Wallarah 2
COAL PROJECT

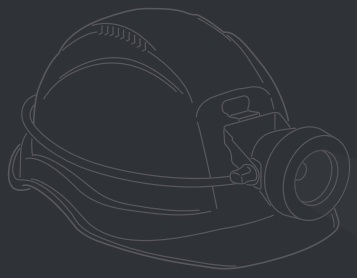
Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

Appendix O

Ecological Impact Assessment



Hansen Bailey
ENVIRONMENTAL CONSULTANTS

WALLARAH 2 COAL PROJECT

Ecological Impact Assessment

For:

Hansen Bailey

March 2013

Final

PO Box 2474, Carlingford Court 2118
www.cumberlandecology.com.au

Report No. 11084RP6

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.

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Position: Director

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Executive Summary

S1 Introduction

Cumberland Ecology was commissioned by Hansen Bailey Environmental Consultants (Hansen Bailey) on behalf of the Wyong Areas Coal Joint Venture (WACJV) to prepare an Ecological Impact Assessment (EIA) report for the Wallarah 2 Coal Project (the Project). The purpose of the assessment is to form part of an Environmental Impact Assessment (EIS) being prepared by Hansen Bailey to support an application for Development Consent under Division 4.1 in Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Project.

This report examines the terrestrial flora and fauna assemblages and their habitats within and surrounding the Project Boundary and neighbouring WACJV owned lands, including areas within which mine subsidence will occur (collectively, the Study Area) and assesses the impacts of the proposed construction and operation of the Project on biodiversity values within the Study Area. This assessment also examines the impact on threatened fauna and flora species, populations and ecological communities protected under both State and Commonwealth legislation.

The specific objectives of this assessment are to:

- Present and analyse the results of literature and database reviews;
- Present results from recent field surveys and describe the flora and fauna present or likely to occur within the Study Area based on collected information;
- Identify and consider the impacts of the Project upon threatened species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act) recorded in the Study Area or likely to be present therein; and
- Prescribe a Biodiversity Offset Strategy (BOS) that will protect threatened flora and fauna, compensate for the potential residual impacts of the Project that cannot be otherwise avoided or mitigated, and provide for a net gain of conserved woodland and forest habitats in the long term.

This EIA addresses the Director-General's Environmental Assessment Requirements (DGRs) in accordance with the requirements in Part 2 in Schedule 2 to the *Environmental Planning & Assessment Regulation 2000* (EP&A Regs). The Project requires approval from a Planning Assessment Commission under Part 4 of the EP&A Act.

S2 Project Background

The Project is managed by the WACJV. The WACJV was granted Exploration Licence (EL) 4911, EL 4912 and Authorisation 405 in 1995 and EL 5903 in 2001, which together comprise the WACJV Mining Authorities. The Project is located within the Wyong Local Government Area (LGA), approximately 4.7 km north-west of central Wyong, and 45 km south-west of Newcastle.

Development Consent is sought to operate a coal mine within the Project Boundary for a period of 28 years. The proposed underground mine will be supported by two surface facility sites and an air intake shaft (collectively the Infrastructure Boundary), for which a small portion of land will be cleared and developed.

The Project was referred to the Commonwealth Minister for the Environment in May 2012 due to potential impacts on the following matters of national environmental significance (MNES):

- Nationally threatened species and ecological communities; and
- Listed migratory species.

The Project was declared a "controlled action" on 15 June 2012 due to the likelihood of significant impact on the EPBC Act listed threatened species including the plants Charmhaven Apple (*Angophora inopina*) and Black-eyed Susan (*Tetratheca juncea*); both listed as Vulnerable under the EPBC Act, and two fauna species; the Spotted-tailed Quoll (*Dasyurus maculates maculatus*) and the Giant Barred Frog (*Mixophyes iteratus*), listed as Endangered under the EPBC Act. At the time of the referral, significant impacts were also considered possible for a number of other species protected by the EPBC Act.

This report has therefore formally considered the impacts of the Project on MNES.

S3 Methods

S3.1 Desktop assessments

Desktop studies were conducted by Cumberland Ecology in 2012 to identify the key ecological attributes and issues including Key Threatening Processes occurring as a result of the Project, of the Study Area. A comprehensive database of information relevant to the Study Area and surrounds exists as a result of numerous ecological studies conducted in the locality and Wyong LGA. While data collected from surveys conducted by OzArk Pty Ltd from 2006 – 2012 forms the bulk of the ecological data reviewed, this assessment also considered published and unpublished information gathered from previous ecological studies completed between 1998 and 2003 by BHP Billiton and ERM for sites in the vicinity of the Project.

Relevant vegetation mapping that was completed on behalf of the Wyong LGA was reviewed for this assessment. Other existing information about the biodiversity values of the Study Area and its surrounds were obtained through the Office of Environment and Heritage Atlas of NSW Wildlife database (OEH 2012a) and SEWPaC EPBC Protected Matters Search Tool (SEWPaC 2012g). The number and age of records of threatened species recorded within a 10 km radius of the Study Area was used to assess the likelihood of threatened species occurring. The Protected Matters Search Tool was used to provide a list of MNES that are predicted to occur based on the presence of suitable habitat, and was used to guide threatened species searches during field surveys.

