

However the alteration of the development footprint has resulted in a change in the density estimates for tree hollows within the impact and offset areas. The updated density estimates are presented in **Table 3.4**. .

Table 3.4 Tree Hollow densities in impact and offset areas

	Total # Hollows	# large hollows	# medium hollows	# small hollows
Impact Mean/ha	15.9	1.2	7.6	7.1
Offset Mean/ha	33.3	2.2	15.0	16.1

Considering that hollow abundance is typically overestimated in ground-based assessments (Gibbons *et al.*, 2000; Harper *et al.*, 2004; Koch, 2008; Rayner *et al.*, 2010), the number of hollows that are likely to be present in the Study Area is expected to be much lower than the provided estimate. Although the current density calculations have resulted in a significant increase in hollow density compared to the 2013 EIA calculations, it is noted that estimates for the offset areas have consistently been higher than the densities for the impact areas and an approximate offset ratio of 2:1 for tree hollows has been maintained.

3.7 Fauna of the Study Area

A suite of native fauna species have been recorded within the Study Area and a comprehensive list of fauna species is provided in **Appendix G (Table G1)** of the 2013 Terrestrial EIA. No additional native fauna species were recorded within the Addendum Study Area.

3.7.1 Threatened Fauna Species

Twenty-one threatened fauna species, listed under the TSC Act and/or EPBC Act have been recorded within the Study Area during surveys conducted specifically for the Project (**Table 3.5, Figure 3.5**). An additional seven threatened fauna species have been recorded within the Study Area during previously commissioned studies conducted between 1999 and 2003 (**Table 3.5**). Detailed descriptions of these species are provided in **Section 5.7.1** of the 2013 Terrestrial EIA.

Table 3.5 Threatened Fauna Recorded within the Study Area

Scientific Name	Common Name	TSC Status	EPBC Status	Subsidence Impact Limit	Buttonderry Site	Hue Hue Road Offset Site	Tooheys Road Site	Original Rail Loop
Crinia tinnula	Wallum Froglet	V					+	+
Mixophyes iteratus	Giant Barred Frog	E1	E	+				
Litoria aurea	*Green and Golden Bell Frog	E1	V	+				
Litoria brevipalmata	*Green-thighed Frog	V		+				
Calyptorhynchus lathami	Glossy Black Cockatoo	V				+	+	
Daphoenositta chrysoptera	Varied Sittella	V			+	+	+	
Glossopsitta pusilla	Little Lorikeet	V				+	+	
Hieraaetus	Little Eagle	V		+				

Table 3.5 Threatened Fauna Recorded within the Study Area

Scientific Name	Common Name	TSC Status	EPBC Status	Subsidence Impact Limit	Buttonderry Site	Hue Hue Road Offset Site	Tooheys Road Site	Original Rail Loop
morphnoides								
Ninox strenua	Powerful Owl	V		+	+		+	
Tyto novaehollandiae	Masked Owl	V					+	
Tyto tenebricosa	Sooty Owl	V		+				
Ephippiorhynchus asiaticus	*Black-necked Stork	E1		+			+	
Ixobrychus flavicollis	*Black Bittern	V		+				
Epthianura albifrons	*White-fronted Chat						+	
Limosa limosa	*Black-tailed Godwit	V	M				+	
Cercartetus nanus	Eastern Pygmy Possum	V		+				
Dasyurus maculatus	*Spotted-tailed Quoll	V	E	+				
Petaurus norfolcensis	Squirrel Glider	V					+	
Petaurus australis	Yellow-bellied Glider	V		+		+		
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	+				
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V					+	
Mormopterus	East-coast	V		+				

Table 3.5 Threatened Fauna Recorded within the Study Area

Scientific Name	Common Name	TSC Status	EPBC Status	Subsidence Impact Limit	Buttonderry Site	Hue Hue Road Offset Site	Tooheys Road Site	Original Rail Loop
norfolkensis	Freetail Bat							
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		+			+	+
Kerivoula papuensis	Golden-tipped Bat					+		
Miniopterus australis	Little Bentwing Bat	V		+				
Miniopterus orianae oceanensis	Eastern Bentwing Bat	V		+				
Myotis macropus	Southern Myotis	V		+			+	
Scoteanax rueppellii	Greater Broad-nosed Bat	V		+			+	

*: Indicates species recorded from other commissioned studies between 1999 – 2003
Key: E/E1 = Endangered; V = Vulnerable

Although only 11 of these species have previously been recorded within the Tooheys Road Site, 25 of these species are considered likely to occur within the Tooheys Road Area and Addendum Study Area due to the presence of suitable habitat and high mobility of the avifauna. The Black-necked Stork and Black Bittern are considered unlikely to occur within the Addendum Study Area due to a relative lack of habitat. However, as these species are highly mobile avifauna, there is limited potential for these species to pass through the Addendum Study Area.

The Paperbark Swamp community within the Addendum Study Area constitutes potential habitat for the threatened amphibians, particularly the Wallum Froglet while the Scribbly Gum woodland community constitutes potential foraging habitat for threatened woodland avifauna and mammals. However, breeding and roosting habitat for threatened avifauna and arboreal mammals within the Addendum Study Area is limited due to the relative lack of large and medium hollows. Limited roosting habitat in the form of small hollows and decorticating bark is present for the non-cave dwelling microchiropteran bat species.

3.7.2 Migratory Species

Six EPBC listed migratory bird species have been recorded within the Study Area (**Table 3.6, Figure 3.4**). No additional migratory species were identified in the Addendum Study Area. These species are protected under various international agreements such as the China Australia Migratory Bird Agreement (CAMBA), Japan Australia Migratory Bird Agreement (JAMBA), Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention. Detailed descriptions of these species are provided in **Section 5.7.2** of the 2013 Terrestrial EIA.

Table 3.6 Migratory Species Recorded within the Study Area

Scientific Name	Common Name	EPBC Status	Subsidence Impact Limit	Buttonderry Site	Hue Hue Road Offset Site	Tooheys Road Site	Original Rail Loop
Ardea alba	Great Egret	C, J	+				
Ardea ibis	Cattle Egret	C, J	+				
Haliaeetus leucogaster	White-bellied Sea-eagle	C		+	+	+	+
Hirundapus caudacutus	White-throated Needletail	C,J,K	+			+	
Monarcha melanopsis	Black-faced Monarch	B	+				
Rhipidura rufifrons	Rufous Fantail	B	+				

B – Bonn, C – CAMBA, J – JAMBA, K – ROKAMBA

Of these species, the White-bellied Sea-eagle and White-throated Needletail are considered likely to occur within the Addendum Study Area due to the presence of suitable habitat. Although suitable habitat for the remaining migratory species is limited within the Addendum Study Area, they may still pass through the area as part of a wider migratory pathway.

Coordinate System: MGA Zone 56 (GDA 94)

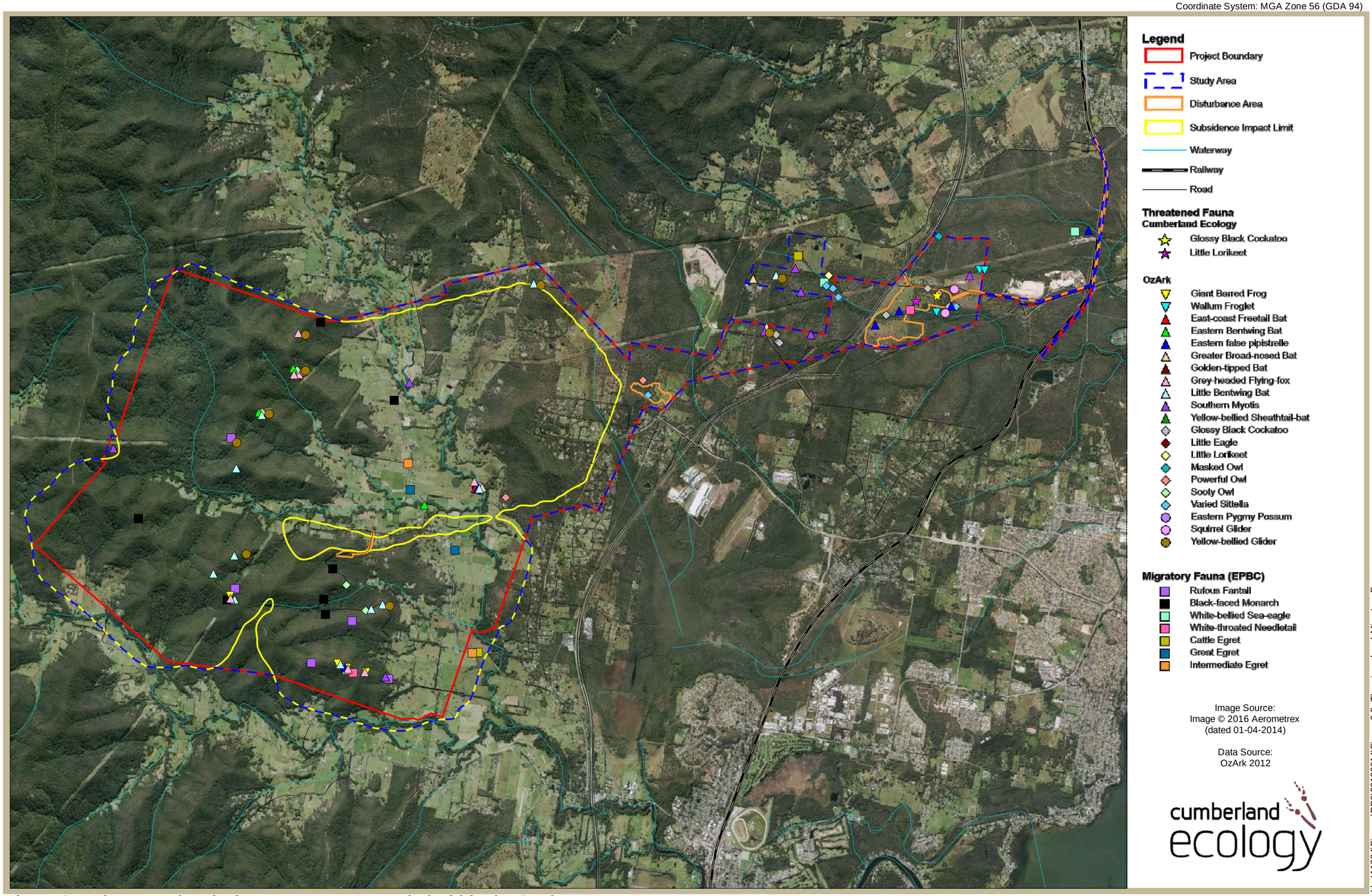


Figure 3.5. Threatened and Migratory Fauna Recorded within the Study Area

1000 0 1000 2000 3000 4000 m

3.7.3 Potentially Occurring Threatened and Migratory species

The following threatened and migratory fauna species were assessed in the 2013 EIA as having potential to occur within the Study Area for the Project based on a combination of suitable habitat, distribution and frequency as indicated by the Atlas records and PMST search, and confirmed sightings in the locality.

- Giant Burrowing Frog (*Heleioporus australiacus*);
- Littlejohn's Tree Frog (*Litoria littlejohni*);
- Stuttering Frog (*Mixophyes balbus*);
- Stephens' Banded Snake (*Hoplocephalus stephensii*);
- Australasian Bittern (*Botaurus poiciloptilus*);
- Australian Painted Snipe (*Rostratula australis*);
- Barking Owl (*Ninox connivens*);
- Bush Stone-curlew (*Burhinus grallarius*);
- Fork-tailed Swift (*Apus pacificus*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Rainbow Bee-eater (*Merops ornatus*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Satin Flycatcher (*Myiagra cyanoleuca*);
- Swift Parrot (*Lathamus discolor*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*); and
- Koala (*Phascolarctos cinereus*).

Detailed descriptions of these species are provided in **Section 5.8** of the 2013 Terrestrial EIA and an updated assessment of the Likelihood of Occurrence within the updated Project Boundary is provided in **Appendix A**.

Of the species listed above, the following are considered as having the potential to occur within the Addendum Study Area due to the presence of suitable foraging, roosting or breeding habitat

- Giant Burrowing Frog (*Heleioporus australiacus*);

- Littlejohn's Tree Frog (*Litoria littlejohni*);
- Barking Owl (*Ninox connivens*);
- Bush Stone-curlew (*Burhinus grallarius*);
- Fork-tailed Swift (*Apus pacificus*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Satin Flycatcher (*Myiagra cyanoleuca*); and
- Swift Parrot (*Lathamus discolor*).

Chapter 4

Impact Assessment

This Chapter considers the change in the ecological impacts that will result from the proposed Amendment to the Project.

The ecological impacts of the proposed changes to some components of the surface infrastructure for the Project are largely related to a reduction in direct habitat loss resulting from vegetation clearing and reduced related impacts such as habitat fragmentation or edge effects.

4.1 Direct Loss of Vegetation and Habitat

The largest direct impact of the Project is the removal of native vegetation that provides habitat for native flora and fauna, and performs an important role in regulating ecosystem health (McIntyre *et al.*, 2002). Removal of native vegetation is considered a KTP under both the TSC Act and EPBC Act.

The Amendment has resulted in a considerable reduction in the total amount of vegetation to be cleared. The Amendment will reduce the total amount of vegetation disturbance for the Tooheys Road Site from approximately 89 ha to 63 ha or approximately 30 percent.

The areas within the disturbance footprint consist of moderate to good condition vegetation, except for areas of Exotic/Agricultural/Low Diversity Grassland which are considered low condition vegetation. Areas of vegetation to be removed by the Project are shown in **Figure 4.1**. A comparison of the total amount of vegetation to be removed from the original footprint and alternate footprint is provided in **Table 4.1**.

Coordinate System: MGA Zone 56 (GDA 94)

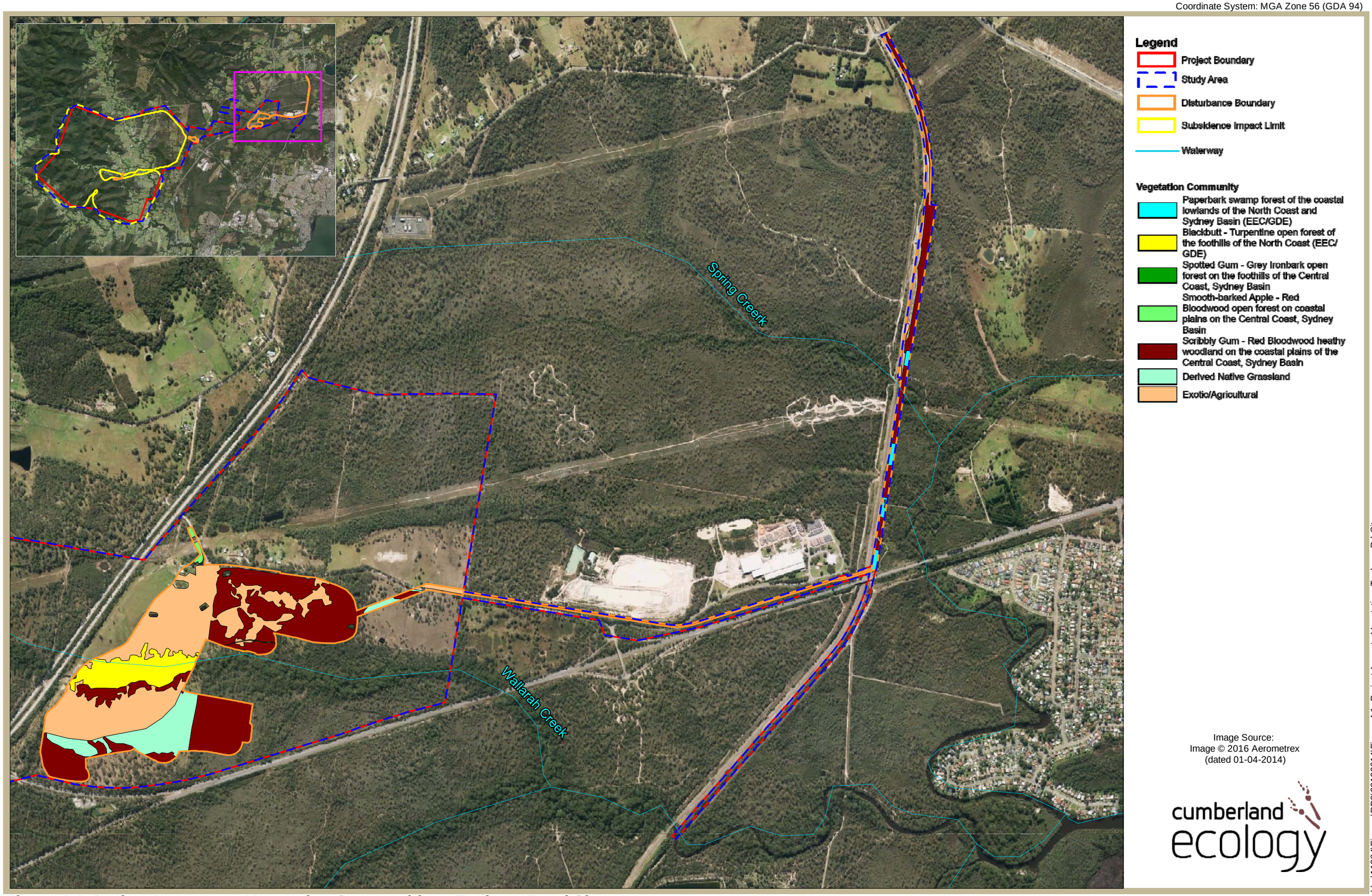


Figure 4.1. Project Impacts on Vegetation Communities - Tooheys Road Site

250 0 250 500 750 1000 m

Table 4.1 Comparison of Vegetation Communities within the Original and Alternate Disturbance Footprints

Vegetation Community	Area of Vegetation within Original Disturbance Footprint (ha)				Area of Vegetation within Alternate Disturbance Footprint (ha)				
	Tooheys Road Site	Buttonderry Site	Western Shaft Site	TOTAL	Tooheys Road Site	Buttonderry Site	Western Shaft Site	TOTAL	Area of reduction (ha)
Blackbutt - Turpentine open forest of the foothills of the North Coast (EEC)	5.86			5.86	5.41			5.41	**0.45**
Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin				0.00				0.00	**0.00**
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin			1.69	1.69			1.69	1.69	**0.00**
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC)	1.08			1.08	0.63			0.63	**0.45**
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin (EEC)				0.00				0.00	**0.00**
Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin (EEC)				0.00				0.00	**0.00**
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	33.81			33.81	28.13			28.13	**5.68**
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	1.75	2.01		3.77	0.25	2.01		2.26	**1.50**

Table 4.1 Comparison of Vegetation Communities within the Original and Alternate Disturbance Footprints

Vegetation Community	Area of Vegetation within Original Disturbance Footprint (ha)				Area of Vegetation within Alternate Disturbance Footprint (ha)				
	Tooheys Road Site	Buttonderry Site	Western Shaft Site	TOTAL	Tooheys Road Site	Buttonderry Site	Western Shaft Site	TOTAL	Area of reduction (ha)
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)		4.47		4.47		4.47		4.47	**0.00**
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin			0.81	0.81			0.81	0.81	**0.00**
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)	1.77			1.77				0.00	**1.77**
Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin (EEC)				0.00				0.00	**0.00**
Derived Native Grassland	7.25			7.25	6.01			6.01	**1.24**
Exotic/Agricultural/Low Diversity Grassland	24.24	3.57	0.18	27.99	22.02	3.57	0.18	25.64	**2.22**
Water/Farm Dam	0.54	0.04		0.58	0.47	0.04		0.51	**0.07**
Cleared	13.21	0.19	0.49	13.89		0.19	0.49	0.69	**13.21**
Total EEC vegetation	*8.71*	*4.47*	*0.00*	*13.18*	*6.04*	*4.47*	*0.00*	*10.51*	***2.67***
Total Native Vegetation	*51.53*	*6.48*	*2.50*	*60.51*	*40.43*	*6.48*	*2.50*	*49.42*	***11.10***
Total Vegetation	*75.77*	*10.05*	*2.69*	*88.51*	*62.45*	*10.05*	*2.69*	*75.19*	***13.32***
Total Area	*89.52*	*10.28*	*3.18*	*102.98*	*62.92*	*10.28*	*3.18*	*76.38*	***26.60***

As shown in **Table 4.1**, the Amendment will result in significantly less disturbance compared to the original Project. Despite the reduction in total area of vegetation to be removed, the direct removal of vegetation communities is still likely to result in the following impacts:

- Removing or reducing the availability of important habitat features that may offer forage, shelter or breeding opportunities for fauna, thus putting more pressure on remaining habitat to provide these features;
- Exacerbating fragmentation and isolation of already patchy woodland areas; and
- Increasing edge effects, particularly along linear patches.

However, the magnitude of these impacts will be slightly less than the predicted impacts of the original Project. Detailed assessments of these impacts are provided in **Sections 6.1.1 – 6.1.3** of the 2013 EIA. These assessments remain valid for the amended development footprint despite the reduction in total area of vegetation to be cleared.

4.2 Indirect Impacts

The following indirect impacts were assessed in the 2013 EIA.

- Noise;
- Light;
- Vehicle strike;
- Erosion;
- Discharge to Wallarah Creek; and
- Weeds and feral animals.

There is no significant change to these indirect impacts all be it that they will be less as a result of the Amendment. Therefore the assessments of indirect impacts outlined in the 2013 EIA remain valid.

4.3 Impacts to Regionally Significant Vegetation and Corridors

The Project is located in close proximity to several large areas of native vegetation within State Forests and Conservation Reserves. This includes Jilliby SCA, and Wyong State Forest (Wyong SF), Ourimbah SF and Olney SF. Parts of Jilliby SCA and Wyong SF are located within the Extraction Area and are not affected by the Amendment. The Ourimbah SF and Olney SF are in the vicinity of but outside the Project Boundary, and will therefore not be impacted.

Therefore the assessments of impacts to regionally significant vegetation and corridors outlined in the 2013 EIA remain valid.

4.4 Impacts on Aquatic Habitats

The primary impacts to aquatic habitats from the original Project include removal of riparian vegetation along Wallarah Creek and Spring Creek for surface infrastructure and creek crossings.

The Amendment has resulted in a reduction of approximately 0.45 ha of riparian vegetation to be cleared along Wallarah Creek The alternate development footprint also removes the requirement for the previously proposed rail crossings across Wallarah Creek.

The Amendment has also resulted in the removal of the rail crossing at Spring Creek, resulting in a reduction of approximately 0.5 ha of riparian vegetation to be cleared along Spring Creek as well as the retention of some Class 2 fish habitat.

The re-location of the rail spur to the eastern side of the Main Northern Rail Line ensures that the rail spur will cross Spring Creek directly adjacent to the existing rail crossings, and therefore can be seen as an extension of an existing crossing. The reaches of Spring Creek (main channel plus minor tributaries) where the proposed crossings will be constructed are already highly disturbed by the direct proximity of the existing rail crossings. The currently proposed crossing would in effect only constitute a widening of the existing crossings, and would result in very minor additional impacts to Spring Creek in this area.

Overall, the impacts on aquatic habitats from the proposed extension of the existing crossings across Spring Creek are outweighed by the benefits from avoiding the previously proposed rail crossings across Spring Creek and Wallarah Creek, resulting in an overall reduction of impacts on aquatic habitats.

4.5 Impacts to Endangered Ecological Communities

Several vegetation communities present in the Study Area are listed as EECs under the TSC Act, including the following:

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion;
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions; and
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.

The change in the disturbance footprint affects the Swamp Sclerophyll Forest EEC and River-Flat Eucalypt Forest EEC.

The Swamp Sclerophyll Forest EEC is represented in the Study Area by three communities:

- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin;
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin; and
- Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin.

The River-Flat Eucalypt Forest EEC is represented in the Study Area by two communities:

- Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin; and
- Blackbutt - Turpentine open forest of the foothills of the North Coast.

The Amendment reduces the total area of Swamp Sclerophyll Forest EEC to be cleared from 2.85 ha to 0.63 ha, resulting in the retention of 2.22 ha. The area of River-Flat Eucalypt Forest EEC to be cleared is reduced from 5.86 ha to 5.41 ha, resulting in the retention of 0.45 ha. All other impacts on these EECs remain unchanged.

The Assessments of Significance prepared for the original Project indicated no significant impact to these EECs was predicted to occur. As the impacts of the Project on these EECs has been reduced, the findings of the Assessments of Significance as outlined in Appendix H of the 2013 EIA remain valid for the Amended Project.

4.6 Impacts to Threatened Flora Species

The original disturbance footprint would have resulted in the removal of 1 known specimen of *Acacia bynoeana* and the removal of individuals or clumps of *Tetratheca juncea* from approximately 28 locations. The 2013 EIA estimated that approximately 80 specimens of *Angophora inopina* would be removed. However, based on the additional numbers of individuals recorded near the power easement during the 2013 field surveys, it is estimated that upwards of 200 individuals would have been removed as a result of the original Project.

The Amendment will not remove any known specimens of *Acacia bynoeana* and removal of *Tetratheca juncea* individuals/clumps has been reduced to one known location. It is estimated that approximately 130 specimens of *Angophora inopina* will be removed from the alternate disturbance footprint. The removal of the previously proposed rail loop will therefore avoid impacts to the large numbers of *Angophora inopina* located within the power easement area. The locations of known occurrences of threatened flora species that will be retained as a result of the removal of the original proposed rail loop area shown in **Figure 4.2**.

Coordinate System: MGA Zone 56 (GDA 94)

Figure 4.2. Locations of Retained Threatened Flora Species within the Tooheys Road Site

The Amendment will result in a significant reduction in the area of potential habitat for recorded and potentially occurring threatened flora species to be removed. A comparison of the total amount of potential habitat for each recorded and potentially occurring threatened flora species to be removed from the original footprint and alternate footprint is provided in **Table 4.2**.

Table 4.2 Reduction in potential habitat for threatened flora species to be removed

Threatened species	Habitat required	Habitat in original impact area (ha)	Habitat in alternate impact area (ha)	Increase in habitat retained (ha)
Acacia bynoeana	Scribbly Gum woodland, Smooth-barked Apple forest, Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest	42.9	35.7	7.2
Angophora inopina	Paperbark Swamp forest Scribbly Gum woodland, Smooth-barked Apple forest, Swamp Mahogany forest,	40.4	31.0	9.4
Cryptostylis hunteriana	Blackbutt - Turpentine forest Scribbly Gum woodland, Smooth-barked Apple forest, Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest,	48.7	41.1	7.6
Grevillea parviflora subsp parviflora	Scribbly Gum woodland Smooth-barked Apple forest Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest Swamp Mahogany forest,	44.6	35.7	9.0
Melaleuca biconvexa	Blackbutt – Turpentine forest, Paperbark Swamp forest Phragmites australis and Typha orientalis coastal freshwater wetlands Swamp Mahogany swamp forest, Woollybutt - Paperbark sedge forest,	8.7	6.0	2.7
Tetratheca juncea	Blackbutt – Turpentine forest Scribbly Gum woodland, Smooth-barked Apple forest,	50.5	41.1	9.4

Table 4.2 Reduction in potential habitat for threatened flora species to be removed

Threatened species	Habitat required	Habitat in original impact area (ha)	Habitat in alternate impact area (ha)	Increase in habitat retained (ha)
	Spotted Gum - Broad-leaved Ironbark forest, , Spotted Gum - Grey Ironbark forest, Swamp Mahogany Forest,			
Potentially occurring flora species (*Asterolasia elegans, Caladenia tessellata, Callistemon linearifolius, Corunastylis sp.* Charmhaven, *Eucalyptus camfieldii, Genoplesium insignis, Maundia triglochinoides, Rhizanthella slateri, Rutidosis heterogama, Syzygium paniculatum, Thelymitra sp. adorata, Eucalyptus parramattensis subsp. parramattensis*)	Collectively all vegetation communities occurring in Project Boundary (except Exotic/Agricultural/Low Diversity grasslands)	60.5	49.4	11.1

Note: any discrepancies in area between the original footprint areas provided in this table and corresponding tables in the 2013 EIA are due to reassessment of suitable habitat for the threatened species based on updated records and species profiles.

The Assessments of Significance prepared for the original Project indicated no significant impact to these threatened flora species was predicted to occur. As the impacts of the Project on these threatened flora species has been reduced, the findings of the Assessments of Significance as outlined in Appendix H of the 2013 Terrestrial EIA remain

valid for the Amended Project. As the potentially occurring threatened orchid, *Corunastylis* sp Charmhaven was not assessed as part of the 2013 EIA, an Assessment of Significance for this species is provided in **Appendix C**.

4.7 Impacts to Threatened Fauna Species

Numerous threatened fauna species have been recorded within the Study Area. The potential impacts of the Project on these species are mostly related to the potential disturbance and removal of habitat.

The Amendment has resulted in a significant reduction in the area of potential habitat for recorded and potentially occurring threatened fauna species to be removed. A comparison of the total amount of potential habitat for each recorded and potentially occurring threatened fauna species to be removed from the original footprint and alternate footprint is provided in **Table 4.3**. As habitat removal is the main predicted impact of the Project, fauna with similar habitat requirements have been grouped for the purposes of habitat assessment.

Table 4.3 Reduction in potential habitat for threatened fauna species to be removed

Threatened species	Habitat required	Habitat in original impact area (ha)	Habitat in alternate impact area (ha)	Increase in habitat retained (ha)
Amphibians (Wallum Froglet, Giant Barred Frog, Green and Golden Bell Frog, Green-thighed Frog, Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog)	Blackbutt – Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Paperbark Swamp Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands, Swamp Mahogany Forest,	10.4	7.7	2.7
Forest Owls (Powerful Owl, Masked Owl, Barking Owl, Sooty Owl)	Mountain Blue Gum - Turpentine Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark, Spotted Gum – Grey Ironbark,	44.5	37.4	7.2
Arboreal mammals (Eastern Pygmy Possum, Squirrel Glider, Yellow-bellied Glider)	Blackbutt – Turpentine forest Mountain Blue Gum - Turpentine forest, Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark forest,	50.4	42.8	7.6

Table 4.3 Reduction in potential habitat for threatened fauna species to be removed

Threatened species	Habitat required	Habitat in original impact area (ha)	Habitat in alternate impact area (ha)	Increase in habitat retained (ha)
Microchiropteran Bats (Yellow-bellied Sheathtail-bat, East-coast Freetail Bat, Eastern False Pipistrelle, Little Bentwing Bat, Eastern Bentwing Bat, Golden-tipped Bat, Southern Myotis, Greater Broad-nosed Bat, Large-eared Pied Bat)	Blackbutt – Turpentine Forest Mountain Blue Gum Turpentine forest, Scribbly Gum – Red Bloodwood woodland Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark forest,,	50.4	42.8	7.6
Wetland birds (Black Bittern, Black-necked Stork, Black-tailed Godwit, White-fronted Chat, Australasian Bittern)	Paperbark Swamp Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands Swamp Mahogany Forest,	2.9	0.6	2.3
Migratory Parrots (Little Lorikeet, Swift Parrot)	Blackbutt – Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood; Smooth-barked Apple - Red Bloodwood open forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest, Swamp Mahogany swamp forest	51.6	41.7	9.9
Cockatoos (Glossy Black Cockatoo, Gang-gang Cockatoo)	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood open forest Spotted Gum – Broad Leaved Ironbark Forest, Spotted Gum - Grey Ironbark forest,	42.9	35.7	7.2
Regent Honeyeater	Blackbutt – Turpentine forest; Scribbly Gum - Red Bloodwood; Smooth-barked Apple - Red Bloodwood open forest;	48.7	41.1	7.6

Table 4.3 Reduction in potential habitat for threatened fauna species to be removed

Threatened species	Habitat required	Habitat in original impact area (ha)	Habitat in alternate impact area (ha)	Increase in habitat retained (ha)
	Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest,			
Grey-headed Flying Fox	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood open forest Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany forest	52.2	42.8	9.4
Little Eagle	Blackbutt – Turpentine forest, Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple - Red Bloodwood forest,	43.4	35.8	7.6
Varied Sittella	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood forest,	37.6	30.4	7.2
Bush Stone-curlew	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood forest,	37.6	30.4	7.2
Koala	Blackbutt - Turpentine forest; Mountain Blue Gum - Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest Swamp Mahogany swamp forest	53.3	43.4	9.9
Spotted tailed Quoll	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood woodland; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany swamp forest	53.3	43.4	9.9

Note: any discrepancies in area between the original footprint areas provided in this table and corresponding tables in the 2013 EIA are due to reassessment of suitable habitat for the threatened species based on updated records and species profiles.

4.8 Impacts from Key Threatening Processes

Impacts from the following KTPs were assessed in the 2013 EIA.

- Clearing of native vegetation;
- Alteration of natural flow regimes or rivers and streams and their floodplains and wetlands;
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis;
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae; and
- Anthropogenic climate change.

There will be no significant change to the impacts from these KTPs as a result of the Amendment. In fact, the impacts associated with clearing of native vegetation are expected to be reduced. Therefore the assessments of impacts from KTPs outlined in the 2013 EIA remain valid.

Chapter 5

Impact Assessment on MNES

This chapter provides an assessment of the impacts of the Project on MNES, specifically those recorded from the Study Area, and those considered to have potential to occur with a particular focus on MNES listed as 'controlled action' species.

5.1 Significant Impact Assessments

Detailed descriptions of MNES and assessments against relevant significant impact guidelines were conducted for the following species as part of the 2013 EIA.

Threatened flora:

- *Angophora inopina* (Charmhaven Apple);
- *Tetratheca juncea* (Black-eyed Susan);
- *Acacia bynoeana* (Bynoe's Wattle);
- *Cryptostylis hunteriana* (Leafless Tongue Orchid);
- *Grevillea parviflora* (Small-flower Grevillea);
- *Melaleuca biconvexa* (Biconvex Paperbark);
- *Asterolasia elegans;*
- *Caladenia tessellata* (Thick-lipped Spider Orchid);
- *Eucalyptus camfieldii* (Camfield's Stringybark);
- *Rhizanthella slateri* (Eastern Underground Orchid);
- *Rutidosis heterogama* (Heath Wrinklewort)
- *Syzygium paniculatum (*Magenta Lilly-Pilly*);*

Threatened Fauna:

- Giant Barred Frog (*Mixophyes iteratus*);

- Green and Golden Bell Frog (*Litoria aurea*);
- Giant Burrowing Frog (*Heleioporus australiacus*);
- Litttejohn's Tree Frog (*Litoria littlejohni*);
- Stuttering Frog (*Mixophyes balbus*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Australasian Bittern (*Botaurus poiciloptilus*);
- Australian Pained Snipe (*Rostratula australis*);
- Swift Parrot (*Lathamus discolor*);
- Grey-headed Flying Fox (*Pteropus poliocephalus*);
- Spotted-tailed Quoll (*Dasyurus maculatus*);
- Koala (*Phascolarctos cinereus*); and
- Large-eared Pied Bat (*Chalinolobus dwyeri*).

Migratory Fauna

- Black-faced Monarch;
- Cattle Egret;
- Great Egret;
- Rufous Fantail;
- White-bellied Sea-eagle;
- White-throated Needletail;
- Black-tailed Godwit;
- Latham's Snipe;
- Glossy Ibis;
- Fork-tailed Swift;
- Satin Flycatcher; and
- Rainbow Bee-eater.

The impacts on MNES will not change as a result of the Amendment.

Residual impacts on MNES are generally confined to the removal of native vegetation. As the Amendment will result in a reduction of removal of native vegetation, there has been a corresponding reduction in residual impacts on MNES. Therefore, the assessments conducted for MNES in the 2013 EIA remain valid. Although the Regent Honeyeater and Swift Parrot have been uplisted from Endangered to Critically Endangered since the 2013 EIA, the assessments conducted for the 2013 EIA remain valid as the Significant Impact Criteria for assessment are the same for critically endangered and endangered species.

The reductions in impacted areas of potential habitat for threatened flora and fauna listed under the EPBC Act are provided in **Tables 5.1 – 5.2** below.