S3.2 Field surveys in the Study Area

The environment within the Study Area was systematically surveyed between 2006 and early 2012 by OzArk Pty Ltd and by Cumberland Ecology in mid-late 2012. Field surveys included comprehensive flora and fauna surveys over a range of seasons. Terrestrial surveys were conducted, where practicable, in accordance with accepted conventional guidelines (DEC (NSW) 2004) and included quadrat sampling, habitat assessments, targeted species searches, trapline surveys, nocturnal surveys and bat surveys (harp and anabat). Detailed summaries of the methods and survey effort are provided within this report.

S4 Results

S4.1 Vegetation communities

The vegetation within the Study Area is a mix of young, regrowth, and regenerating forest and woodland communities, wetland and riparian areas and grassland that has been derived from the clearing of the original woodland and forest communities (Table S1.1). The grassland unit is dominated by exotic agricultural species, and occurs in livestock grazing paddocks and turf farms with some scattered areas dominated by a variety of native perennial grass and forb species. Some of the vegetation communities in the Study Area conform to communities that are listed as Endangered Ecological Communities (EECs) under the TSC Act. No EPBC listed EECs were found within the Study Area.

Table S.1.1 Vegetation Communities recorded in the Study Area

Vegetation Community	TSC Status
Blackbutt - Turpentine open forest of the foothills of the North Coast	EEC
Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin	EEC
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	EEC
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin	EEC

Table S.1.1 Vegetation Communities recorded in the Study Area

Vegetation Community	TSC Status
Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin	EEC
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin	EEC
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	EEC
Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin	EEC
Derived Native Grassland	
Exotic/Agricultural/Low Diversity Grassland	

S4.2 Groundwater Dependent Ecosystems

Vegetation communities present in the Study Area that have potential to comprise Groundwater Dependent Ecosystems (GDEs) include:

- Blackbutt – Turpentine open forest of the hills of the North Coast;
- Coachwood – Crabapple warm temperate rainforest of the North Coast and Northern Sydney Basin;
- Paperbark Swamp forest of the coastal lowlands of the North Coast and Sydney Basin;
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin;
- Swamp Mahogany 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 Jilliby Jilliby Creek and Wallarah Creeks flow through the Study Area and there is potential for there to be a groundwater component to the flows. Several areas of swamp / wetland are present in low lying areas in close proximity to water, and are often waterlogged within the Study Area, and may also comprise GDEs.

S4.3 Flora

Over 450 plant species were recorded in the Study Area, of which the majority are native. Six threatened plant species listed under the TSC Act and EPBC Act were recorded during surveys within the Study Area. These include:

- *Acacia bynoeana* (Bynoe's Wattle) (Vulnerable - EPBC Act; Endangered - TSC Act);
- *Angophora inopina* (Charmhaven Apple) (Vulnerable - EPBC Act and TSC Act);
- *Cryptostlis hunteriana* (Leafless Tongue Orchid) (Vulnerable - EPBC Act and TSC Act);
- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) (Vulnerable - EPBC Act and TSC Act);
- *Melaleuca biconvexa* (Biconvex Paperbark) (Vulnerable - EPBC Act and TSC Act); and
- *Tetratheca juncea* (Black-eyed Susan) (Vulnerable - EPBC Act and TSC Act).

S4.4 Fauna

The faunal assemblage within the Study Area is dominated by mobile species such as avifauna and microbats. Reptiles, arboreal mammals and terrestrial mammals are not as well represented. A variety of amphibian species are also found in the low-lying wetland and creek areas.

Over the course of all surveys conducted 29 threatened and 8 migratory fauna species have been recorded in the Study Area (see **Table S.1.2**).

Table S.1.2 Threatened and Migratory Fauna recorded in the Study Area

Scientific Name	Common Name	TSC Status	EPBC status
Crinia tinnula	Wallum Froglet	V	
Litoria aurea	Green and Golden Bell Frog	E1	V
Litoria brevipalmata	Green-thighed Frog	V	
Mixophyes iteratus	Giant Barred Frog	E1	E

Table S.1.2 Threatened and Migratory Fauna recorded in the Study Area

Scientific Name	Common Name	TSC Status	EPBC status
Hieraaetus morphnoides	Little Eagle	V	
Calyptorhynchus lathami	Glossy Black Cockatoo	V	
Daphoenositta chrysoptera	Varied Sittella	V	
Ephippiorhynchus asiaticus	Black-necked Stork	E1	
Epthianura albifrons	White-fronted Chat	V	
Glossopsitta pusilla	Little Lorikeet	V	
Hieraaetus morphnoides	Little Eagle	V	
Ixobrychus flavicollis	Black Bittern	V	
Limosa limosa	Black-tailed Godwit	V	C, J,K
Ninox strenua	Powerful Owl	V	
Tyto novaehollandiae	Masked Owl	V	
Tyto tenebricosa	Sooty Owl	V	
Ardea alba	White Egret		M,C,J
Ardea ibis	Cattle Egret		M,C,J
Gallinago hardwickii	Latham's Snipe		M,C,J,K
Haliaeetus leucogaster	White-bellied Sea-Eagle		M,C
Hirundapus caudacutus	White-throated Needletail		M,C,J,K
Monarcha melanopsis	Black-faced Monarch		M,B
Plegadis falcinellus	Glossy Ibis		M,C
Rhipidura rufifrons	Rufous Fantail		M,B
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 norfolkensis	East-coast Freetail Bat	V	
Falsistrellus tasmaniensis	Eastern False pipistrelle	V	
Kerivoula papuensis	Golden-tipped Bat	V	
Miniopterus australis	Little Bentwing Bat	V	
Miniopterus orianae oceanensis (formerly Miniopterus schreibersii oceanensis)	Eastern Bentwing Bat	V	

Table S.1.2 Threatened and Migratory Fauna recorded in the Study Area

Scientific Name	Common Name	TSC Status	EPBC status
Myotis macropus (formerly Myotis adversus)	Southern Myotis	V	
Scoteanax rueppellii	Greater Broad-nosed Bat	V	

Key: E/E1 = Endangered, V = Vulnerable, M = Migratory Species.
Migratory agreements: B = Bonn convention, C = CAMBA, J = JAMBA, K = ROKAMBA

S5 Impacts

The largest direct impact of the Project is the removal of native vegetation from the Infrastructure Boundary. Approximately 89 ha of vegetation comprising remnant and regenerating forest and woodland and large areas of open grassland with scattered trees will be removed over the life of the Project. Areas of vegetation to be cleared include:

- 13.2 ha of State-listed EECs;
- 47.3 ha of other native vegetation not listed under legislation; and
- 28.5 ha of modified grassland/pasture lands and artificial dams not listed under legislation.

Several swampy communities in the Study Area have potential to comprise GDEs and approximately 8.7 ha of potential GDE vegetation will be removed by the Project. This comprises 1.1 ha of Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin, 1.8 ha of Swamp Mahogany forest on coastal lowlands of the North Coast and northern Sydney Basin and 5.9 ha of Blackbutt – Turpentine open forest of the hills of the North Coast. These areas are a very small proportion of the extent of these communities in the Study Area and the locality.

An offset package has been developed to offset the impacts of clearing and this will result in the protection for conservation of approximately 200 ha of native vegetation, including all of the EECs and GDEs to be impacted in the Infrastructure Boundary. Considering the relatively minor loss of EEC and GDE vegetation, the extensive areas of these communities that occur in the locality it is not expected that the Project will result in a significant impact to EECs or GDEs.

The native vegetation communities to be cleared currently provide habitat for a range of flora and fauna, including species listed as threatened or migratory under the EPBC Act and/or TSC Act. The main impacts to flora and fauna involve the removal of forest and woodland habitat. The removal of low diversity grasslands is not expected to be important as these areas do not support a high diversity of species and habitats. Approximately 53 ha of forest and woodland habitat and 7.3 ha of Derived Native Grassland (DNG) will be removed for threatened species by the project.

These impacts are not considered to be significant due to the large areas of native vegetation that will remain in the study area and in surrounding parts of the locality. Several large patches of vegetation occur nearby including several State Forests and Conservation Reserves, and these provide large areas of high quality habitat for native species. Furthermore, in excess of 2,500 ha of vegetation will remain in the study area outside of the Infrastructure Boundary. These areas will continue to provide high quality habitat for all the threatened species recorded from or with potential to occur in the Study Area. Furthermore, the removal of this vegetation is not likely to fragment or isolate areas of habitat as the areas to be cleared are mostly located on the edge of already disturbed land, and vegetation communities and habitat will remain contiguous.

There is also some potential for impacts associated with subsidence to occur due to the longwall method of mining that is being employed for the Project. Mining under watercourses on floodplains, or in other relatively flat-lying areas, may result in localised diversion of water flows and possible minor increases in the incidence of flooding, erosion and other impacts. Altered flows and stream chemistry may have an impact on the lifecycle of aquatic species and riparian vegetation. However, modelling results indicate that the impacts of subsidence for this Project are likely to be minor. No loss of surface water flows will occur due to deep cracking, and although a transient drop in the alluvial water table will occur locally as the underground mining progresses, this is expected to be minor, and is predicted to rebound within 6 months. Although an overall drop in alluvial water table elevation will occur, this will be a relatively uniform drop that will be difficult to detect as the alluvial water table will continue to be subject to fluctuation according to rainfall. Although depressurisation will occur within hardrock strata at depth, the hardrock water table is not expected to be significantly affected. For these reasons it is expected that the vegetation in the SIL will continue to provide habitat for native flora fauna species and this vegetation will not be negatively affected by subsidence.

The Project has the potential to affect the flow regime and water quality of Wallarah Creek through the discharge of surplus mine water into a tributary of Wallarah Creek at the Tooheys Road Site. There is also potential for increased bank erosion, particularly at the point of discharge, and changes to water quality, such as salinity, temperature and pH, from the treated water discharges into the Wallarah Creek tributary. Altered flows and stream chemistry may have an impact on the lifecycle of aquatic species and riparian vegetation. However results from surface water studies indicate that the impacts from the relatively low flow discharge rates are likely to be minor. The discharge will not alter the ephemeral nature of Wallarah Creek and is unlikely to increase bank erosion. As surplus mine water will be treated to a quality which is similar to the receiving water from Wallarah Creek, water quality is not expected to be significantly affected. For these reasons it is expected that the riparian vegetation and aquatic habitats at the Tooheys Road site will not be negatively affected by the treated water discharge and will continue to provide habitat for native flora and fauna species.

The State's primary coal producing region occurs within the Hunter-Central Rivers CMA region. The CMA has experienced extensive vegetation clearance and continues to be subject to significant landscape modification as a result of past and present land practices, including agriculture, urban development and mining.

Multiple underground coal mining projects are already established in close proximity to the Project. Each of these mines require associated surface infrastructure and have a surface disturbance footprint.

When considered together with the Project, a high proportion of the surrounding locality will continue to be subject to extensive underground mining although there will be only limited direct surface disturbance and clearing. In contrast, however, relatively significant surface disturbance will continue to occur for proposed residential, industrial and infrastructure land uses within the locality and region over next two to three decades.