Table 5.1 Reduction in potential habitat for threatened MNES flora species to be removed

Threatened species	Habitat required	Original Impact	Alternate Impact	Habitat Retained
Acacia bynoeana	Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest	42.9	35.7	7.2
Angophora inopina	Paperbark Swamp forest Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple - Red Bloodwood forest, Swamp Mahogany forest,	40.4	31.0	9.4
Cryptostylis hunteriana	Blackbutt - Turpentine open forest Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest,	48.7	41.1	7.6
Grevillea parviflora subsp parviflora	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood open forest Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest Swamp Mahogany forest,	44.6	35.7	9.0
Melaleuca biconvexa	Blackbutt – Turpentine forest, Paperbark Swamp forest Phragmites australis and Typha orientalis coastal freshwater wetlands Swamp Mahogany swamp forest, Woollybutt - Paperbark sedge forest,	8.7	6.0	2.7

Table 5.1 Reduction in potential habitat for threatened MNES flora species to be removed

Threatened species	Habitat required	Original Impact	Alternate Impact	Habitat Retained
Tetratheca juncea	Blackbutt – Turpentine forest Scribbly Gum woodland, Smooth-barked Apple forest , Spotted Gum - Broad-leaved Ironbark forest Spotted Gum - Grey Ironbark open forest, Swamp Mahogany Forest,	50.5	41.1	9.4
Asterolasia elegans	Blackbutt - Turpentine open forest Mountain Blue Gum - Turpentine forest, Scribbly Gum woodland Smooth-barked Apple forest, Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest,	50.4	42.8	7.6
Caladenia tessellata	Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark open forest	5.3	5.3	0.0
Eucalyptus camfieldii,	Scribbly Gum - Red Bloodwood heathy	33.8	28.1	5.7
Rhizanthella slateri	Blackbutt - Turpentine forest Coachwood - Crabapple rainforest Mountain Blue Gum - Turpentine forest Rough-barked Apple woodland, Scribbly Gum woodland, Smooth-barked Apple forest Spotted Gum - Broad-leaved Ironbark forest Spotted Gum - Grey Ironbark forest	50.4	42.8	7.6
Syzygium paniculatum,	Coachwood – Crabapple rainforest	0.0	0.0	0.0

Note: any discrepancies in area between the original footprint areas provided in this table and corresponding tables in the 2013 EIA are due to reassessment of suitable habitat for the threatened species based on updated records and species profiles

Table 5.2 Reduction in potential habitat for threatened MNES fauna species to be removed

Threatened species	Habitat required	Original Impact	Alternate Impact	Habitat Retained
Giant Barred Frog	Blackbutt - Turpentine open forest, Coachwood - Crabapple rainforest, Mountain Blue Gum - Turpentine open forest Paperbark Swamp Forest, Swamp Mahogany swamp forest	10.4	7.7	2.7
Green and Golden Bell Frog	Blackbutt - Turpentine open forest, Paperbark Swamp Forest, Swamp Mahogany swamp forest	8.7	6.0	2.7
Giant Burrowing Frog	Phragmites australis wetlands, Scribbly Gum woodland Smooth-barked Apple forest	37.6	30.4	7.2
Littlejohn's Tree Frog	Blackbutt - Turpentine open forest, Mountain Blue Gum - Turpentine open forest Paperbark Swamp Forest, Spotted Gum - Grey Ironbark forest, Swamp Mahogany swamp forest	11.2	8.5	2.7
Stuttering Frog	Blackbutt - Turpentine open forest; Coachwood - Crabapple rainforest	5.9	5.4	0.4
Regent Honeyeater	Blackbutt – Turpentine forest; Scribbly Gum woodland Smooth-barked Apple forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest,	48.7	41.1	7.6
Australasian Bittern	Phragmites australis wetlands	0.0	0.0	0.0
Australian Painted Snipe	Phragmites australis wetlands, Exotic/Agricultural/Low Diversity Grassland; Water/Farm Dam	28.6	26.3	2.3
Swift Parrot	Blackbutt – Turpentine forest; Paperbark swamp forest; Scribbly Gum woodland Smooth-barked Apple forest; Spotted Gum - Broad-leaved Ironbark forest;	51.6	41.7	9.9

Table 5.2 Reduction in potential habitat for threatened MNES fauna species to be removed

Threatened species	Habitat required	Original Impact	Alternate Impact	Habitat Retained
	Spotted Gum - Grey Ironbark forest, Swamp Mahogany swamp forest			
Grey-Headed Flying-fox	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum woodland; Smooth-barked Apple forest Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany forest	52.2	42.8	9.4
Spotted Tailed Quoll	Blackbutt - Turpentine forest; Mountain Blue Gum - Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany swamp forest	53.3	43.4	9.9
Koala	Blackbutt - Turpentine forest; Mountain Blue Gum - Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest Swamp Mahogany swamp forest	53.3	43.4	9.9
Large-eared Pied Bat	Blackbutt - Turpentine forest, Mountain Blue Gum - Turpentine forest,	52.2	42.8	9.4

Table 5.2 Reduction in potential habitat for threatened MNES fauna species to be removed

Threatened species	Habitat required	Original Impact	Alternate Impact	Habitat Retained
	Scribbly Gum woodland, Smooth-barked Apple forest, Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest, Swamp Mahogany swamp forest			

Note: any discrepancies in area between the original footprint areas provided in this table and corresponding tables in the 2013 EIA are due to reassessment of suitable habitat for the threatened species based on updated records and species profiles

5.2 Commonwealth Offset Calculations

The DoE (formerly SEWPaC), during their review of the draft of the 2013 EIS for the Project determined that the residual impacts on MNES, particularly the controlled action species were not adequately quantified and that an analysis of the proposed Biodiversity Offset Package against the requirements of the Commonwealth Offsets policy (the Policy) was required.

Potential impacts on MNES, particularly to 'controlled action' species, were assessed using the EPBC Act *Offsets Assessment Guide* and submitted to DoE in June 2013.

As the Amendment has reduced the area of potential habitat for each controlled action species, updated calculations were conducted using the EPBC Act *Offsets Assessment Guide.*

The updated assessments for the alternate disturbance footprint determined that the proposed Biodiversity Offset Package provides in excess of the required offsets for each controlled action species (**Table 5.3**). The improvement in the offset requirements between the original Project and amended Project for each controlled action species from the retention of vegetation in the offset areas only, as calculated by the *Offsets Assessment Guide,* is provided in **Table 5.4**. The completed assessment spreadsheets are provided in **Appendix D** while summary tables providing justification of values entered into the *Offsets Assessment Guide* are provided in **Appendix E**.

Table 5.3 Summary of Offsets Assessment Guide Calculations for Controlled Action Species – Alternative Disturbance Boundary

Scientific Name	Common Name	EPBC status	Area of habitat removed (ha)	Habitat quality	Total Quantum of Impact (calculator adjusted ha)	Offset - Retained Vegetation		Offset - Revegetation		Total % of impact offset
						Area of habitat (ha)	% of impact offset	Area of habitat (ha)	% of impact offset	
Angophora inopina	Charmhaven Apple	V	31.0	7	21.7	123.8	192.8	31.3	25.4	218.2
Tetratheca juncea	Black-eyed Susan	V	41.1	6	24.7	192.1	248.3	31.3	22.3	270.6
Mixophyes iteratus	Giant Barred Frog	E	7.7	4	3.08	27.1	122.6			122.6
Dasyurus maculatus	Spotted-tailed Quoll	E	43.4	4	17.36	196	186.9			186.9

Table 5.4 Improvement of proposed offsets for Controlled Action MNES

Controlled action species	Percentage of direct offset requirement met from vegetation retained in offset areas (minimum 90% required)	
	Original Project	Amended Project
Angophora inopina	137.03%	192.78%
Tetratheca juncea	202.82%	248.3%
Giant Barred Frog	91.47%	122.64%
Spotted-tailed Quoll	101.6%	186.94%

Chapter 6

Impact Mitigation

The purpose of this chapter is to summarise the changes and improvements in the mitigation measures proposed to ameliorate the impacts of the Project on flora and fauna.

The mitigation measures for the Project, as outlined in the 2013 EIS, followed the following hierarchy of principles:

- Avoid – to the extent possible, the Project has been designed to avoid or minimise ecological impacts;
- Mitigate – where certain impacts are unavoidable through design changes, mitigation measures have been introduced to ameliorate the ecological impacts of the Project; and
- Compensate – the residual impacts of the Project, following the implementation of mitigation measures, have been compensated to offset what would otherwise be a net loss of habitat.

The measures to avoid and mitigate remain largely unchanged from the 2013 EIS. In fact, the amended project further avoids clearing of EEC vegetation and removal of threatened flora species compared to the original project. The requirements for monitoring programs, management plans and protection mechanisms are also unaffected by the Amendment and are as outlined in Chapter 8 of the 2013 Terrestrial EIA and Chapters 5 and 6 of the Aquatic EIA.

The Alternate Disturbance Boundary has resulted in a loss of approximately 0.8 ha, comprising 0.3 ha of Scribbly Gum Woodland, 0.4 ha of Derived Native Grassland and 0.1 ha of Exotic Grassland, from the Tooheys Road Southern Offset. With the exception of this small area, the proposed Biodiversity Offset Package (BOP) remains largely unchanged,

Despite the minor loss from the Tooheys Road Southern Offset, the offset ratios for the Alternate Disturbance Boundary are substantially increased as a result of the Amendment. The final BOP was prepared in accordance with the requirements of the 'OEH Interim Offset Policy 2011' and relevant advice provided by OEH during consultations following the exhibition of the 2013 EIS (as detailed in the RTS).

The improvements in the ratios for vegetation communities and potential habitat for threatened flora and threatened fauna are provided in **Tables 6.1 – 6.3** below. The distribution of vegetation communities across the three offset areas is provided in **Figure**

6.1. The locations of recorded threatened and migratory species within the offset properties are shown in **Figure 6.2**.

Table 6.1 Improvement in offset ratios for Vegetation Communities

		Original Project			Amended Project		
Formation	**Vegetation Community**	**Impact area**	**Offset area**	**Ratio**	**Impact area**	**Offset area**	**Ratio**
Wet Sclerophyll Forests (Grassy subformation)	Blackbutt - Turpentine open forest of the foothills of the North Coast	5.9	16.9	*2.9*	5.4	16.9	*3.1*
Wet Sclerophyll Forests (Shrubby subformation)	Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	1.7	0.0	*0.0*	1.7	0.0	*0.0*
Subtotal for Wet Sclerophyll Forests		**7.6**	**16.9**	***2.2***	**7.1**	**16.9**	***2.4***
Dry Sclerophyll Forests (Shrubby subformation)	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	33.8	39.8	*1.2*	28.1	39.5	*1.4*
Dry Sclerophyll Forests (Shrubby subformation)	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	3.8	74.0	*19.6*	2.3	74.0	*32.7*
Dry Sclerophyll Forests (Shrubby subformation)	Derived Native Grassland	7.3	11.0	*1.5*	6.01	10.6	*1.8*
Dry Sclerophyll Forests (Shrub/grass subformation)	Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)	4.5	55.4	*12.4*	4.5	55.4	*12.4*
Dry Sclerophyll Forests (Shrub/grass subformation)	Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	0.8	0.0	*0.0*	0.8	0.0	*0.0*

Table 6.1 Improvement in offset ratios for Vegetation Communities

		Original Project			Amended Project		
Formation	**Vegetation Community**	**Impact area**	**Offset area**	**Ratio**	**Impact area**	**Offset area**	**Ratio**
Subtotal for Dry Sclerophyll Forests		**50.1**	**180.2**	***3.6***	**41.7**	**179.5**	***4.3***
Forested Wetlands	Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC)	1.1	3.9	*3.6*	0.6	3.9	*6.2*
Forested Wetlands	Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin (EEC)	0.00	0.4	*N/A*	0.0	0.4	*N/A*
Forested Wetlands	Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)	1.8	6.3	*3.6*	0.0	6.3	*N/A*
Subtotal for Forested Wetlands		**2.9**	**10.6**	***3.7***	**0.6**	**10.6**	***16.8***

Note: Offset area calculations for the Amended Project utilise the reduced area for the Tooheys Road Southern Offset.

Table 6.2 Improvement in offset ratio of available habitat for Threatened Flora

		Original Project			Amended Project		
Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Habitat ratio	Habitat in impact area (ha)	Habitat within offset area (ha)	Habitat ratio
Acacia bynoeana	Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum - Broad-leaved Ironbark forest, Spotted Gum - Grey Ironbark forest	42.9	169.2	*3.9*	35.7	168.9	*4.7*
Angophora inopina	Paperbark Swamp forest Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple - Red Bloodwood forest, Swamp Mahogany forest,	40.4	124.1	*3.1*	31.0	123.8	*4.0*
Cryptostylis hunteriana	Blackbutt - Turpentine open forest Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest,	48.7	186.1	*3.8*	41.1	185.8	*4.5*
Grevillea parviflora subsp parviflora	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood open forest Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest Swamp Mahogany forest,	44.6	175.5	*3.9*	35.7	175.2	*4.9*

Table 6.2 Improvement in offset ratio of available habitat for Threatened Flora

		Original Project			Amended Project		
Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Habitat ratio	Habitat in impact area (ha)	Habitat within offset area (ha)	Habitat ratio
Melaleuca biconvexa	Blackbutt – Turpentine forest, Paperbark Swamp forest Phragmites australis and Typha orientalis coastal freshwater wetlands Swamp Mahogany swamp forest, Woollybutt - Paperbark sedge forest,	8.7	27.1	*3.1*	6.0	27.1	*4.5*
Tetratheca juncea	Blackbutt – Turpentine forest Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood , Spotted Gum - Broad-leaved Ironbark grassy open forest, , Spotted Gum - Grey Ironbark open forest, Swamp Mahogany Forest,	50.5	192.4	*3.8*	41.1	192.1	*4.7*
Potentially occurring flora species (*Asterolasia elegans, Caladenia tessellata, Callistemon linearifolius, Eucalyptus camfieldii, Genoplesium insignis, Maundia*	Collectively all vegetation communities occurring in Project Boundary (except Exotic/Agricultural/Low Diversity grasslands)	60.5	207.6	*3.4*	49.4	207.0	*4.2*

Table 6.2 Improvement in offset ratio of available habitat for Threatened Flora

		Original Project			Amended Project		
Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Habitat ratio	Habitat in impact area (ha)	Habitat within offset area (ha)	Habitat ratio
triglochinoides, Rhizanthella slateri, Rutidosis heterogama, Syzygium paniculatum, Thelymitra sp. adorata, Eucalyptus parramattensis subsp. parramattensis)							

Note: any discrepancies in area between the original footprint areas provided in this table and corresponding tables in the 2013 EIA are due to reassessment of suitable habitat for the threatened species based on updated records and species profiles. Offset area calculations for the Amended Project utilise the reduced area for the Tooheys Road Southern Offset.

Table 6.3 Improvement in offset ratio of available habitat for Threatened Fauna

		Original Project			Amended Project		
Threatened species	**Habitat required**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**
Amphibians (Wallum Froglet, Giant Barred Frog, Green and Golden Bell Frog, Green-thighed Frog, Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog)	Blackbutt – Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Paperbark Swamp Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands, Swamp Mahogany Forest,	10.4	27.1	*2.6*	7.7	27.1	*3.5*
Forest Owls (Powerful Owl, Masked Owl, Barking Owl, Sooty Owl)	Mountain Blue Gum - Turpentine Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark, Spotted Gum – Grey Ironbark,	44.5	169.2	*3.8*	37.4	168.9	*4.5*
Arboreal mammals (Eastern Pygmy Possum, Squirrel Glider, Yellow-bellied Glider)	Blackbutt – Turpentine forest Mountain Blue Gum - Turpentine forest, Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest,	50.4	186.1	*3.7*	42.8	185.8	*4.3*
Microchiropteran Bats (Yellow-	Blackbutt – Turpentine Forest	50.4	186.1	*3.7*	42.8	185.8	*4.3*

Table 6.3 Improvement in offset ratio of available habitat for Threatened Fauna

		Original Project			Amended Project		
Threatened species	**Habitat required**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**
bellied Sheathtail-bat, East-coast Freetail Bat, Eastern False Pipistrelle, Little Bentwing Bat, Eastern Bentwing Bat, Golden-tipped Bat, Southern Myotis, Greater Broad-nosed Bat, Large-eared Pied Bat)	Mountain Blue Gum Turpentine forest, Scribbly Gum – Red Bloodwood woodland Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark forest,,						
Wetland birds (Black Bittern, Black-necked Stork, Black-tailed Godwit, White-fronted Chat, Australasian Bittern)	Paperbark Swamp Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands Swamp Mahogany Forest,	2.9	10.2	*3.6*	0.6	10.2	*16.3*
Migratory Parrots (Little Lorikeet, Swift Parrot)	Blackbutt – Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood; Smooth-barked Apple - Red Bloodwood open forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest, Swamp Mahogany swamp forest	51.6	196.3	*3.8*	41.7	196.0	*4.7*
Cockatoos (Glossy Black Cockatoo, Gang-gang	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood open forest	42.9	169.2	*3.9*	35.7	168.9	*4.7*

Table 6.3 Improvement in offset ratio of available habitat for Threatened Fauna

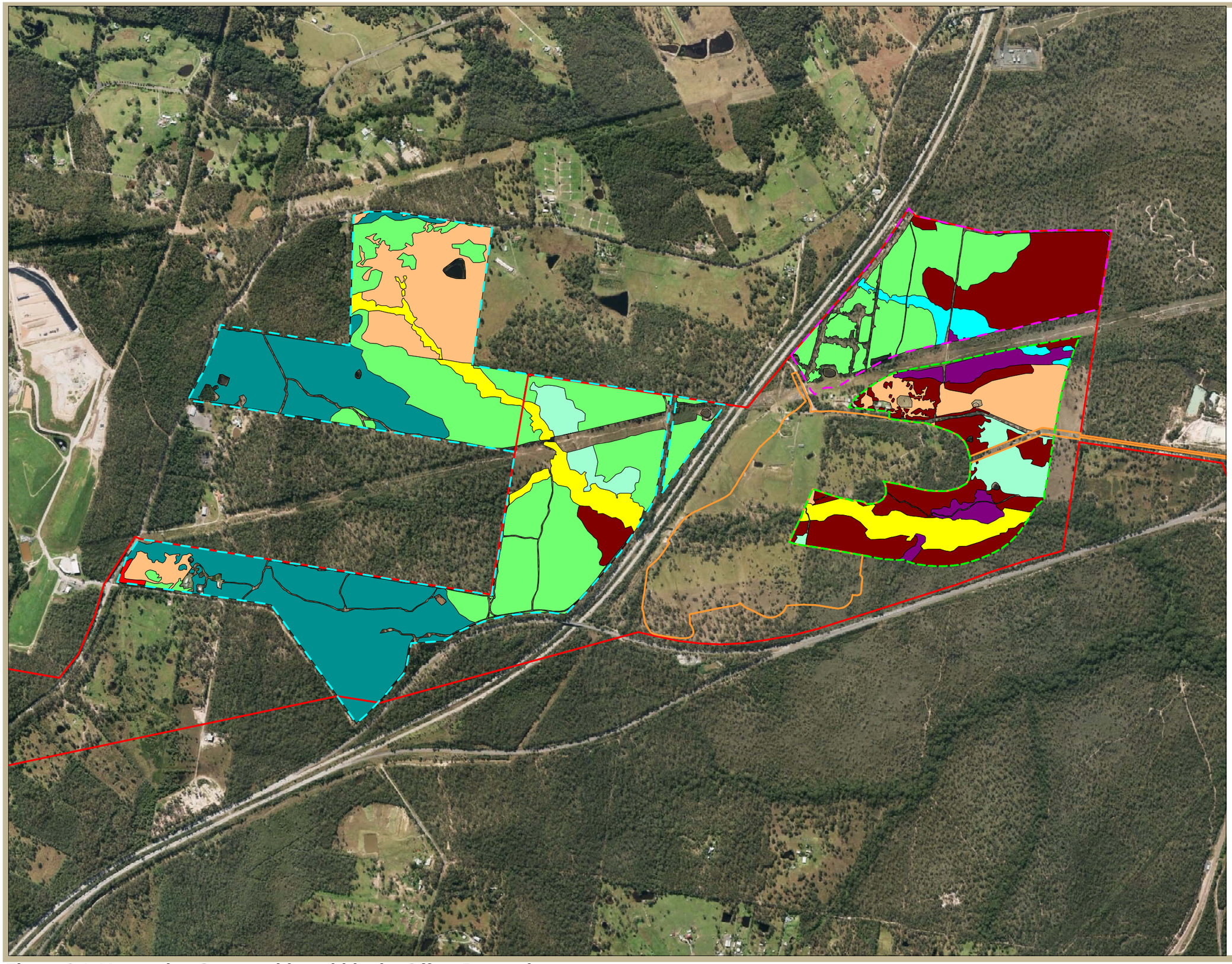
		Original Project			Amended Project		
Threatened species	**Habitat required**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**
Cockatoo)	Spotted Gum – Broad Leaved Ironbark Forest, Spotted Gum - Grey Ironbark forest,						
Regent Honeyeater	Blackbutt – Turpentine forest; Scribbly Gum - Red Bloodwood; Smooth-barked Apple - Red Bloodwood open forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest,	48.7	186.1	*3.8*	41.1	185.8	*4.5*
Grey-headed Flying Fox	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood open forest Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany forest	52.2	192.4	*3.7*	42.8	192.1	*4.5*
Little Eagle	Blackbutt – Turpentine forest, Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple - Red Bloodwood forest,	43.4	130.7	*3.0*	35.8	130.4	*3.6*
Varied Sittella	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood forest,	37.6	113.8	*3.0*	30.4	113.5	*3.7*

Table 6.3 Improvement in offset ratio of available habitat for Threatened Fauna

		Original Project			Amended Project		
Threatened species	**Habitat required**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**	**Habitat in impact area (ha)**	**Habitat within offset area (ha)**	**Habitat ratio**
Bush Stone-curlew	Scribbly Gum - Red Bloodwood woodland Smooth-barked Apple - Red Bloodwood forest,	37.6	113.8	*3.0*	30.4	113.5	*3.7*
Koala	Blackbutt - Turpentine forest; Mountain Blue Gum - Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest Swamp Mahogany swamp forest	53.3	196.3	*3.7*	43.4	196.0	*4.5*
Spotted tailed Quoll	Blackbutt - Turpentine forest; Mountain Blue Gum - Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood woodland; Smooth-barked Apple - Red Bloodwood forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany swamp forest	53.3	196.3	*3.7*	43.4	196.0	*4.5*

Note: any discrepancies in area between the original footprint areas provided in this table and corresponding tables in the 2013 EIA are due to reassessment of suitable habitat for the threatened species based on updated records and species profiles. Offset area calculations for the Amended Project utilise the reduced area for the Tooheys Road Southern Offset.

Coordinate System: MGA Zone 56 (GDA 94)



Legend

- Project Boundary
- Disturbance Boundary
- Hue Hue Road Offset Area
- Tooheys Road Southern Offset Area
- Tooheys Road Northern Offset Area

Vegetation Communities

- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC/GDE)
- Rough-barked Apple - red gum grassy woodland of the McDonald River Valley on the Central Coast, Sydney Basin (EEC)
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC/GDE)
- Blackbutt - Turpentine open forest of the foothills of the North Coast (EEC/GDE)
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin
- Derived Native Grassland
- Exotic/Agriculture/Low Diversity Grassland

Image Source:
Image © 2016 Aerometrex
(dated 01-04-2014)

cumberland ecology

Grid North

I:\...\11084\Figures\RP9\20160614\Figure 6.1. Vegetation Communities_Offset

Figure 6.1. Vegetation Communities within the Offset Properties

250 0 250 500 750 1000 m

Coordinate System: MGA Zone 56 (GDA 94)

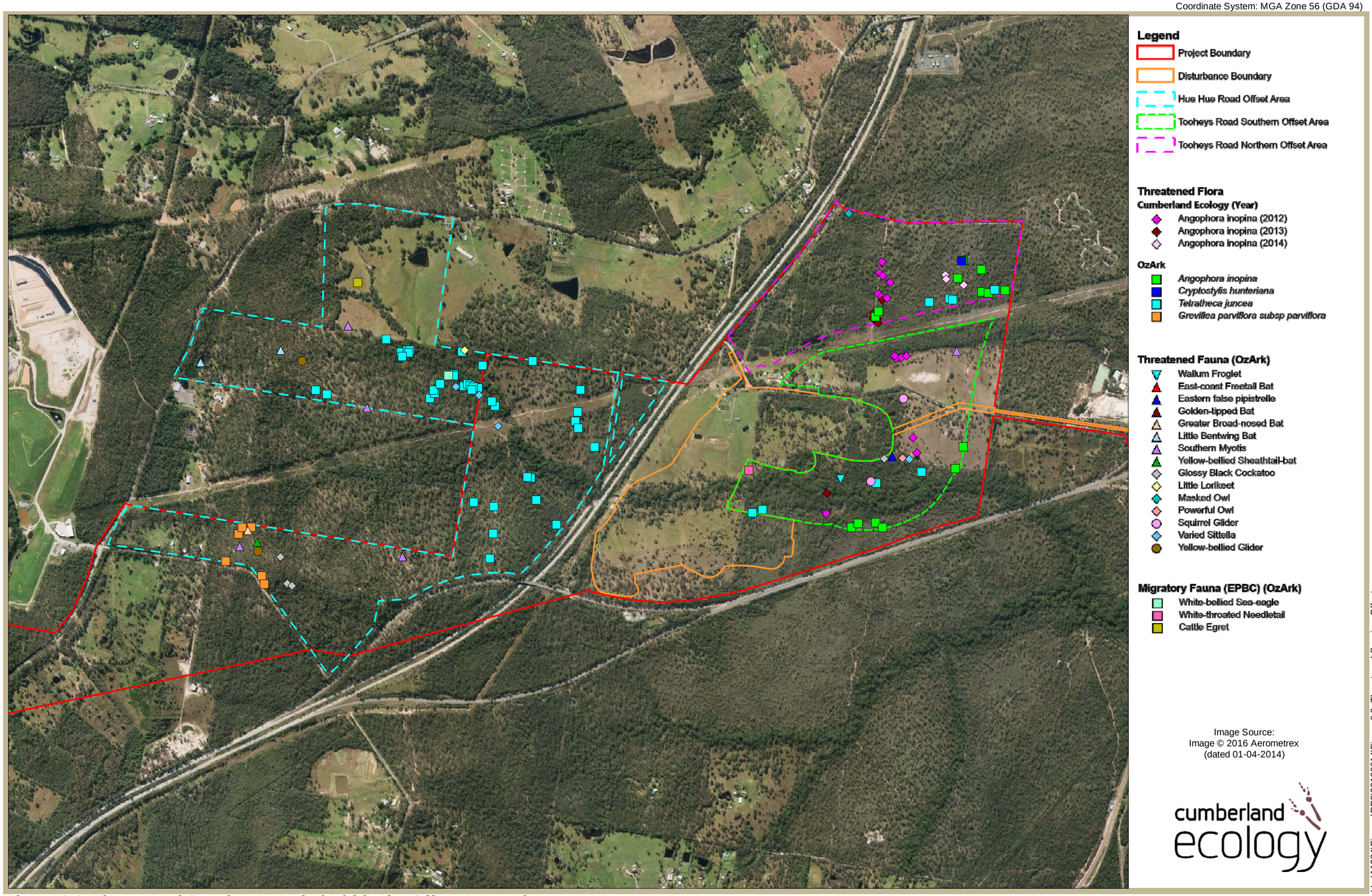


Figure 6.2. Threatened Species recorded within the Offset Properties

250 0 250 500 750 1000 m

Chapter 7

Conclusions

A high portion of the land within the Project Boundary is currently used for farming or as pasture land and this usage has resulted in significant modification and disturbance, ranging from severely modified cropping lands such as turf farms, to improved pastures and modified native grasslands used for grazing. Notwithstanding this, there are large areas of relatively intact remnant vegetation on steeper slopes and mountain tops in the western areas of the Project Boundary, as well as numerous patches of mature and regenerating woodland on low-lying areas in the eastern parts of the Project Boundary.

The Amendment has resulted in an approximately 30% decrease in the area of vegetation to be cleared from the Tooheys Road Site (from 89 ha to 63 ha). This includes reduction of 0.45 ha of River Flat Eucalypt Forest EEC and 2.22 ha of Swamp Sclerophyll Forest EEC to be cleared. The reduction in area of vegetation to be cleared has also resulted in a 30% decrease in the amount of habitat for native flora and fauna, including threatened species, being cleared. The Amendment has also resulted in a significant reduction in the numbers of *Angophora inopina*, (Vulnerable - TSC Act and EPBC Act) and *Tetratheca juncea* (Vulnerable - TSC Act and EPBC Act) individuals to be removed.

Further potential impacts from indirect effects such as edge effects and weed invasion as well as subsidence, such as surface cracking and changes in water tables remain unchanged for the Amendment.

The forest and woodland vegetation in the Project Boundary provides habitat for a range of threatened and migratory fauna species, listed under the TSC Act and/or EPBC Act that have been recorded within the Study Area. Given the scale of the Project's potential impacts on flora and fauna listed by the EPBC Act, in particular *Angophora inopina* (Charmhaven Apple), *Tetratheca juncea* (Black-eyed Susan), Giant Barred Frog (*Mixophyes iteratus*) and Spotted-tailed Quoll (*Dasyurus maculatus*), the Project was deemed to be a controlled action under the EPBC Act.

In recognition of the potential ecological impacts from clearing substantial mitigation and amelioration measures have been proposed for the Project. The mitigation and amelioration measures proposed for the Project remain largely unchanged as a result of the Amendment. However as a result of the reduction in the disturbance footprint, there has been an improvement in the proposed Biodiversity Offset Package.

When the mitigation and offsetting package is considered, no significant impacts are predicted to occur to threatened species as a result of the Amendment, and the Project will provide a major ecological benefit in the medium to long term.

References

Bell, S. A. J. (2002a). *The Natural Vegetation of the Wyong Local Government Area, Central Coast, New South Wales: Technical Report*. Eastcoast Flora Survey, Kotara Fair, NSW.

Bell, S. A. J. (2002b). *The Natural Vegetation of the Wyong Local Government Area, Central Coast, New South Wales: Vegetation Community Profiles*, Kotara Fair, NSW.

Botanic Gardens Trust (2016). "PlantNET." Retrieved 2016, from http://www.rbgsyd.nsw.gov.au/search_plant_net.

Cumberland Ecology (2013). *Wallarah 2 Coal Project: Ecological Impact Assessment*. Cumberland Ecology Pty. Ltd, Epping, NSW.

DEC (NSW) (2004). *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)*. New South Wales Department of Environment and Conservation, Hurstville, NSW.

DECCW (NSW) (2009). *Field Survey Methods*. Department of Environment, Climate Change and Water, Hurtsville.

DEWR (2007). *Draft Policy Statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999*.

DoE (2015). "EPBC Protected Matters Search Tool." Commonwealth Department of Environment.

Gibbons, P., Lindenmayer, D. B., Barry, S. C. and Tanton, M. T. (2000). "Hollow formation in eucalypts from temperate forests in southeastern Australia." *Pacific Conservation Biology* **6**: 218-228.

Hansen Bailey (2013). *Wallarah 2 Coal Project: Response to Submissions*. Hansen Bailey Environmental Consultants, Singleton, NSW.

Harden, G. J. (1990-1993). *Flora of NSW Volumes 1-4*. New South Wales University Press, Kensington.

Harper, M. J., McCarthy, M. A., van der Ree, R. and Fox, J. C. (2004). "Overcoming bias in ground-based surveys of hollow-bearing trees using double-sampling." *Forest Ecology and Management* **190**(291-300).

Koch, A. J. (2008). "Errors associated with two methods of assessing tree hollow occurrence and abundance in *Eucalyptus obliqua* forest, Tasmania." *Forest Ecology and Management* **255**(674-685).

Marine Pollution Research (2013). *Wallarah 2 Coal Project: Aquatic Ecology Impact Assessment*. Marine Pollution Research Pty Ltd, Church Point, NSW.

McIntyre, S., McIvor, J. G. and Heard, K. M. (2002). *Managing and Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood.

NSW Scientific Commitee (2013). *Corunastylis sp. Charmhaven - critically endangered species listing*.

OEH (2008). "Wyong LGA Endangered Ecological Communities: EECs Map 2009."

OEH (2011). *Principles for the use of biodiversity offsets in NSW*. Office of Environment and Heritage (NSW),.

OEH (2014). *Corunastylis sp Charmhaven (NSW896673) - Threatened Species Profile*.

OEH (2015). "Atlas of NSW WIldlife." Retrieved 2015.

Poore, M. E. D. (1955). "The use of phytosociological methods in ecological investigations. 1. The Braun-Blanquet System." *Journal of Ecology* **42**: 216-224.

Rayner, L., Ellis, M. and Taylor, J. E. (2010). "Double sampling to assess the accuracy of ground-based surveys of tree hollows in eucalypt woodlands." *Austral Ecology* **36**(252-260).

Appendix A

Likelihood of Occurrence Assessment

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
Flora	*Acacia bynoeana*	Bynoe's Wattle	E1	V	Found in heath and woodland on sandy soils. Prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches.	Suitable habitat present	12	Confirmed	High
Flora	*Angophora inopina*	Charmhaven Apple	V	V	Found in open dry sclerophyll woodland of with a dense shrub understorey. Occurs on deep white sandy soils over sandstone, often with some gravelly laterite	Suitable habitat present	426	Confirmed	Confirmed
Flora	*Caladenia tessellata*	Thick Lip Spider Orchid	E1	V	Generally found in grassy sclerophyll woodland on clay loam or sandy soils	Some potential habitat present		Low	Low
Flora	*Callistemon linearifolius*	Netted Bottle Brush	V		Grows in dry sclerophyll forest on the coast and adjacent ranges	Suitable habitat present		High	High

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
Flora	*Corunastylis insignis (was Genoplesium insignis)*	Variable Midge Orchid	E4A	CE	Grows in patches of Themeda australis (Kangaroo Grass) amongst shrubs and sedges in heathland and forest.	Suitable habitat present	1	High	High
Flora	*Corunastylis sp. Charmhaven (NSW896673)*		E4A	CE	Found in low woodland to heathland with shrubby understorey and ground layer. Only known from a single location in the Gorokan/Charmhaven area.	Some suitable habitat present	4	Moderate	Moderate
Flora	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	Grows in dry sclerophyll forest on the coast and adjacent ranges	Suitable habitat present	1	Confirmed	High
Flora	*Eucalyptus camfieldii*	Camfield's Stringybark	V	V	Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges.	Some suitable habitat present	1	Moderate	Moderate
Flora	*Eucalyptus parramattensis*	Eucalyptus parramattensis C.	E2		Found in dry sclerophyll woodland on sandy soils in low,	Some suitable habitat present	100	Moderate	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
	subsp. parramattensis	Hall. subsp. parramattensis in Wyong and Lake Macquarie local government areas			often wet sites				
Flora	*Grevillea parviflora subsp. parviflora*	Small-flower Grevillea	V	V	Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest.	Suitable habitat present	127	Confirmed	Moderate
Flora	*Maundia triglochinoides*		V		Grows in swamps or shallow freshwater on heavy clay.	Some suitable habitat present	2	Moderate	Unlikely
Flora	*Melaleuca biconvexa*	Biconvex Paperbark	V	V	Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects	Suitable habitat present	128	Confirmed	Moderate
Flora	*Rhizanthella slateri*	Eastern Australian Underground Orchid	V	E	The species grows in eucalypt forest but no informative assessment of the likely	Potential habitat present		Moderate	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					preferred habitat for the species is available				
Flora	*Rutidosis heterogama*	Heath Wrinklewort	V	V	Mostly inhabits heath, and is often found along disturbed roadsides on moist sites with granitic substrates in podsolic and lithosolic soils. Found in open forest and in sedgeland/heathland within shrubby open forest and woodland.	Some suitable habitat present	74	Moderate	Low
Flora	*Syzygium paniculatum*	Magenta Lilly Pilly	E1	V	Occurs on gravels, sands, silts and clays in riverside gallery rainforest and remnants of littoral rainforest	Suitable habitat present	2	High	Unlikely
Flora	*Tetratheca glandulosa*	Glandular Pink-bell	V		Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Occupies ridgetops, upper-	No suitable habitat present		Unlikely	Unlikely

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					slopes and to a lesser extent mid-slope sandstone benches.				
Flora	*Tetratheca juncea*	Black-eyed Susan	V	V	Found in sandy, occasionally moist heath and in dry sclerophyll vegetation communities. preferred substrates are: sandy skeletal soil on sandstone, sandy-loam soils, low nutrients; and clayey soil from conglomerates	Suitable habitat present	176	Confirmed	High
Flora	*Thelymitra sp. adorata*	Wyong Sun Orchid	E4A	CE	The species occurs in woodland with grassy understorey in well-drained clay loam or shale derived soils	Suitable habitat present	7	High	Low
Amphibia	*Crinia tinnula*	Wallum Froglet	V		Only found in acid paperbark swamps in the 'wallum' country of coastal South East Queensland and Northern NSW	Suitable habitat present	44	Confirmed	High
Amphibia	*Heleioporus*	Giant Burrowing	V	V	Inhabits heath, woodland and	Suitable habitat present		High	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
	australiacus	Frog			open forest with sandy soils. Generally lives in the heath or forest and will travel several hundred metres to creeks to breed. Burrows into deep litter or loose soil, emerging to feed or breed after rain.				
Amphibia	*Litoria aurea*	Green and Golden Bell Frog	E1	V	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (Typha spp.) or spikerushes (Eleocharis spp.).	Suitable habitat present	5	Confirmed	Low
Amphibia	*Litoria brevipalmata*	Green-thighed Frog	V		Found in rainforests, wet sclerophyll forests and swamp forests	Suitable habitat present	5	Confirmed	Low
Amphibia	*Litoria littlejohni*	Littlejohn's Tree Frog	V	V	Inhabit forest, coastal woodland and heath from 100 to 950 m above sea level (White & Ehmann 1997), but the species	Suitable habitat present		High	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					is not associated with any specific vegetation types				
Amphibia	*Mixophyes balbus*	Stuttering Frog	E1	V	Inhabits rainforest and wet, tall open forest. Requires freshwater streams and undisturbed riparian vegetation for habitation and breeding.	Some suitable habitat present	20	Moderate	Unlikely
Amphibia	*Mixophyes iteratus*	Giant Barred Frog	E1	E	Inhabit deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m.	Suitable habitat present	14	Confirmed	Moderate
Amphibia	*Pseudophryne australis*	Red-crowned Toadlet	V		Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings	No suitable habitat present		Unlikely	Unlikely
Aves	*Anthochaera phrygia*	Regent Honeyeater	E4A	M,CE	Patchy distribution in NSW and confined to two main breeding areas and fragmented woodland. Strongly nomadic in response to	Some suitable habitat present		Moderate	Low