The Project will add to ecological impacts that continue to be experienced on a regional scale by removing approximately 89 ha of vegetation, of which 60.5 ha consists of remnant forest, open woodland and derived native grassland and the remainder of improved pasture. Without any amelioration measures, the Project would contribute to the cumulative impact on Endangered Ecological Communities as listed under the TSC Act. The Project would also have significant impacts, both direct and indirect, on threatened flora and fauna within the locality, such as removal of *Angophora inopina* (direct impact) and loss of potential habitat for the Giant Barred Frog (indirect impact). The Project's offsets will provide significant benefits in terms of wildlife corridor protection that are consistent with the broad conservation planning objectives in local and regional planning strategies.

S6 Impact Mitigation

A number of amelioration measures have been designed to minimise the ecological impacts of the Project. The approach is based upon the following hierarchy of principles of avoidance, mitigation and compensation described within the Part 3A Guidelines for Threatened Species Assessment for the use of environmental offsets under the EPBC Act:

- **Avoid**: developments should be designed to avoid or minimise ecological impacts, where possible;
- **Mitigate**: where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the proposed development; and
- **Compensate**: the residual impacts of the Project, following the implementation of mitigation measures, should be compensated for in some way to offset what would otherwise be a net loss of habitat.

S6.1 Avoidance

Avoiding environmental impacts has been considered where possible throughout the Project planning and design phases and significant modification to the design of the Project has led to the current proposal. Where feasible, clearing of native vegetation has been avoided by locating surface infrastructure where facilities already exist and proposing the construction of an underground drift, thus avoiding the need for a surface overland conveyor. The design and layout of the longwall mine and its coal extraction methods have also been modified to include latest technological improvements to minimise surface expression of subsidence.

It is considered the most efficient alternative as it provides for improved biodiversity outcomes while being socially and economically viable.

S6.2 Mitigation Measures

The following mitigation measures should be implemented:

- Preparation of a Biodiversity Management Plan (BMP) for construction that contains detailed mitigation and management measures. This plan should include information such as protocols for vegetation clearing including inspection of hollows, feral animal and pest control, rehabilitation objectives, further detailed design measures and ongoing monitoring;
- Undertake ongoing weed and feral animal management and monitoring through a weed management plan; and
- Monitor water quality and flow in the creeks and streams for surface expression of subsidence impacts.

S6.3 Biodiversity Offset Strategy BOS

A Biodiversity Offset Strategy (BOS) has been developed to offset the residual impacts of the Project on flora and fauna. The BOS addresses the residual impacts of the Project in a strategic and meaningful way that will deliver a real biodiversity outcome, and will ensure that the Project does not result in a net loss of biodiversity values. The Project adopts a "maintain or improve" approach to offsetting; aiming to achieve no net loss of biodiversity values, including the area and condition of habitat for fauna, over the life of the Project.

The main components of the BOS are:

- Onsite Offsets, comprising conservation of areas proposed for retention around the proposed rail-loop at the Tooheys Road Site; and
- Offsite Offset Land, comprising land purchased by the WACJV at Hue Hue Road which is to be secured permanently for conservation and managed under a site-specific Biodiversity Management Plan (BMP) to improve and maintain the conservation values of the offsite offset land.

The BOS will address the predicted loss of 53.3 ha of remnant forest and woodland and 7.3 ha of DNG by provision of 208 ha of offset land, or a ratio of 3.4:1 for total native vegetation (EEC and Non – EEC vegetation) to be cleared.

The BOS will address the predicted loss of 13.2 ha of State listed EECs by the provision of 83 ha of like-for-like vegetation or a ratio of 6.3:1.

The BOS will provide approximately 200 ha of forest and woodland that provides habitat for the threatened species recorded from the Study Area including 135.45 ha for *Angophora inopina,* 192.8 ha *Tetratheca juncea*, 118.8 ha for the Spotted-tailed Quoll and 78.1 ha for the Giant Barred Frog.

S7 Conclusion

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, to improved pastures and modified native grasslands used for grazing.

Despite the impacts of past agriculture, clearing for infrastructure for the Project would have further impacts on the ecology of the local area if no mitigation and compensation measures were proposed. Without amelioration, it would result in the net loss of approximately 60.5 ha of native forest and woodland and DNG, including 13.2 ha of State-listed EECs. The vegetation that is proposed to be cleared also provides habitat for a range of threatened flora and fauna species as well as migratory species listed under the TSC Act and / or the EPBC Act that were recorded or are likely to occur within the Study Area.

In recognition of the potential ecological impacts of the Project, a BOS has been developed to compensate for the residual impacts on threatened species and ecological communities that cannot be addressed through avoidance and mitigation measures. The BOS will protect approximately 200 ha of forest and woodland habitat for native flora and fauna, including 83 ha of State Listed EECs. These areas would provide upfront mitigation of the Project's impacts on locally occurring biodiversity. The inclusion of these lands as biodiversity offsets would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented.

The impacts from subsidence are considered to be negligible, especially in light of the mine layout measures taken to avoid creek confluences and the technological updates to the longwall design that will significantly reduce surface expression of subsidence. Notwithstanding this, monitoring programmes, conducted before, during and after subsidence are recommended to record conditions to the floodplain and threatened species such as the Giant Barred Frog (*Mixophyes iteratus*).