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					blossoming trees. Inhabit temperate woodland and dry open forest; generalist foragers that occur in Box-Ironbark woodland and riparian forests of River Sheoak that contain a large number of mature trees, high canopy cover and mistletoes.				
Aves	*Botaurus poiciloptilus*	Australasian Bittern	E1	E	Occurs mainly in densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands	Some suitable habitat present	2	Moderate	Unlikely
Aves	*Burhinus grallarius*	Bush Stone-curlew	E1		Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Nest on the ground in a scrape or small bare patch	Suitable habitat present	4	High	Moderate
Aves	*Calidris ferruginea*	Curlew Sandpiper	E1	M,CE,C,J,K	Generally occupies littoral and estuarine habitats, and in New	No suitable habitat present		Unlikely	Unlikely

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					South Wales is mainly found in intertidal mudflats of sheltered coasts				
Aves	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V		Generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas	Some suitable habitat present	7	Moderate	Moderate
Aves	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V		Inhabit open forest and woodlands in which stands of she-oak species, particularly Black She-oak, Forest She-oak or Drooping She-oak occur. Dependent on large hollow-bearing eucalypts for nest sites.	Suitable habitat present	33	Confirmed	High
Aves	*Chthonicola*	Speckled Warbler	V		Typical habitat would include	Some marginal habitat		Low	Low

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
	sagittata				large, relatively undisturbed remnants of scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	present			
Aves	*Daphoenositta chrysoptera*	Varied Sittella	V		Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Suitable habitat present	20	Confirmed	Moderate
Aves	*Dasyornis brachypterus*	Eastern Bristlebird	E1	E	Inhabits low dense vegetation in a broad range of habitat types including sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest	Some potential habitat present		Unlikely	Unlikely
Aves	*Ephippiorhynchus asiaticus*	Black-necked Stork	E1		Inhabit permanent freshwater wetlands including margins of	Some suitable habitat present	13	Confirmed	Unlikely

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries.				
Aves	*Epthianura albifrons*	White-fronted Chat			Found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas	Some marginal habitat present		Confirmed	Unlikely
Aves	*Glossopsitta pusilla*	Little Lorikeet	V		Inhabit dry growth and logged sclerophyll forests in the eastern part of their range, and in remnant woodland patches on the western slopes. Show high nest site fidelity; use small hollows in smooth barked eucalypts and riparian trees.	Suitable habitat present	15	Confirmed	High

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
Aves	*Grantiella picta*	Painted Honeyeater	V	V	Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. Specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	Some marginal habitat present		Low	Low
Aves	*Haematopus longirostris*	Pied Oystercatcher	E1		Favours intertidal flats of inlets and bays, open beaches and sandbanks	No suitable habitat present		Unlikely	Unlikely
Aves	*Hieraaetus morphnoides*	Little Eagle	V		Often seen over woodland and forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest.	Suitable habitat present	4	Confirmed	Moderate
Aves	*Irediparra gallinacea*	Comb-crested Jacana	V		Inhabits freshwater wetlands with abundant floating vegetation, such as water-lilies or water hyacinth, forming a mat on the	No suitable habitat present	2	Unlikely	Unlikely

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					water surface.				
Aves	*Ixobrychus flavicollis*	Black Bittern	V		Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation	Suitable habitat present	3	Confirmed	Unlikely
Aves	*Limosa limosa*	Black-tailed Godwit	V	M,C,J,K	Usually found in sheltered bays, estuaries and lagoons but can also occur further inland on mudflats and in water less than 10 cm deep, around muddy lakes and swamps	Some marginal habitat present		Confirmed	Low
Aves	*Ninox connivens*	Barking Owl	V		Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting	Suitable habitat present	2	High	Moderate
Aves	*Ninox strenua*	Powerful Owl	V		Inhabits a range of vegetation types, from woodland and open	Suitable habitat present	23	Confirmed	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					sclerophyll forest to tall open wet forest and rainforest.				
Aves	*Pandion cristatus*	Eastern Osprey	V		Mostly found in coastal areas but occasionally travel inland along major rivers. Frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes	Some marginal habitat present	1	Low	Low
Aves	*Petroica boodang*	Scarlet Robin	V		Found in dry eucalypt forests and woodlands with open, grassy understory with few scattered shrubs. Occurs in both mature and regrowth vegetation and occasionally in male or wet forest communities, or in wetlands and tea-tree swamps.	Some marginal habitat present		Low	Low

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
Aves	*Petroica phoenicea*	Flame Robin	V		Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys	Some marginal habitat present		Low	Low
Aves	*Ptilinopus regina*	Rose-crowned Fruit-Dove	V		Occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.	Some potential habitat present		Unlikely	Unlikely
Aves	*Ptilinopus superbus*	Superb Fruit-Dove	V		Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.	Some potential habitat present	1	Unlikely	Unlikely
Aves	*Tyto novaehollandiae*	Masked Owl	V		Lives in dry eucalypt forests and woodlands from sea level to	Suitable habitat present	12	Confirmed	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					1100m.				
Aves	*Tyto tenebricosa*	Sooty Owl	V		Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	Suitable habitat present	35	Confirmed	Low
Aves (Migratory)	*Apus pacificus*	Fork-tailed Swift		M,C,J,K	Non-breeding visitor to all parts of Australia. Mostly found over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh of inland plains	Some suitable habitat present	3	Moderate	Moderate
Aves (Migratory)	*Ardea alba*	Great Egret		M,C,J	Found in a wide range of wetland habitats such as swamps, marshes; salt lakes and mangroves but also frequents flooded grasslands, pastures or agricultural lands; reservoirs, sewage treatment ponds and drainage channels	Suitable habitat present		Confirmed	Low

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
Aves (Migratory)	*Ardea ibis*	Cattle Egret		M,C,J	Occurs in tropical and temperate grasslands, woodlands, terrestrial wetlands and cropland with poor drainage.	Suitable habitat present	18	Confirmed	Moderate
Aves (Migratory)	*Gallinago hardwickii*	Latham's Snipe		M,C,J,K	Inhabit permanent and ephemeral open, freshwater wetlands with low, dense vegetation and areas of mud which are either exposed or beneath a very shallow covering of water.	Some suitable habitat present	3	Confirmed	Moderate
Aves (Migratory)	*Haliaeetus leucogaster*	White-bellied Sea-Eagle		M,C	Australian distribution along the coastline; in NSW, also extends inland along some of the larger waterways. Generally forage over large expanses of open water, in-shore waters and open terrestrial habitats.	Suitable habitat present	14	Confirmed	High
Aves	*Hirundapus*	White-throated		M,C,J,K	Non-breeding visitor to Australia.	Some suitable habitat	13	Confirmed	High

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
(Migratory)	*caudacutus*	Needletail			Occur over most types of habitat, present particularly above wooded areas including open forest and rainforest, between trees or in clearings and below the canopy. Less commonly recorded flying above woodland and treeless areas, such as grassland or swamps.				
Aves (Migratory)	*Lathamus discolor*	Swift Parrot	E1	M,CE	Inhabit open eucalypt forests and woodlands, including box–ironbark communities, and farmland with remnant patches of eucalypt woodland.	Suitable habitat present	2	High	High
Aves (Migratory)	*Merops ornatus*	Rainbow Bee-eater		M,J	Inhabit heathland, open forests and woodlands, shrublands, and various cleared or semi-cleared habitats, including farmland and areas of human habitation. Often occur in open, cleared or	Suitable habitat present	1	High	High

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					lightly-timbered areas located in close proximity to permanent water.				
Aves (Migratory)	*Monarcha melanopsis*	Black-faced Monarch		M,B	Inhabit rainforests, eucalypt woodlands, coastal scrub and damp gullies, and open woodland when migrating.	Suitable habitat present		Confirmed	Moderate
Aves (Migratory)	*Myiagra cyanoleuca*	Satin Flycatcher		M,B	Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests	Some suitable habitat present		Moderate	Moderate
Aves (Migratory)	*Plegadis falcinellus*	Glossy Ibis		C	Generally found near shallow waters of swamps, lakes floodplains and ricefields, mostly in well-vegetated wetlands	Some marginal habitat present	1	Confirmed	Moderate
Aves	*Rhipidura rufifrons*	Rufous Fantail		M,B	Found in rainforest, dense wet	Suitable habitat present		Confirmed	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
(Migratory)					eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation				
Aves (Migratory)	*Rostratula australis*	Australian Painted Snipe	E1	E	Inhabits fringes of shallow inland wetlands, swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Some suitable habitat present		Moderate	Low
Mammalia	*Cercartetus nanus*	Eastern Pygmy-possum	V		Broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred.	Suitable habitat present	2	Confirmed	Moderate
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	Inhabit well-timbered areas containing gullies. High site fidelity and roost in caves, crevices in cliffs and old mine workings frequenting low to mid-	Suitable habitat present	3	High	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					elevation dry open forest and woodland close to these features.				
Mammalia	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E	Inhabits a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Use hollow-bearing trees, logs, caves, crevices and rocky cliff-faces as den sites.	Suitable habitat present	5	Confirmed	Moderate
Mammalia	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows.	Suitable habitat present	21	Confirmed	High
Mammalia	*Isoodon obesulus obesulus*	Southern Brown Bandicoot (eastern)	E1	E	Generally only found in heath or open forest with a heathy understorey on sandy or friable soils	No suitable habitat present		Unlikely	Unlikely
Mammalia	*Kerivoula*	Golden-tipped Bat	V		Typically inhabit rainforest and	Suitable habitat present	12	Confirmed	High

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
	papuensis				adjacent wet and dry sclerophyll forest up to 1000m; also recorded in tall open forest, Casuarina-dominated riparian forest and coastal Melaleuca forests. Roost mainly in rainforest gullies on small first- and second-order streams in abandoned hanging nests, tree hollows, dense foliage and epiphytes.				
Mammalia	*Miniopterus australis*	Little Bentwing-bat	V		Inhabit well timbered areas including rainforest, wet and dry sclerophyll forest, Melaleuca swamps and coastal forests. Roost in caves, artificial structures and tree hollows.	Suitable habitat present	34	Confirmed	High
Mammalia	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels,	Suitable habitat present	43	Confirmed	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					buildings and other man-made structures				
Mammalia	*Mormopterus norfolkensis*	Eastern Freetail-bat	V		Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures	Suitable habitat present	30	Confirmed	High
Mammalia	*Myotis macropus*	Southern Myotis	V		Fishing bat that occurs in habitats near water, including mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River red gum woodland.	Suitable habitat present	20	Confirmed	High
Mammalia	*Petaurus australis*	Yellow-bellied Glider	V		Inhabit tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils.	Suitable habitat present	81	Confirmed	Moderate

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					Highly mobile with large home ranges (20-85 ha) to encompass dispersed and seasonally variable forage resources.				
Mammalia	*Petaurus norfolcensis*	Squirrel Glider	V		Inhabit mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey.	Suitable habitat present	62	Confirmed	Moderate
Mammalia	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E1	V	Inhabit rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north.	No suitable habitat present		Unlikely	Unlikely
Mammalia	*Phascolarctos*	Koala	V	V	Inhabit eucalypt woodlands and	Suitable habitat present	10	High	Low

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
	cinereus				forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.				
Mammalia	*Potorous tridactylus*	Long-nosed Potoroo	V	V	Inhabits dry/wet sclerophyll forests or coastal heaths with dense understorey and occasional open areas	Some potential habitat present		Low	Low
Mammalia	*Pseudomys novaehollandiae*	New Holland Mouse		V	Inhabit open heathland, open woodland with a heathland understorey and vegetated sand dunes in coastal areas and up to 100 km inland on sandstone country.	No suitable habitat present		Unlikely	Unlikely
Mammalia	*Pseudomys gracilicaudatus*	Eastern Chestnut Mouse	V		Occur in heathland and more common in dense, wet heath and swamps.	Some suitable habitat present	2	Moderate	Low
Mammalia	*Pteropus*	Grey-headed	V	V	Occur in subtropical and	Suitable habitat present	33	Confirmed	High

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
	poliocephalus	Flying-fox			temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops				
Mammalia	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V		Roosts singly or in small groups in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forage in most habitats and appear to defend aerial territories.	Suitable habitat present	4	Confirmed	Moderate
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V		Inhabit cool temperate to tropical moist forests, woodland and rainforest. Prefer moist gullies within mature coastal forest or rainforest. May roost in tree hollows and buildings.	Suitable habitat present	30	Confirmed	High
Reptilia	*Hoplocephalus bungaroides*	Broad-headed Snake	E1	V	Inhabits rock crevices and under flat sandstone rocks on exposed	No suitable habitat present		Unlikely	Unlikely

Table A.1 Likelihood of Occurrence of Threatened and Migratory Species within the Addendum Study area and Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	BioNet Records (10 km radius)	Likelihood of occurrence (Study Area)	Likelihood of occurrence (Addendum Study Area)
					cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.				
Reptilia	*Hoplocephalus stephensii*	Stephens' Banded Snake	V		Partly tree-dwelling snake that inhabits rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day.	Some suitable habitat present	1	Moderate	Unlikely
Insecta	*Petalura gigantea*	Giant Dragonfly	E1		Live in permanent swamps and bogs with some free water and open vegetation.	No suitable habitat present		Unlikely	Unlikely

Appendix B

Recorded Flora Species

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Acacia brownii	Native		+			
Acacia decurrens	Native			+		+
Acacia falcata	Native		+			
Acacia floribunda	Native					+
Acacia implexa	Native		+	+		
Acacia irrorata subsp. irrorata	Native		+			+
Acacia linifolia	Native					+
Acacia longifolia subsp. longifolia	Native		+		+	+
Acacia myrtifolia	Native	+				
Acacia podalyriifolia	Native					+
Acacia schinoides	Native		+			
Acacia sp.	Native				+	
Acacia suaveolens	Native		+	+	+	+
Acacia terminalis subsp. longiaxialis	Native		+			
Acacia ulicifolia	Native		+			+
Acrotriche divaricata	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Actinotus helianthi	Native		+			
Actinotus minor	Native		+	+	+	+
Adiantum aethiopicum	Native		+	+	+	+
Adiantum formosum	Native		+			
Adiantum hispidulum	Native		+	+		
Ageratina adenophora	Exotic		+		+	+
Allocasuarina littoralis	Native		+	+	+	+
Allocasuarina paludosa?	Native	+				
Allocasuarina torulosa	Native		+	+	+	
Allocasuarina verticillata	Native					+
*Anagallis arvensis**	Exotic		+	+		
*Andropogon virginicus**	Exotic		+	+	+	+
Angophora costata	Native		+	+	+	+
Angophora floribunda	Native		+		+	+
Angophora inopina	Native		+	+	+	+
Anisopogon avenaceus	Native		+			+
Aotus sp.	Native				+	
Araujia sericifera	Exotic					+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Aristida ramosa	Native				+	+
Aristida sp.	Native				+	
Aristida vagans	Native		+		+	+
Aristida warburgii	Native		+		+	
Arthrochilus prolixus	Native		+			+
Arthropodium minus	Native		+			
Arthropodium sp.	Native				+	
Asplenium australasicum	Native		+			+
Aster subulatus	Exotic				+	
Astrotricha latifolia	Native		+			
Austrodanthonia setacea	Native		+			
Austrodanthonia sp	Native			+	+	
Austrodanthonia tenuior	Native		+	+		
Austrostipa pubescens	Native		+	+	+	+
Austrostipa ramosissima	Native		+			
Austrostipa scabra subsp. falcata	Native		+			
Austrostipa sp	Native				+	
Austrostipa verticillata	Native		+			

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
*Axonopus fissifolius**	Exotic		+	+	+	+
Azolla pinnata	Native			+		
Backhousia myrtifolia	Native		+			
Baeckea diosmifolia	Native		+			+
Baeckea sp.	Native					+
Banksia cunninghamii ssp. cunninghamii	Native	+			+	
Banksia marginata	Native					+
Banksia oblongifolia	Native		+	+	+	+
Banksia robur	Native	+				+
Banksia serrata	Native		+			
Banksia spinulosa	Native	+	+		+	
Bauera rubioides	Native	+				+
Baumea articulata	Native	+				
Baumea juncea	Native			+		
Baumea rubiginosa	Native	+				
Baumea sp.	Native				+	
*Bidens pilosa**	Exotic	+			+	+
Billardiera scandens	Native		+	+	+	+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Blandfordia grandiflora	Native		+			
Blandfordia nobilis	Native					+
Blechnum ambiguum	Native	+				
Blechnum aspera	Native			+		
Boronia polygalifolia	Native		+		+	+
Bossiaea ensata	Native		+			
Bossiaea heterophylla	Native		+		+	
Bossiaea obcordata	Native		+	+	+	
Bossiaea prostrata	Native		+		+	+
Bossiaea rhombifolia subsp. rhombifolia	Native		+			
Bossiaea scolopendria	Native	+				
Brachyloma daphnoides	Native				+	
Brachyscome linearifolia	Native		+			
Breynia oblongifolia	Native		+	+	+	+
Briza maxima	Exotic					+
*Briza minor**	Exotic			+		
Briza sp	Exotic				+	
Briza subaristata	Exotic			+		+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Brunoniella australis	Native		+		+	
Brunoniella pumilio	Native		+		+	
Brunoniella sp.	Native				+	
Burchardia umbellata	Native		+	+	+	
Bursaria longisepala	Native		+			
Bursaria spinosa	Native		+		+	
Caesia parviflora var. parviflora	Native		+			+
Caesia parviflora var. vittata	Native		+			
Caladenia catenata	Native		+			
Callistemon citrinus	Native		+			
Callistemon linearis	Native		+	+	+	+
Callistemon salignus	Native		+	+		
Callistemon shiressii	Native		+	+		
Calochilus paludosus	Native		+			
Calochilus robertsonii	Native		+			
Calochlaena dubia	Native		+		+	
Carex appressa	Native			+		
Carex inversa	Native					+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Carex longebrachiata	Native			+		
Cassinia uncata	Native		+			
Cassytha glabella f. glabella	Native		+		+	+
Casuarina glauca	Native					+
Caustis flexuosa	Native	+				
*Centaurium tenuiflorum**	Exotic			+		+
Centella asiatica	Native		+	+	+	+
Centella cordifolia	Native		+			
Centella hydro	Native				+	
Cerastium glomeratum	Exotic				+	
Ceratopetalum apetalum	Native		+			
Ceratopetalum gummiferum	Native		+		+	
Cheilanthes sieberi	Native		+	+		+
Chloris gayana	Exotic					+
Choricarpia leptopetala	Native		+	+		
Chorizandra cymbaria	Native		+			
Chorizema sp.	Native					+
*Chrysanthemoides monilifera**	Exotic		+			+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
*Cinnamomum camphora**	Exotic			+		+
*Cirsium vulgare**	Exotic			+		
Cissus antarctica	Native		+	+		
Cissus hypoglauca	Native		+	+		
Citriobatus pauciflorus	Native	+		+		
Claoxylon australe	Native		+			
Clematis aristata	Native	+				+
Clematis glycinoides	Native				+	+
Clerodendrum tomentosum	Native		+			
Comesperma ericinum	Native		+	+	+	+
Comesperma sphaerocarpum	Native		+			
Commelina cyanea	Native			+		
Commersonia fraseri	Native		+			
Conospermum ericifolium	Native					+
Conyza bonariensis	Exotic			+	+	
*Conyza sp.**	Exotic	+				
Conyza sumatrensis	Exotic					+
*Cortaderia selloana**	Exotic					+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Corymbia gummifera	Native		+	+	+	+
Corymbia maculata	Native		+	+	+	+
*Cotula coronopifolia**	Exotic		+			
Cryptandra ericoides	Native	+				
Cryptostylis erecta	Native		+			
Cryptostylis hunteriana	Native		+			
Cryptostylis sp.	Native				+	
Cryptostylis subulata	Native		+		+	+
Cyathea australis	Native				+	
Cyathochaeta diandra	Native		+	+	+	+
Cymbidium sp.	Native					+
Cymbidium suave	Native		+		+	
Cymbopogon refractus	Native		+	+		+
*Cynodon dactylon**	Exotic		+	+	+	+
*Cyperus brevifolius**	Exotic			+	+	
Cyperus caespiticius	Native			+		
Cyperus eragrostis	Exotic			+		+
Cyperus gracilis	Native					+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Cyperus polystachyos	Native	+		+	+	
Dampiera stricta	Native		+	+	+	+
Daviesia genistifolia	Native	+				+
Daviesia leptophylla	Native					+
Daviesia squarrosa	Native		+	+	+	
Daviesia ulicifolia subsp. ulicifolia	Native		+	+	+	
Daviesia umbellulata	Native		+			
Dendrophthoe vitellina	Native		+	+		
Desmodium rhytidophyllum	Native		+	+	+	
Deyeuxia parviseta var. parviseta	Native		+			
Deyeuxia quadriseta	Native		+			
Dianella caerulea var. assera	Native		+			
Dianella caerulea var. caerulea	Native		+		+	+
Dianella caerulea var. producta	Native	+			+	+
Dianella longifolia	Native				+	
Dianella revoluta var. revoluta	Native		+	+	+	+
Dichelachne micrantha	Native		+	+	+	+
Dichelachne rara	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Dichondra repens	Native		+		+	
Dichopogon fimbriatus	Native	+				
Digitaria diffusa	Native		+		+	
Digitaria parviflora	Native	+			+	
Digitaria ramularis	Native		+			
Digitaria sp.	Native				+	
Dillwynia glaberrima	Native	+				
Dillwynia parviflora	Native			+		
Dillwynia retorta	Native		+	+	+	
Dillwynia sp	Native				+	
Dioscorea transversa	Native		+	+		
Diospyros australis	Native		+	+		
Diploglottis cunninghamii	Native		+			
Dipodium punctatum	Native		+			+
Diuris alba	Native		+			
Diuris aurea	Native		+			
Dodonaea triquetra	Native		+		+	+
Doodia aspera	Native		+			

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Drosera auriculata	Native		+			
Drosera peltata	Native	+			+	
Drosera pygmaea	Native			+		
Drosera spatulata	Native				+	+
Echinopogon caespitosus var. caespitosus	Native		+	+	+	+
Echinopogon ovatus	Native		+		+	
Elaeocarpus reticulatus	Native	+		+	+	
Eleocharis sphacelata	Native			+		
Embelia australiana	Native		+			
Empodisma minus	Native		+		+	+
Entolasia marginata	Native					+
Entolasia stricta	Native		+	+	+	+
Epacris microphylla	Native		+	+	+	+
Epacris obtusifolia	Native	+				+
Epacris pulchella	Native		+	+	+	+
Epaltes australis	Native		+			
Epaltes sp	Native			+	+	
Eragrostis brownii	Native		+		+	+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Eragrostis curvula	Exotic					+
Eragrostis leptostachya	Native		+			
Eragrostis sp.	Native			+	+	
Eucalyptus acmenoides	Native		+	+		+
Eucalyptus amplifolia subsp. amplifolia	Native		+			
Eucalyptus capitellata	Native		+	+	+	+
Eucalyptus deanei	Native		+	+		
Eucalyptus fergusonii subsp. dorsiventralis	Native		+			
Eucalyptus fibrosa	Native		+		+	
Eucalyptus globoidea	Native		+		+	
Eucalyptus haemastoma	Native		+	+	+	+
Eucalyptus paniculata	Native			+		
Eucalyptus pilularis	Native		+		+	+
Eucalyptus placita	Native		+			
Eucalyptus punctata	Native		+			
Eucalyptus racemosa	Native		+			
Eucalyptus resinifera subsp. resinifera	Native		+	+	+	
Eucalyptus robusta	Native		+	+	+	

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Eucalyptus saligna	Native		+	+		
Eucalyptus siderophloia	Native		+			
Eucalyptus signata	Native				+	
Eucalyptus tereticornis	Native			+		
Eucalyptus umbra	Native		+		+	
Euchiton sp.	Native			+		
Eustrephus latifolius	Native		+		+	
Exocarpus cupressiformis	Native				+	+
Fimbristylis dichotoma	Native				+	+
Gahnia aspera	Native			+		
Gahnia clarkei	Native		+	+	+	+
Gahnia radula	Native		+			
Gahnia sieberiana	Native	+			+	
Gahnia sp.	Native				+	
Gamochaeta americana	Exotic					+
Gamochaeta purpurea (formerly Gnaphalium americanum)	Exotic			+		
Geitonoplesium cymosum	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Genoplesium archeri	Native					+
Genoplesium fimbriatum	Native		+			
Gleichenia dicarpa	Native		+	+	+	+
Glochidion ferdinandi	Native		+	+	+	+
Glycine clandestina	Native		+		+	+
Glycine microphylla	Native		+	+	+	+
Glycine tabacina	Native		+		+	+
Gnaphalium sp.	Native			+	+	
Gompholobium glabratum	Native		+			
Gompholobium grandiflorum	Native	+			+	
Gompholobium huegelii	Native					+
Gompholobium latifolium	Native		+			
Gompholobium pinnatum	Native		+	+	+	+
Gonocarpus micranthus	Native		+	+	+	+
Gonocarpus tetragynus	Native		+	+	+	+
Gonocarpus teucrioides	Native	+				
Goodenia bellidifolia subsp. bellidifolia	Native		+	+	+	
Goodenia hederacea subsp. hederacea	Native		+		+	+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Goodenia heterophylla subsp. heterophylla	Native		+	+	+	
Goodenia paniculata	Native	+				+
Grevillea parviflora subsp. parviflora	Native		+			
Grevillea sericea subsp. sericea	Native		+		+	+
Grevillea speciosa	Native	+		+		
Guioa semiglauca	Native			+		
Gymnostachys anceps	Native		+	+		
Haemodorum planifolium	Native	+				+
Haemodorum sp.	Native					+
Hakea bakeriana	Native		+			
Hakea dactyloides	Native	+			+	+
Hakea laevipes subsp. laevipes	Native		+	+	+	
Hakea sericea	Native		+		+	+
Hakea teretifolia	Native	+		+	+	+
Hardenbergia violacea	Native		+		+	+
Hemarthria uncinata var. uncinata	Native		+	+	+	
Hibbertia aspera subsp. aspera	Native		+		+	
Hibbertia dentata	Native		+		+	

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Hibbertia empetrifolia subsp. empetrifolia	Native		+			+
Hibbertia obtusifolia	Native			+		
Hibbertia pedunculata	Native		+			
Hibbertia riparia	Native			+		+
Hibbertia rufa	Native	+				
Hibbertia scandens	Native		+		+	
Hibbertia sp.	Native				+	+
Hibbertia vestita	Native		+			
Hibiscus heterophyllus subsp. heterophyllus	Native		+			
Hovea linearis	Native		+			
Hovea purpurea	Native	+				
Hybanthus monopetalus	Native		+		+	+
Hydrocotyle laxiflora	Native		+			
Hydrocotyle peduncularis	Native				+	
Hydrocotyle sibthorpioides	Native		+			
Hydrocotyle tripartita	Native		+			
Hypericum gramineum	Native		+	+	+	
Hypericum japonicum	Native			+	+	

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
*Hypochaeris radicata**	Exotic		+	+	+	+
Imperata cylindrica	Native		+	+	+	+
Ischaemum australe	Native					+
Isopogon anemonifolius	Native		+		+	+
Isopogon anethifolius	Native				+	
Joycea pallida	Native		+			
Juncus bufonius	Native				+	
*Juncus cognatus**	Exotic		+	+	+	
Juncus continuus	Native		+	+		
Juncus kraussii	Native			+		
Juncus planifolius	Native	+		+		
Juncus prismocarpus	Native	+				
Juncus sp	Native			+	+	
Juncus subsecundus	Native		+			
Kunzea ambigua	Native		+	+	+	+
Kunzea capitata	Native		+			
Lachnagrostis filiformis	Native		+			+
Lachnagrostis sp.	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Lagenophora stipitata	Native		+		+	
Lambertia formosa	Native		+	+	+	+
*Lantana camara**	Exotic		+			+
Laxmannia gracilis	Native		+		+	
Lepidosperma concavum	Native		+		+	+
Lepidosperma elatius	Native		+			
Lepidosperma filiforme	Native				+	
Lepidosperma gunnii	Native		+			
Lepidosperma laterale	Native		+		+	+
Lepidosperma quadrangulatum	Native	+				
Lepidosperma sp.	Native				+	+
Lepidosperma urophorum	Native			+		
Leptocarpus tenax	Native	+				+
Leptospermum continentale	Native	+			+	+
Leptospermum juniperinum	Native		+	+	+	+
Leptospermum laevigatum	Native	+				
Leptospermum petersonii	Native		+			
Leptospermum polygalifolium	Native		+	+	+	+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Leptospermum sp	Native				+	
Leptospermum trinervium	Native		+	+	+	+
Lepyrodia muelleri	Native		+		+	
Lepyrodia scariosa	Native		+	+	+	+
Lepyrodia sp.	Native					+
Leucopogon attenuatus	Native		+			
Leucopogon esquamatus	Native		+	+		+
Leucopogon juniperinus	Native			+		
Leucopogon lanceolatus var. lanceolatus	Native		+	+		
Leucopogon microphyllus	Native	+			+	+
Leucopogon muticus	Native				+	
Leucopogon virgatus	Native					+
Ligustrum lucidum	Exotic					+
Ligustrum sinense	Exotic					+
Lindsaea linearis	Native		+	+	+	+
Lindsaea microphylla	Native		+	+	+	
Lissanthe strigosa subsp. strigosa	Native		+		+	
Lissanthe strigosa subsp. subulata	Native		+			

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Livistona australis	Native		+			
Lobelia anceps	Native		+	+		
Lobelia gibbosa	Native		+			
Lobelia sp.	Native			+		
Logania albiflora	Native		+			
Logania pusilla	Native		+			
Lolium rigidum	Exotic					+
Lomandra confertifolia subsp. pallida	Native		+			
Lomandra confertifolia subsp. rubiginosa	Native	+				
Lomandra cylindrica	Native		+			
Lomandra filiformis subsp. coriacea	Native		+			
Lomandra filiformis subsp. filiformis	Native		+	+	+	
Lomandra glauca	Native		+	+		+
Lomandra longifolia	Native		+	+	+	+
Lomandra multiflora subsp. multiflora	Native		+	+	+	+
Lomandra obliqua	Native		+		+	+
Lomatia silaifolia	Native		+			
*Lotus corniculatus**	Exotic			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Ludwigia peploides	Native			+		
Macrozamia flexuosa	Native		+			
Macrozamia reducta	Native		+			
Macrozamia spiralis	Native	+				
Marsdenia flavescens	Native		+			
Maytenus silvestris	Native		+	+	+	
Melaleuca decora	Native		+		+	
Melaleuca erubescens	Native		+			
Melaleuca linariifolia	Native		+	+	+	+
Melaleuca nodosa	Native		+	+	+	+
Melaleuca quinquenervia	Native			+		+
Melaleuca sieberi	Native		+	+	+	+
Melaleuca sp.	Native					+
Melaleuca styphelioides	Native		+	+		
Melaleuca thymifolia	Native		+		+	+
Melichrus procumbens	Native		+			
Melichrus urceolatus	Native				+	
Melicope micrococca	Native		+	+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Microlaena stipoides	Native		+	+	+	+
Micromyrtus ciliata	Native				+	
Mirbelia rubiifolia	Native		+	+	+	+
Mitrasacme polymorpha	Native		+	+	+	
Monotoca scoparia	Native		+	+		
Morinda jasminoides	Native		+	+	+	
Myrsine variabilis	Native			+		
Notelaea longifolia f. longifolia	Native		+		+	
Rytidosperma longifolium	Native		+			
Ochna serrulata	Exotic					+
Olearia tomentosa	Native			+		
Opercularia diphylla	Native		+		+	+
Opercularia sp	Native				+	
Opercularia varia	Native		+		+	
Oplismenus aemulus	Native			+		
Oplismenus imbecillis	Native		+		+	
Orthoceras strictum	Native		+			
Ottelia ovalifolia ssp ovalifolia	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Oxalis exilis	Native				+	
Oxalis perennans	Native		+		+	+
Ozothamnus diosmifolius	Native	+			+	+
Pandorea pandorana	Native		+	+		+
Panicum bicolor	Native	+				
Panicum effusum	Native					+
Panicum simile	Native		+	+	+	+
Parsonsia straminea	Native		+	+	+	+
Paspalidium aversum	Native		+			
Paspalidium distans	Native		+	+	+	+
Paspalum dilatatum	Exotic			+	+	+
Paspalum orbiculare	Native	+				
Paspalum quadrifarium	Exotic					+
Paspalum radiatum	Native	+				
*Paspalum urvillei**	Exotic		+			+
*Passiflora edulis**	Exotic		+			
Patersonia glabrata	Native		+		+	
Patersonia longifolia	Native	+				+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Patersonia sericea	Native		+	+	+	+
Patersonia sp.	Native					+
Pellaea falcata	Native		+			+
Pellaea paradoxa	Native			+		
Pennisetum clandestinum	Exotic				+	
Persicaria hydropiper	Native			+		
Persicaria lapathifolia	Native			+		
Persicaria praetermissa	Native			+		
Persoonia levis	Native		+		+	+
Persoonia linearis	Native		+	+	+	+
Petrophile pulchella	Native		+	+	+	+
Petrophile sessilis	Native				+	
Petrophile sp.	Native	+				
Phragmites australis	Native	+				
Philydrum lanuginosum	Native	+		+		
Phyllanthus hirtellus	Native		+			
Pimelea linifolia subsp. linifolia	Native		+	+	+	+
Pinus radiata	Exotic					+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Pittosporum multiflorum	Native		+			
Pittosporum revolutum	Native			+		+
Pittosporum sp	Native			+		
Pittosporum undulatum	Native		+			+
*Plantago lanceolata**	Exotic			+	+	+
Platysace ericoides	Native		+			
Platysace lanceolata	Native	+				
Platysace linearifolia	Native		+			
Plectranthus parviflorus	Native		+			
Plinthanthesis paradoxa	Native		+			
Poa affinis	Native		+		+	
*Poa annua**	Exotic			+		
Poa labillardierei var. labillardierei	Native		+	+		
Poa sieberiana	Native				+	
Poa sp	Native					+
Podolobium ilicifolium	Native		+			
Podolobium scandens	Native		+			
Podolobium sp	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Polygala sp	Exotic			+		
Polymeria calycina	Native		+		+	
*Polypogon monspeliensis**	Exotic	+				
Polyscias sambucifolia	Native	+		+	+	+
Polystichum australiense	Native		+			+
Pomaderris sp	Native				+	
Pomax umbellata	Native		+			
Poranthera ericifolia	Native		+			+
Prasophyllum elatum	Native		+			+
Pratia purpurascens	Native		+		+	
Pseuderanthemum variabile	Native			+	+	
Psilotum nudum	Native					+
Pteridium esculentum	Native		+	+	+	+
Pterostylis sp	Native				+	
Ptilothrix deusta	Native		+	+	+	+
Ptilothrix sp.	Native			+		
Pultenaea daphnoides	Native	+				
Pultenaea elliptica	Native	+			+	