When the monitoring, mitigation and offsetting package is considered, no significant impacts are predicted to occur to threatened species as a result of the Project, and the Project will provide a major ecological benefit in the medium to long term. It will substantially increase the area of forests and woodlands, including prime habitat for threatened species, under conservation tenure in the region. The ratio of native vegetation to be conserved to that cleared will represent a minimum of 6.3:1 for State listed EECs and 2.6:1 for other non-EEC native vegetation (3.4:1 for total native vegetation).

Chapter 1

Introduction

1.1 Purpose

The Wyong Areas Coal Joint Venture (WACJV) seeks a Development Consent under Division 4.1 in Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Wallarah 2 Coal Project (the Project). This Ecological Impact Assessment supports 'The Wallarah 2 Coal Project Environmental Impact Statement' (Wallarah 2 EIS) prepared by Hansen Bailey Environmental Consultants to support the application.

This Ecological Impact Assessment has been prepared in accordance with the Director-General's Environmental Assessment Requirements (DGRs) for the Project issued 12 January 2012 in accordance with the requirements in Part 2 in Schedule 2 to the Environmental Planning & Assessment Regulation 2000 (EP&A Regs). The DGRs of direct or indirect relevance to this EIA are provided in **Appendix A** which also lists where each is addressed in this report**.**

This EIA describes the current ecological values of the Study Area and assesses the potential ecological impacts of the Project. For the purposes of this report, "biodiversity" includes all native fauna and flora, but the assessment focuses 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).

The specific objectives of the EIA are to:

- Present and analyse the results of literature and database reviews;
- Present results from recent field surveys and describe the flora and fauna present or likely to occur within the Study Area based on collected information;
- Identify and consider the impacts of the Project upon threatened species and ecological communities listed under the EPBC Act and TSC Act recorded in the Study Area or likely to be present therein; and
- Prescribe a Biodiversity Offset Strategy (BOS) that will protect threatened flora and fauna, compensate for the potential residual impacts of the Project that cannot be otherwise avoided or mitigated, and provide for a net gain of conserved woodland and forest habitats in the long term.

1.2 Project Background

In 2012, Cumberland Ecology was commissioned by Hansen Bailey Environmental Consultants (Hansen Bailey) on behalf of the WACJV to prepare a revised EIA.

The Project was referred to the Commonwealth Minister for the Environment in May 2012 due to predicted impacts on the following Matters of National Environmental Significance (MNES):

- Nationally threatened species and ecological communities; and
- Listed migratory species.

The Project was declared a "controlled action" on 15 June 2012 due to the likelihood of significant impact on the EPBC Act listed threatened species including the plants Charmhaven Apple (*Angophora inopina*) and Black-eyed Susan (*Tetratheca juncea*); both listed as Vulnerable under the EPBC Act, and two fauna species; the Spotted-tailed Quoll (*Dasyurus maculates maculatus*) and the Giant Barred Frog (*Mixophyes iteratus*), listed as Endangered under the EPBC Act. At the time of the referral, significant impacts were also considered possible for a number of other species protected by the EPBC Act.

This report has therefore formally considered the impacts of the Project on MNES within Chapter 7.

1.2.1 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 is located on the western site of the F3 freeway, just north of the Wyong River. Most of Wyong State Forest and the south to south-eastern parts of Jilliby State Conservation Area (Jilliby SCA) lie within this western extent of the Project Boundary.

Surface facility areas are located on the eastern and western sides of the F3 Freeway. The eastern facilities, known as the Tooheys Road Site, are located between the F3 Freeway and Main Northern Railway and are bordered by Tooheys Road to the north and Motorway Link road to the south (except for the rail spur near the transmission line immediately to the north). The western facilities, known as the Buttonderry Site, are bordered by Hue Hue Road to the east and by the Buttonderry waste management facility to the north.

1.2.2 Project Description

The WACJV was granted Exploration Licence (EL) 4911, EL 4912 and Authorisation 405 in 1995 and EL 5903 in 2001, which together comprise the WACJV Mining Authorities. The WACJV has since conducted extensive exploration and environmental studies and a pre-feasibility study into the development of an underground coal mine within the Mining Authorities.

The Project Boundary comprises an area of approximately 4,559 ha (refer to **Figure 1.2**). The proposed underground mine will be supported by two surface facility sites and an air intake shaft (collectively the Infrastructure Boundary), for which a small portion of land will be cleared and developed.

The Infrastructure Boundary comprises approximately 165 ha within the overall Project Boundary and includes WACJV owned and third party land at the Tooheys Road Site, Buttonderry Site and Western Ventilation Shaft. Within the Infrastructure Boundary 100 ha occurs within the Disturbance Boundary (see **Figure 1.2**).

Development Consent is sought to mine coal within the underground Extraction Area for a period of 28 years. The majority of this resource lies beneath the Wyong State Forest and surrounding ranges (including the Jilliby SCA) while a proportion, to be extracted first, lies beneath a section of the Dooralong Valley and the Hue Hue area. The location of the Project is shown in **Figure 1.1** and **Figure 1.2** shows details of the Conceptual Project layout.

Key features of the Project include:

- The construction and operation of an underground mining operation extracting up to 5.0 Mtpa of export quality thermal coal by longwall methods within the underground Extraction Area;
- Mining and related activities will occur 24 hours a day 7 days a week for a period of 28 years;
- Tooheys Road Site surface facilities on company owned and third party land (subject to a mining lease) between the Motorway Link Road and the F3 Freeway which will include (at least) a rail loop and spur, stockpiles, water and gas management facilities, workshop and offices;
- Buttonderry Site Surface Facilities on company owned land at Hue Hue Road between Sparks Road and the Wyong Shire Council's (WSC) Buttonderry Waste Management Facility. This facility will include (at least) the main personnel access to the mine, main ventilation facilities, offices and employee amenities;
- An inclined tunnel (or "drift") constructed from the coal seam beneath the Buttonderry Site to the surface at the Tooheys Road Site;
- Construction and use of various mining related infrastructure including water management structures, water treatment plant (reverse osmosis or similar), generator, second air intake ventilation shaft, boreholes, communications, water discharge point, powerlines, and easements to facilitate connection to the WSC (after July 2013, the Central Coast Water Corporation) water supply and sewerage system;

- Capture of methane for treatment initially involving flaring as practicable for greenhouse emission management and ultimately for beneficial use of methane such as electricity generation at the Tooheys Road Site;
- Transport of coal by rail to either the Newcastle port for export or to domestic power stations;
- A workforce of approximately 300 full-time company employees (plus an additional 30 contractors); and
- Rehabilitation and closure of the site at cessation of mining operations.

1.2.3 Previous Ecological Assessments

A number of flora and fauna assessments, predominantly by ERM, have been undertaken over several years and seasons within the Project Boundary, Extraction Area and other areas of WACJV owned land.

This ecological assessment builds on and compiles all previous assessments undertaken within the Project Boundary to date and provides an assessment suitable to support the Wallarah EIS and DGRs.

1.3 Related Investigations

The impact assessments within this report have been prepared with consideration for other related environmental studies for the Project, including the following:

- Marine Pollution Research)(2013) Aquatic Ecology Impact Assessment, Wallarah 2 Coal Project;
- Environmental Earth Sciences (2012) Soils and Land Capability Assessment, Wallarah 2 Coal Project;
- Mackie Environmental Research (2013) Groundwater Management Studies, Wallarah 2 Coal Project;
- Mine Subsidence Engineering Consultants (2013) Subsidence Predictions and Impact Assessments, Wallarah 2 Coal Project;
- PAE Holmes (2012) Air Quality and Greenhouse Gas Assessment, Wallarah 2 Coal Project;
- WRM Water & Environment Pty Ltd (2013) Surface Water Impact Assessment, Wallarah 2 Coal Project; and
- Wyong Areas Coal Joint Venture (2012) Subsidence Modelling Study, Wallarah 2 Coal Project.

1.4 Involvement and Authorship

This report was prepared by Cumberland Ecology utilising survey data collected during field inspections conducted in August, November and December 2012, as well as previous survey data collected by OzArk Pty. Ltd. and other consultants between 2006 – 2012. OzArk ecologists and sub-consultants involved in collecting field data for the Project are listed in Table 1.1.

Table 1.1 Personnel involved in OzArk Ecological Field assessments

Assessment Type	Person	Organisation
Flora Assessment	Phil Cameron	Principal Ecologist / Senior Project Manager
Terrestrial Ecology		OzArk Environmental & Heritage Management Pty Limited
Terrestrial Ecology Assistant	Heidi Kolkert	Ecologist
		OzArk Environmental & Heritage Management Pty Limited
Flora Assessment	Stephen Bell	Director and Principal ecologist (flora) Eastcoast Flora Survey
Terrestrial Ecology (fauna)	Deryk Engle	Director and Principal Ecologist
		LesryK Environmental Consultants
Terrestrial Ecology Assistant	Steven Bloomfield	Ecologist
		LesryK Environmental Consultants
Herpetology Assessment	Dr Arthur White	Director and Principal Ecologist Biosphere Environmental Consultants
Herpetology Assessment	Frank Lemckert	Frank Lemckert

1.5 Terms and Abbreviations

The terms and abbreviations used throughout this report are listed in the table below.

Table 1.2 Terms and Abbreviations used in this Report

Terminology	Description
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
DGRs	Director- General's Environmental Assessment Requirements (NSW DP&I)
DP&I	Department of Planning NSW
Disturbance Area	Area of disturbance within the Infrastructure Boundary. The area that will be mechanically altered to implement infrastructure for the Proposal.

Table 1.2 Terms and Abbreviations used in this Report

Terminology	Description
EEC	Endangered Ecological Community
EIA	Ecological Impact Assessment
EIS	Environmental Impact Statement
EP&A Act	NSW Environmental Planning & Assessment Act 1979
EPBC Act	Federal Environment Protection and Biodiversity Conservation Act 1999
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
Infrastructure Boundary	Boundary within which surface infrastructure areas will be located
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
Project Boundary	Encompasses all land the Development Consent will apply to, including the Infrastructure Boundaries and Extraction Area
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	Department of Sustainability, Environment, Water, Population and Communities
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