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Pultenaea ferruginea	Native		+			
Pultenaea paleacea	Native		+			+
Pultenaea polifolia	Native	+			+	+
Pultenaea retusa	Native		+			
Pultenaea sp.	Native				+	
Pultenaea stipularis	Native	+				
Pultenaea tuberculata	Native		+			
Ranunculus inundatus	Native		+	+	+	
Ranunculus plebeius	Native		+			
Restio fastigiatus	Native	+				
Rhodamnia rubescens	Native		+	+		
Romulea rosea	Exotic			+		
Rubus moluccanus var. trilobus	Native		+			
Rubus sp.	Exotic			+		
Rytidosperma sp.	Native					+
Sacciolepis indica	Native	+				
Sarcopetalum harveyanum	Native			+		
Scaevola ramosissima	Native		+		+	+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Schizaea bifida	Native		+			
Schizaea sp	Native				+	
Schoenoplectus mucronatus	Native	+				
Schoenus apogon	Native		+	+		+
Schoenus brevifolius	Native		+			+
Schoenus melanostachys	Native	+				
Schoenus paludosus	Native	+				
Selaginella uliginosa	Native		+		+	+
*Senecio madagascariensis**	Exotic			+	+	+
Senecio prenanthoides	Native		+			
Senna pendula	Exotic					+
Setaria parviflora	Exotic				+	
*Sida rhombifolia**	Exotic			+		
Sisymbrium sp	Exotic			+		
Sisyrinchium micranthum	Exotic			+		
Smilax australis	Native		+	+	+	
Smilax glyciphylla	Native		+		+	+
*Solanum mauritianum**	Exotic	+				

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Soliva sessilis	Exotic				+	
*Sonchus oleraceus**	Exotic	+				
Sowerbaea juncea	Native		+			
Sphaerolobium minus	Native		+		+	
Spirodela sp.	Native			+		
Sporobolus africanus	Exotic				+	
Sporobolus indicus	Native			+		
Sprengelia incarnata	Native	+				
Stackhousia nuda	Native		+	+		
Stackhousia viminea	Native				+	+
Stenocarpus salignus	Native		+			
Stenotaphrum secundatum	Exotic			+		
Stephania japonica var. discolor	Native		+			
Sticherus flabellatus	Native	+				
Stylidium graminifolium	Native		+	+		
Stylidium sp.	Native					+
Syncarpia glomulifera	Native		+	+	+	
Synoum glandulosum subsp. glandulosum	Native		+			

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
*Taraxacum officinale**	Exotic		+			
Tetratheca juncea	Native		+			
Thelionema caespitosum	Native		+			
Thelymitra ixioides var. ixioides	Native		+			
Thelymitra pauciflora	Native		+			
Thelymitra sp.	Native					+
Themeda triandra	Native		+	+	+	+
Thysanotus juncifolius	Native					+
Thysanotus tuberosus subsp. tuberosus	Native		+	+		+
Trachymene incisa subsp. incisa	Native		+			
Tricoryne elatior	Native		+			
Tricoryne simplex	Native		+			
Trifolium repens	Exotic			+	+	
Trifolium sp.	Exotic				+	
Triglochin procera	Native			+		
Triglochin rheophilum	Native			+		
Trochocarpa laurina	Native		+			
Trophis scandens	Native			+		

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Typha orientalis	Native	+				+
Verbena bonariensis	Exotic					+
Vernonia cinerea var. cinerea	Native		+		+	
Villarsia exaltata	Native		+			
Viola betonicifolia subsp. betonicifolia	Native		+			
Viola hederacea	Native		+		+	
*Vulpia muralis**	Exotic			+		
Wahlenbergia communis	Native		+			
Wahlenbergia gracilis	Native				+	+
Wahlenbergia sp.	Native				+	
Wilkiea huegeliana	Native		+			
Xanthorrhoea fulva	Native		+			
Xanthorrhoea latifolia subsp. latifolia	Native		+	+	+	
Xanthorrhoea macronema	Native		+			
Xanthorrhoea media ssp. media	Native	+		+	+	+
Xanthorrhoea resinosa	Native		+		+	
Xanthorrhoea sp	Native			+	+	+
Xanthosia tridentata	Native		+		+	+

Table B.1 Flora Species Recorded within the Addendum Study Area and wider Study Area

Species name	Status	ERM surveys	OzArk Surveys (2005 - 2012)	Cumberland Ecology surveys 2012	Cumberland Ecology surveys 2013	Cumberland Ecology surveys 2015 - 2016 (Addendum Study Area)
Xylomelum pyriforme	Native		+			
Xyris gracilis	Native		+			
Xyris operculata	Native	+				+
Xyris sp.	Native			+		
Zieria pilosa	Native				+	
Zieria smithii	Native	+		+		

Appendix C

Assessment of Significance

C.1 Corunastylis sp Charmhaven

Corunastylis sp. Charmhaven is a species of terrestrial orchid discovered in 2012 at a single location in the Gorokan/Charmhaven area within the Wyong Local Government Area (LGA).

The species is described as having a 1.4 cm long inflorescence bearing 6-9 flowers in a well-spaced spike. The flowers are described as being about 8.5 mm between the tip of dorsal sepal and tips of lateral sepals, 6 mm between tips of lateral petals, green and cream with deep maroon markings (NSW Scientific Committee 2013).

It occurs in low woodland to heathland with a shrubby understory dominated by species such as Black She-oak (*Allocasuarina littoralis*), Prickly Tea-tree (*Leptospermum juniperinum*), Prickly-leaved Paperbark (*Melaleuca nodosa*), Narrow-leaved Bottlebrush (*Callistemon linearis*) and Zigzag Bog-rush (*Schoenus brevifolius*) (OEH 2014).

Although targeted surveys did not detect this species within the Tooheys Road Site, it is considered as having potential to occur within the Addendum Study Area and the wider Tooheys Road Site due to the presence of suitable habitat, in particular the Scribbly Gum woodland community.

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Project will remove approximately 31 ha of potential habitat for these species in the form of Scribbly Gum Woodland and Smooth-barked Apple Forest. An offset package has been developed which will protect approximately 113.5 ha of these vegetation communities. In addition, large areas of similar habitat will remain in the Study Area and the locality. Accordingly, the removal of this small area is not considered likely to place a viable local population of these species at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable to threatened species.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable to threatened species.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality, and

The species is known from only three locations that occur outside the Project Boundary. However approximately 31 ha of native vegetation that may provide suitable habitat for this species will be removed.

Potential habitat to be removed for this species occurs in the Tooheys Road site which is already disturbed and fragmented from current land uses. Vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project.

This species has a highly limited distribution and is known from only three locations. Despite the presence of suitable habitat and occurrence of other closely related Corunastylis species, Corunastylis sp. Charmhaven is not known to occur within the Project Boundary. Therefore the habitat to be removed is not considered to be important for the long term survival of these species. Significant areas of native vegetation will be protected in the offset lands and large occurrences will remain outside the Study Area in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for these species has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan or threat abatement plan has been prepared for these species. Priority Actions have been identified for these species, which have the overall aim of preventing these species from declining further and promoting their recovery. The Project will result in the protection for conservation of approximately 200 ha of native vegetation that will provide high quality habitat for these species and is therefore considered to be consistent with this aim.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The action constitutes the KTP “Clearing of native vegetation” that is relevant to these flora species as this reduces the area of habitat available.

Conclusion

Based on a very conservative estimate, the Project is expected to remove approximately 31 ha of habitat for these species. However, large areas of habitat will remain in surrounding areas and a total of approximately 113.5 ha of potential habitat for this species will be conserved within the offset areas. It is expected that these species will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

Appendix D

Commonwealth Offset Assessment Guide Spreadsheets

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Angophora inopina
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Clearing of 31.0 ha of moderate to good quality habitat for Angophora inopina	**Area**	31	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	21.70	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0										
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Threatened species habitat																					
Area of habitat	Yes	21.70	Adjusted hectares	Part 1 - Protection and management of 123.8 ha of moderate to good quality habitat for Angophora inopina	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	123.8	**Risk of loss (%) without offset**	40%	**Risk of loss (%) with offset**	5%	43.33	95%	41.16	39.55	41.83	192.78%	Yes		
									Future area without offset (adjusted hectares)	74.3	**Future area with offset (adjusted hectares)**	117.6									
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**6**	**Future quality with offset (scale of 0-10)**	**8**	2.00	70%	1.40	1.37					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	21.7	41.83	192.78%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Angophora inopina
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Clearing of 31.0 ha of moderate to good quality habitat for Angophora inopina	**Area**	31	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	21.70	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0										
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Threatened species habitat																					
Area of habitat	Yes	21.70	Adjusted hectares	Part 2 - Revegetation of 31.29 ha of degraded grassland to moderate to good quality woodland habitat for Angophora inopina	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	31.29	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	10%	-3.13	95%	-2.97	-2.86	5.50	25.35%	No		
									Future area without offset (adjusted hectares)	31.3	**Future area with offset (adjusted hectares)**	28.2									
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**0**	**Future quality without offset (scale of 0-10)**	**0**	**Future quality with offset (scale of 0-10)**	**6**	6.00	40%	2.40	2.31					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	21.7	5.50	25.35%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Tetratheca juncea
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Clearing of 41.1 ha of moderate to good quality habitat for Tetratheca juncea	**Area**	41.1	Hectares	
			Quality	**6**	Scale 0-10	
			Total quantum of impact	24.66	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Threatened species habitat																					
Area of habitat	Yes	24.66	Adjusted hectares	Part 1 - Protection and mangement of 192.1 ha of moderate to good quality habitat for Tetratheca juncea	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	192.1	**Risk of loss (%) without offset**	40%	**Risk of loss (%) with offset**	3%	71.08	95%	67.52	64.88	61.23	248.30%	Yes		
									Future area without offset (adjusted hectares)	115.3	**Future area with offset (adjusted hectares)**	186.3									
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**6**	**Future quality without offset (scale of 0-10)**	**5**	**Future quality with offset (scale of 0-10)**	**7**	2.00	70%	1.40	1.37					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	24.66	61.23	248.30%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Tetratheca juncea
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Clearing of 41.1 ha of moderate to good quality habitat for Tetratheca juncea	**Area**	41.1	Hectares	
			Quality	**6**	Scale 0-10	
			Total quantum of impact	24.66	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Threatened species habitat																					
Area of habitat	Yes	24.66	Adjusted hectares	Part 2 - Revegetation of 31.29 ha of degraded grassland to moderate to good quality woodland habitat for Tetratheca juncea	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	31.29	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	10%	-3.13	95%	-2.97	-2.86	5.50	22.31%	No		
									Future area without offset (adjusted hectares)	31.3	**Future area with offset (adjusted hectares)**	28.2									
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**0**	**Future quality without offset (scale of 0-10)**	**0**	**Future quality with offset (scale of 0-10)**	**6**	6.00	40%	2.40	2.31					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	24.66	5.50	22.31%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Mixophyes iteratus
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Clearing of 7.7 ha of moderate to good quality habitat for the Giant Barred Frog	**Area**	7.7	Hectares	
			Quality	**4**	Scale 0-10	
			Total quantum of impact	3.08	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Threatened species habitat																					
Area of habitat	Yes	3.08	Adjusted hectares	Protection and management of 27.1 ha of moderate to good quality habitat for the Giant Barred Frog	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	27.1	**Risk of loss (%) without offset**	40%	**Risk of loss (%) with offset**	5%	9.49	95%	9.01	7.10	3.78	122.64%	Yes		
									Future area without offset (adjusted hectares)	16.3	**Future area with offset (adjusted hectares)**	25.7									
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**4**	**Future quality without offset (scale of 0-10)**	**3**	**Future quality with offset (scale of 0-10)**	**4**	1.00	65%	0.65	0.58					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	3.08	3.78	122.64%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Spotted-tailed Quoll
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Clearing of 43.4 ha of moderate to good quality habitat for the Spotted-tailed Quoll	**Area**	43.4	Hectares	
			Quality	**4**	Scale 0-10	
			Total quantum of impact	17.36	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0										
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Threatened species habitat																					
Area of habitat	Yes	17.36	Adjusted hectares	Protection and management of 196 ha of moderate to good quality habitat for the Spotted-tailed Quoll	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	196	**Risk of loss (%) without offset**	40%	**Risk of loss (%) with offset**	5%	68.60	95%	65.17	51.34	32.45	186.94%	Yes		
									Future area without offset (adjusted hectares)	117.6	**Future area with offset (adjusted hectares)**	186.2									
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**4**	**Future quality without offset (scale of 0-10)**	**4**	**Future quality with offset (scale of 0-10)**	**5**	1.00	65%	0.65	0.58					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	17.36	32.45	186.94%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Appendix E

Commonwealth Offset Assessment Guide - Data Values and Rationale

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
IMPACT	Area of habitat on impact site (ha)	31.0 ha	Total area of potential *A. inopina* habitat to be cleared.
	Quality of impact site	7/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance are important factors influencing the viability of the species. Site Condition Score Site condition score = 6/10. Habitat within the impact area consists of woodland and open forest areas, with hollowing, in moderate to good condition. The vegetation is consists largely of young regrowth vegetation with scattered mature trees. However some scattered patches consist of canopy species only while others have high edge to areas ratios, resulting in an increased susceptibility to edge effects. Some areas are highly modified from existing land uses and include regrowth vegetation on spoil heaps. Site Context Score Site Context = 8/10. Connectivity with the wider locality is variable across the Disturbance Area. The Disturbance Area is present within a stronghold area for this species. Stocking Rate Score

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
			Stocking Rate Score = 7/10. Several individuals recorded within the Disturbance Boundary. However many appear to be in poor condition. Likely to form part of a large population within the locality and wider region.
OFFSET AREAS - RETAINED	Area of habitat on offset properties (ha)	123.8 ha	Located in Tooheys Road South, Tooheys Road North and Hue Hue Road offset areas
	Quality of offset site(s)	Current = 7/10 Future (no offset) = 6/10 Future (with offset) = 8/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance of the species are important factors influencing the viability of the community. Offset areas are located adjacent to impact areas Site condition score Current = 6/10. Habitat within the proposed offset areas consist of woodland and open forest areas, with hollowing, in moderate to good condition. The vegetation is consists largely of young regrowth vegetation with scattered mature trees. However some scattered patches consist of canopy species only while others have high edge to areas ratios, resulting in an increased susceptibility to edge effects. Future (no offset) = 5/10. There is increasing development in the locality and wider LGA. Proposed offset areas are not subject to any protection/conservation scheme and impacts from surrounding land uses have the potential to increase further than current conditions.

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
			Future (with offset) = 8/10. The offsets areas are proposed to be protected in perpetuity. The cessation of grazing activities in adjacent areas is likely to contribute to the improvement of the condition of the vegetation. The presence of young regrowth indicates capability for assisted regeneration. Native grassland areas already show indications of natural regeneration to woodland following cessation of slashing activity. Revegetation work within these and adjacent areas will also assist in the natural regeneration within these patches. Site Context Current = 8/10. Connectivity with the wider locality is variable across the proposed offset areas. All offset areas are present within a stronghold area for this species. Future (no offset) = 7/10. Currently surrounded by agricultural land uses and semi-rural development. Potential for decreased connectivity with other remnants in the wider locality. Future (with offset) = 9/10. Potential for increased connectivity in conjunction with revegetation works. Stocking Rate Score Current = 7/10. Recorded within Tooheys Road North and Tooheys Road South offsets. Likely to form part of a larger population within the locality and wider region. Future (no offset) = 6/10. Currently surrounded by agricultural land uses and semi-rural development. Potential for reduction in population due to increasing impacts from surrounding land uses. Future (with offset) = 8/10. Potential to increase abundance of species.
	Time horizon	20 years	The life of the mine greater than 20 years.
	Time until ecological	10 years	Cessation of current land use activities and implementation of management plans, such as weed management, will benefit this species within a short time frame. However the proposed revegetation of

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
	benefit		degraded areas can potentially take up to 10 years before the understorey approaches the anticipated future quality. Revegetation work in adjacent areas will likely benefit this offset, although there would be a time lag following planting.
	Risk of loss without offset	40%	Risk of loss without offset is estimated to be 40% because the proposed offsets are located in an area with increasing semi-rural development. Additionally the offsets could be subject to a future mining application. There are no formal protection mechanisms in place to protect the vegetation from some permitted types of clearing or other activities under the current zoning. Other risk factors include dieback and drought.
	Risk of loss with offset	5%	Risk of loss with offset estimated to be 5% because a protection mechanism is likely to extinguish risk of further clearing for future development. However, the protection mechanism is unlikely to completely remove risks due to residual factors such as illegal clearing and natural disasters such as fires and drought.
	Confidence in result %	Averted Loss = 95%	Confidence in averted loss is set at 95% assuming there is a very high level of protection afforded by the conservation agreement.
		Increase in Quality = 70%	Confidence in quality is 70% as ongoing and adaptive management under the BMP will increase the chances of success. The understorey in the majority of patches is presently in moderate to good condition and has a good opportunity to improve through assisted natural regeneration. Management measures, such as exclusion fencing and buffer planting are likely to protect the vegetation from ongoing edge impacts and allow it to establish.
OFFSET AREAS - REVEGETATED	Area of habitat on offset	31.29 ha	Located in Tooheys Road South and Hue Hue Road offsets

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
	properties (ha)		
	Quality of offset site(s)	Current = 0/10 Future (no offset) = 0/10 Future (with offset) = 6/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance of the species are important factors influencing the viability of the community. Offset areas are located adjacent to impact areas Site condition score Current = 0/10. Habitat for this species does not occur within these areas. Future (no offset) = 0/10. Habitat for this species would not occur within these areas without the offset. Future (with offset) = 5/10. Significant revegetation work is proposed to restore habitat for this species within the offset. Site Context Current = 1/10. Area present within stronghold area of this species. Does not provide connected woodland in its current form. Future (no offset) = 1/10. Currently used for grazing purposes and unlikely to provide connected woodland in the future. Future (with offset) = 7/10. Potential to become connected with other remnants in the locality. Stocking Rate Score

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
			Current = 0/10. Not recorded within this component of the offset and no habitat currently available. Future (no offset) = 0/10. Currently surrounded by agricultural land uses and unlikely to decrease further than current conditions. Future (with offset) = 5/10. Potential to support the species.
	Time horizon	20 years	The life of the mine greater than 20 years – a large proportion of revegetation will be well advanced after this time.
	Time until ecological benefit	20 years	Time to ecological benefit can potentially take more than 15 years before the trees and shrubs mature and the understorey approaches the anticipated future quality.
	Risk of loss without offset	0%	Risk of loss without offset is estimated to be 0% as this habitat is absent from this component of the Offset Areas.
	Risk of loss with offset	10%	Risk of loss with offset estimated to be 10% because although a protection mechanism is likely to extinguish risk of future development, it is unlikely to completely remove risks associated with due to residual factors such as illegal clearing and natural disasters such as fires and drought. Furthermore, revegetation of degraded areas generally has lower success rates than assisted revegetation of naturally regenerating areas
	Confidence in result %	Averted Loss = 95%	Confidence in averted loss is set at 95% assuming there is a very high level of protection afforded by the conservation agreement.
		Increase in Quality = 40%	Confidence in quality is 40% as significant revegetation work is required to restore the community. Ongoing and adaptive management under the BMP will increase the chances of success. Revegetation

Table E.1 Data Values and Justification for the assessment of Angophora inopina

Component	Value in calculation	Score	Rationale
			work in adjacent areas and management of feral animals is likely to protect the vegetation from ongoing edge impacts and allow it to establish.

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
IMPACT	Area of habitat on impact site (ha)	41.1 ha	Total area of potential *T. juncea* habitat to be cleared.
	Quality of impact site	6/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance are important factors influencing the viability of the species. Site Condition Score Site condition score = 6/10. Habitat within the impact area consists of woodland and open forest areas, with hollowing, in moderate to good condition. The vegetation is consists largely of young regrowth vegetation with scattered mature trees. However some scattered patches consist of canopy species only while others have high edge to areas ratios, resulting in an increased susceptibility to edge effects. Some areas are highly modified from existing land uses and include regrowth vegetation on spoil heaps. Site Context Score Site Context = 6/10. Connectivity with the wider locality is variable across the Disturbance Area. The Disturbance Area is present towards the southern extent of the species distribution. The species is known to occur in conservation reserves in the locality and wider LGA. Connectivity is likely to be limited

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
			due to a predominance of asexual reproduction. Stocking Rate Score Stocking Rate Score = 5/10. Scattered individuals/clumps recorded within the Disturbance Area. Has some potential to form part of a larger population within the locality and wider region, despite a predominance of asexual reproduction.
OFFSET AREAS - RETAINED	Area of habitat on offset properties (ha)	192.1 ha	Located in Tooheys Road South, Tooheys Road North and Hue Hue Road offset areas
	Quality of offset site(s)	Current = 6/10 Future (no offset) = 5/10 Future (with offset) = 7/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance of the species are important factors influencing the viability of the community. Offset areas are located adjacent to impact areas Site condition score Current = 6/10. Habitat within the proposed offset areas consist of woodland and open forest areas, with hollowing, in moderate to good condition. The vegetation is consists largely of young regrowth vegetation with scattered mature trees. However some scattered patches consist of canopy species only while others have high edge to areas ratios, resulting in an increased susceptibility to edge effects.

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
			Future (no offset) = 5/10. There is increasing development in the locality and wider LGA. Proposed offset areas are not subject to any protection/conservation scheme and impacts from surrounding land uses have the potential to increase further than current conditions. Future (with offset) = 8/10. The offsets areas are proposed to be protected in perpetuity. The cessation of grazing activities in adjacent areas is likely to contribute to the improvement of the condition of the vegetation. The presence of young regrowth indicates capability for assisted regeneration. Native grassland areas already show indications of natural regeneration to woodland following cessation of slashing activity. Revegetation work within these and adjacent areas will also assist in the natural regeneration within these patches. Site Context Current = 6/10. Connectivity with the wider locality is variable across the offset areas. The proposed offsets are located towards the southern extent of the species distribution. The species is known to occur in conservation reserves in the locality and wider LGA. Connectivity is likely to be limited due to a predominance of asexual reproduction. Future (no offset) = 6/10. Currently surrounded by agricultural land uses and semi-rural development. Some potential for decreased connectivity with other remnants in the wider locality but is unlikely to increase significantly over current conditions, given the predominance of asexual reproduction. Future (with offset) = 6/10. Some potential for increased connectivity in conjunction with revegetation works but is likely to be limited due to the predominance of asexual reproduction. Stocking Rate Score Current = 6/10. Large numbers of clumps recorded within the Tooheys Road North and Hue Hue Road offsets. Some scattered individuals also present in the Tooheys Road South offsets. Has some potential

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
			to form part of a larger population within the locality and wider region, despite a predominance of asexual reproduction. Future (no offset) = 5/10. Currently surrounded by agricultural land uses and semi-rural development. Potential for reduction in population due to increasing impacts from surrounding land uses. Future (with offset) = 7/10. Potential to increase abundance of species.
	Time horizon	20 years	The life of the mine greater than 20 years.
	Time until ecological benefit	10 years	Cessation of current land use activities and implementation of management plans, such as weed management, will benefit this species within a short time frame. However the proposed revegetation of degraded areas can potentially take up to 10 years before the understorey approaches the anticipated future quality. Revegetation work in adjacent areas will likely benefit this offset, although there would be a time lag following planting.
	Risk of loss without offset	40%	Risk of loss without offset is estimated to be 40% because the proposed offsets are located in an area with increasing semi-rural development. Additionally the offsets could be subject to a future mining application. There are no formal protection mechanisms in place to protect the vegetation from some permitted types of clearing or other activities under the current zoning. Other risk factors include dieback and drought.
	Risk of loss with offset	5%	Risk of loss with offset estimated to be 5% because a protection mechanism is likely to extinguish risk of further clearing for future development. However, the protection mechanism is unlikely to completely remove risks due to residual factors such as illegal clearing and natural disasters such as fires and drought.
	Confidence	Averted Loss	Confidence in averted loss is set at 95% assuming there is a very high level of protection afforded by the

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
	in result %	= 95%	conservation agreement.
		Increase in Quality = 70%	Confidence in quality is 70% as ongoing and adaptive management under the BMP will increase the chances of success. The understorey in the majority of patches is presently in moderate to good condition and has a good opportunity to improve through assisted natural regeneration. Management measures, such as exclusion fencing and buffer planting are likely to protect the vegetation from ongoing edge impacts and allow it to establish.
OFFSET AREAS - REVEGETATED	Area of habitat on offset properties (ha)	31.29 ha	Located in Tooheys Road South and Hue Hue Road offsets
	Quality of offset site(s)	Current = 0/10 Future (no offset) = 0/10 Future (with offset) = 6/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance of the species are important factors influencing the viability of the community. Offset areas are located adjacent to impact areas Site condition score Current = 0/10. Habitat for this species does not occur within these areas. Future (no offset) = 0/10. Habitat for this species would not occur within these areas without the offset. Future (with offset) = 5/10. Significant revegetation work is proposed to restore habitat for this species

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
			within the offset. Site Context Current = 1/10. Area present within stronghold area of this species. Does not provide connected woodland in its current form. Future (no offset) = 1/10. Currently used for grazing purposes and unlikely to provide connected woodland in the future. Future (with offset) = 7/10. Potential to become connected with other remnants in the locality. Stocking Rate Score Current = 0/10. Not recorded within this component of the offset and no habitat currently available. Future (no offset) = 0/10. Currently surrounded by agricultural land uses and unlikely to decrease further than current conditions. Future (with offset) = 5/10. Potential to support the species.
	Time horizon	20 years	The life of the mine greater than 20 years – a large proportion of revegetation will be well advanced after this time.
	Time until ecological benefit	20 years	Time to ecological benefit can potentially take more than 15 years before the trees and shrubs mature and the understorey approaches the anticipated future quality.
	Risk of loss without offset	0%	Risk of loss without offset is estimated to be 0% as this habitat is absent from this component of the Offset Areas.

Table E.2 Data Values and Justification for the assessment of Tetratheca juncea

Component	Value in calculation	Score	Rationale
	Risk of loss with offset	10%	Risk of loss with offset estimated to be 10% because although a protection mechanism is likely to extinguish risk of future development, it is unlikely to completely remove risks associated with due to residual factors such as illegal clearing and natural disasters such as fires and drought. Furthermore, revegetation of degraded areas generally has lower success rates than assisted revegetation of naturally regenerating areas.
	Confidence in result %	Averted Loss = 95%	Confidence in averted loss is set at 95% assuming there is a very high level of protection afforded by the conservation agreement.
		Increase in Quality = 40%	Confidence in quality is 40% as significant revegetation work is required to restore the community. Ongoing and adaptive management under the BMP will increase the chances of success. Revegetation work in adjacent areas and management of feral animals is likely to protect the vegetation from ongoing edge impacts and allow it to establish.

Table E.3 Data Values and Justification for the assessment of the Giant Barred Frog

Component	Value in calculation	Score	Rationale
IMPACT	Area of habitat on impact site (ha)	7.7 ha	Total area of potential Giant Barred Frog habitat to be cleared.
	Quality of impact site	4/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance are important factors influencing the viability of the species. Site Condition Score Site condition score = 6/10. Habitat within the impact area has limited areas of riparian and swamp forest in moderate to good condition. The vegetation is consists largely of young regrowth vegetation with scattered mature trees. However some scattered patches high edge to areas ratios, resulting in an increased susceptibility to edge effects. There are some 2nd order streams present which provide some potential breeding habitat for this species. Site Context Score Site Context = 4/10. Connectivity with the wider locality is variable across the Disturbance Area. The Disturbance Area is not in the vicinity of any known stronghold (Coffs Harbour) for this species. Lack of baseline data limits the assessment of the distribution of this species. However, the disturbance areas are not located near the boundaries of known distribution for this species.

Table E.3 Data Values and Justification for the assessment of the Giant Barred Frog

Component	Value in calculation	Score	Rationale
			Stocking Rate Score Stocking Rate Score = 1/10. No individuals were recorded within the Disturbance Area. However 4 individuals were recorded within Project Boundary areas to the west of the infrastructure areas. There is some potential to form part of a larger population within the locality and wider region, although this may be limited due to the ephemeral nature of smaller water bodies in the area.
OFFSET AREAS - RETAINED	Area of habitat on offset properties (ha)	27.1 ha	Located in Tooheys Road South, Tooheys Road North and Hue Hue Road offset areas
	Quality of offset site(s)	Current = 4/10 Future (no offset) = 3/10 Future (with offset) = 4/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance of the species are important factors influencing the viability of the community. Offset areas are located adjacent to impact areas Site condition score Current = 6/10. Habitat within the proposed offset areas has areas of riparian and swamp forest in moderate to good condition. The vegetation is consists largely of young regrowth vegetation with scattered mature trees. However some scattered patches high edge to areas ratios, resulting in an increased susceptibility to edge effects. There are some 2nd order streams present which provide some potential

Table E.3 Data Values and Justification for the assessment of the Giant Barred Frog

Component	Value in calculation	Score	Rationale
			breeding habitat for this species. Future (no offset) = 5/10. There is increasing development in the locality and wider LGA. Proposed offset areas are not subject to any protection/conservation scheme and impacts from surrounding land uses have the potential to increase further than current conditions. Future (with offset) = 8/10. The offsets areas are proposed to be protected in perpetuity. The cessation of grazing activities in adjacent areas is likely to contribute to the improvement of the condition of the vegetation. The proposed feral species management will further reduce threats to this species. Site Context Current = 4/10. Connectivity with the wider locality is variable across the Proposed offset areas. These offset areas are not in the vicinity of any known stronghold (Coffs Harbour) for this species. Lack of baseline data limits the assessment of the distribution of this species. However, the disturbance areas are not located near the boundaries of known distribution for this species. Future (no offset) = 4/10. Currently surrounded by agricultural land uses and semi-rural development. Some potential for decreased connectivity with other remnants in the wider locality but is unlikely to increase significantly over current conditions. Future (with offset) = 4/10. Some potential for increased connectivity in conjunction with management plans but is likely to be limited due to the ephemeral nature of the smaller water bodies in the area. Stocking Rate Score Current = 1/10. No individuals were recorded within the offset areas. However 4 individuals were recorded within Project Boundary areas to the west of the infrastructure areas. There is some potential to form part of a larger population within the locality and wider region, although this may be limited due to the ephemeral nature of smaller water bodies in the area.

Table E.3 Data Values and Justification for the assessment of the Giant Barred Frog

Component	Value in calculation	Score	Rationale
			Future (no offset) = 0/10. Currently surrounded by agricultural land uses and semi-rural development. Potential for reduction in population due to increasing impacts from surrounding land uses Future (with offset) = 1/10. Assessment of the potential to increase abundance of species is limited due to lack of data on breeding success for this species.
	Time horizon	20 years	The life of the mine greater than 20 years.
	Time until ecological benefit	10 years	Cessation of current land use activities and implementation of management plans, such as weed management and feral species management, will benefit this species within a short time frame. However the proposed revegetation of degraded areas can potentially take up to 10 years before the understorey approaches the anticipated future quality. Revegetation work in adjacent areas will likely benefit this offset, although there would be a time lag.
	Risk of loss without offset	40%	Risk of loss without offset is estimated to be 40% because the proposed offsets are located in an area with increasing semi-rural development. Additionally the offsets could be subject to a future mining application. There are no formal protection mechanisms in place to protect the vegetation from some permitted types of clearing or other activities under the current zoning. Other risk factors include dieback and drought.
	Risk of loss with offset	5%	Risk of loss with offset estimated to be 5% because a protection mechanism is likely to extinguish risk of further clearing for future development. However, the protection mechanism is unlikely to completely remove risks due to residual factors such as illegal clearing and natural disasters such as fires and drought.
	Confidence in result %	Averted Loss = 95%	Confidence in averted loss is set at 95% assuming there is a very high level of protection afforded by the conservation agreement.

Table E.3 Data Values and Justification for the assessment of the Giant Barred Frog

Component	Value in calculation	Score	Rationale
		Increase in Quality = 65%	Confidence in quality is 65% as ongoing and adaptive management under the BMP will increase the chances of success. The understorey in the majority of patches is presently in moderate to good condition and has a good opportunity to improve through assisted natural regeneration. Management measures, such as control of weeds and feral species will reduce the threats to the Giant Barred Frog.

Table E.4 Data Values and Justification for the assessment of the Spotted-tailed Quoll

Component	Value in calculation	Score	Rationale
IMPACT	Area of habitat on impact site (ha)	43.4 ha	Total area of potential Spotted-tailed Quoll habitat to be cleared.
	Quality of impact site	4/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance are important factors influencing the viability of the species. Site Condition Score Site condition score = 6/10. Habitat within the impact area consists of woodland and open forest areas, with hollowing, in moderate to good condition. However some scattered patches consist of canopy species only while others have high edge to areas ratios, resulting in an increased susceptibility to edge effects. Some areas are highly modified from existing land uses and include regrowth vegetation on spoil heaps. The Disturbance area has moderate to good foraging habitat for this species but is likely to be more limited for breeding habitat due to limited availability of caves and rocky outcrops for den sites. Site Context Score Site Context = 5/10. Connectivity with the wider locality is variable across the Disturbance Area. The Disturbance Area is well within the known distribution for this species. Stocking Rate Score

Table E.4 Data Values and Justification for the assessment of the Spotted-tailed Quoll

Component	Value in calculation	Score	Rationale
			Stocking Rate Score = 1/10. No individuals were recorded within the Disturbance Area. However this species moves over large home ranges and has been historically recorded in the locality and wider LGA.
OFFSET AREAS - RETAINED	Area of habitat on offset properties (ha)	196.0 ha	Located in Tooheys Road South, Tooheys Road North and Hue Hue Road offset areas
	Quality of offset site(s)	Current = 4/10 Future (no offset) = 4/10 Future (with offset) = 5/10	Quality Weighting Site Condition = 33%; Site Context = 33%; Stocking Rate = 33% The weighting is shared equally between condition, context and stocking rate because condition of habitat, connectivity and patch size, and abundance of the species are important factors influencing the viability of the community. Offset areas are located adjacent to impact areas Site condition score Current = 6/10. Habitat within the impact area consists of woodland and open forest areas, with hollowing, in moderate to good condition. However some scattered patches consist of canopy species only while others have high edge to areas ratios, resulting in an increased susceptibility to edge effects. The Disturbance area has moderate to good foraging habitat for this species but is likely to be more limited for breeding habitat due to limited availability of caves and rocky outcrops for den sites. Future (no offset) = 5/10. There is increasing development in the locality and wider LGA. Proposed offset areas are not subject to any protection/conservation scheme and impacts from surrounding land uses have the potential to increase further than current conditions.

Table E.4 Data Values and Justification for the assessment of the Spotted-tailed Quoll

Component	Value in calculation	Score	Rationale
			Future (with offset) = 8/10. The offsets areas are proposed to be protected in perpetuity. The cessation of grazing activities in adjacent areas is likely to contribute to the improvement of the condition of the vegetation and thus habitat quality for this species. The proposed feral species management will further reduce threats to this species. Site Context Current = 5/10. Connectivity with the wider locality is variable across the offset areas. These areas are well within the known distribution for this species Future (no offset) = 5/10. Currently surrounded by agricultural land uses and semi-rural development. Some potential for decreased connectivity with other remnants in the wider locality but is unlikely to increase significantly over current conditions. Future (with offset) = 6/10. Some potential for increased connectivity in conjunction with management plans. Stocking Rate Score Current = 1/10. No individuals were recorded within the Disturbance Area. However this species moves over large home ranges and has been historically recorded in the locality and wider LGA. Future (no offset) = 1/10. Currently surrounded by agricultural land uses and semi-rural development. . Some potential for decreased connectivity with other populations in the wider locality but is unlikely to increase significantly over current conditions, given the wide-ranging nature of this species. Future (with offset) = 1/10. Assessment of the potential to increase abundance of species is limited due to lack of data on breeding success for this species.
	Time horizon	20 years	The life of the mine greater than 20 years.

Table E.4 Data Values and Justification for the assessment of the Spotted-tailed Quoll

Component	Value in calculation	Score	Rationale
	Time until ecological benefit	10 years	Cessation of current land use activities and implementation of management plans, such as weed management and feral species management, will benefit this species within a short time frame. However the proposed revegetation of degraded areas can potentially take up to 10 years before the understorey approaches the anticipated future quality. Revegetation work in adjacent areas will likely benefit this offset, although there would be a time lag.
	Risk of loss without offset	40%	Risk of loss without offset is estimated to be 40% because the proposed offsets are located in an area with increasing semi-rural development. Additionally the offsets could be subject to a future mining application. There are no formal protection mechanisms in place to protect the vegetation from some permitted types of clearing or other activities under the current zoning. Other risk factors include dieback and drought.
	Risk of loss with offset	5%	Risk of loss with offset estimated to be 5% because a protection mechanism is likely to extinguish risk of further clearing for future development. However, the protection mechanism is unlikely to completely remove risks due to residual factors such as illegal clearing and natural disasters such as fires and drought.
	Confidence in result %	Averted Loss = 95%	Confidence in averted loss is set at 95% assuming there is a very high level of protection afforded by the conservation agreement.
		Increase in Quality = 65%	Confidence in quality is 65% as ongoing and adaptive management under the BMP will increase the chances of success. The understorey in the majority of patches is presently in moderate to good condition and has a good opportunity to improve through assisted natural regeneration. Management measures, such as control of weeds and feral species will reduce the threats to the Spotted-tailed Quoll.