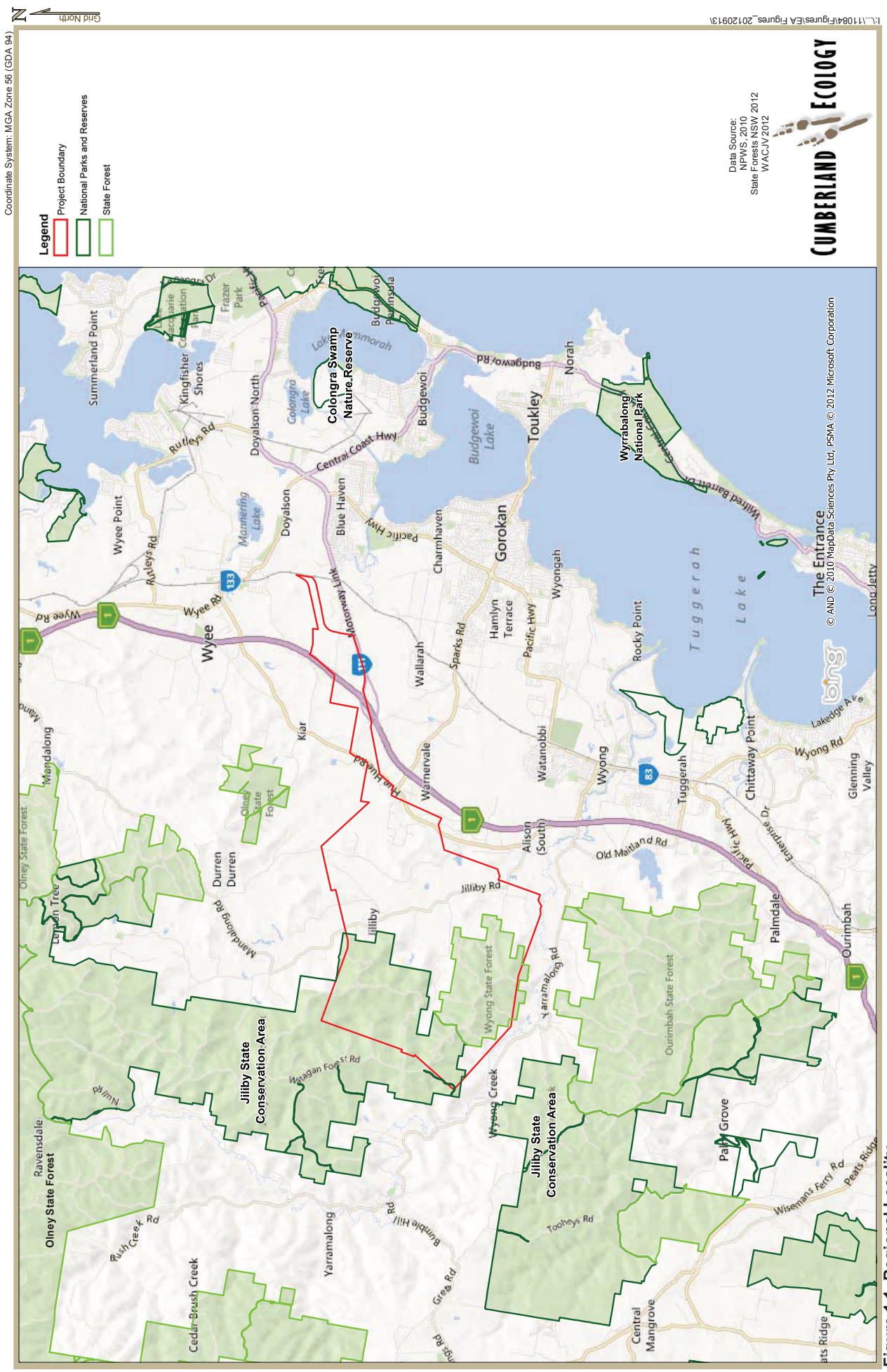

Figure 1.1. Regional Locality

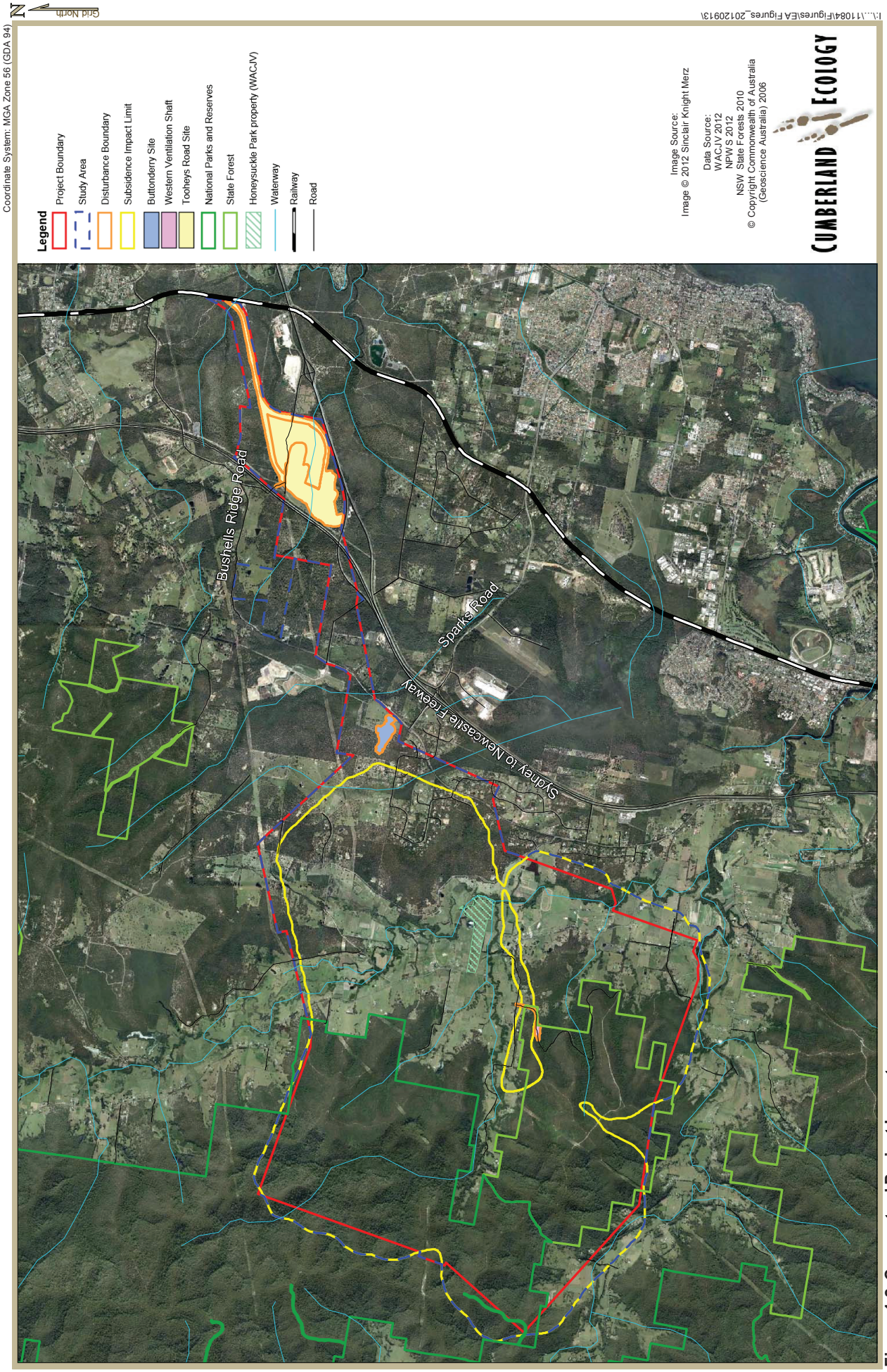

Figure 1.2. Conceptual Project Layout

Chapter 2

Legislative Framework

A number of Local Council, State and Commonwealth Acts, Policies and Guidelines are relevant to the proposed development. Those relevant to this report are discussed below.

2.1 Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act is the overarching planning legislation in NSW. This Act provides for the consideration of the environment and biodiversity values, which is addressed in Section 5A (Significant effect on species, populations or ecological communities or their habitats). This includes threatened species, communities, habitat and processes as listed under the *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act).

The Project is classified as State Significant Development as it meets the requirements of Clause 10, Schedule 1 of State Environmental Planning Policy (State and Regional Development) 2011 (SEPP S&RD).

Under the EP&A Act, an EIS is required for development proposals and must be prepared in accordance with the DGRs. This report forms the ecological assessment component of the EIS that is required to enable the Project to be assessed under Part 4.1 of the EP&A Act. DGRs for the Project have been received the NSW Department of Planning and Infrastructure (DP&I) and the provisions that are relevant to ecology include:

- Measures to avoid, reduce or mitigate impacts on biodiversity;
- Accurate estimates of proposed vegetation clearing;
- A detailed assessment of potential impacts of the development on any:
  - Terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and
  - Regionally significant remnant vegetation or vegetation corridors.
- A detailed assessment of the impacts to matters of National Environmental Significance;

- A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.

Details of the DGRs relevant to this EIA and where they are addressed are provided in **Appendix A.**

2.2 Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act through threat abatement and species recovery programs.

The TSC Act requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat. In order to determine whether potential impacts are "significant", the potential impacts of developments, land use changes or activities need to undergo an "Assessment of Significance" under Section 5A of the EP&A Act.

2.3 Environmental Protection and Biodiversity Act 1999 (EPBC Act)

Under the EPBC Act, any action (which includes a development, project or activity) that is considered likely to have a significant impact on MNES (including nationally threatened ecological communities (TECs), species and listed migratory species) must be referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC). The purpose of the referral is to allow a decision to be made about whether an action is a "controlled action" and requires approval on a Commonwealth level.

The Project was referred to the Commonwealth Minister for the Environment in May 2012 due to likely impacts on the following MNES:

- Nationally threatened species and ecological communities; and
- Listed migratory species.

A delegate for the Commonwealth Minister for SEWPaC declared the Project a controlled action in June 2012 due to the likelihood of significant impact on the EPBC Act listed threatened species including the plants Charmhaven Apple (*Angophora inopina*) and Black-eyed Susan (*Tetratheca juncea*); both listed as Vulnerable under the EPBC Act, and two fauna species; the Spotted-tailed Quoll (*Dasyurus maculates maculatus*) and the Giant Barred Frog (*Mixophyes iteratus*), listed as Endangered under the EPBC Act. Significant impacts are also considered possible for a number of other species protected by the EPBC Act.

Accordingly, the Project will require Commonwealth Government approval to proceed. The Project will be assessed via an accredited process with the NSW DP&I under Part 4.1 of the EP&A Act. The Commonwealth Minister for SEWPaC has provided input into the formation of the DGRs (**Appendix A**) and thus, the requirements for Commonwealth assessment are included in the State assessment process.

The impacts of the Project upon MNES are examined in detail within Chapter 7 of this EIA.

2.4 Other State Legislation and Policies

Further NSW legislation and planning policies that are relevant to the protection of biodiversity include:

- *Water Act 1912*;
- *National Parks and Wildlife Act 1974*;
- *Fisheries Management Act 1994*;
- *Water Management Act 2000*;
- *Threatened Species Conservation Amendment (Biodiversity Banking) Act 2006*.
- *NSW State Groundwater Dependent Ecosystems Policy (DLWC (NSW), 2002)*;
- SEPPs
    - State Environmental Planning Policy No. 14 – Coastal Wetlands;
    - State Environmental Planning Policy No. 26 – Littoral Rainforests or State Environmental Planning Policy (Major Projects) 2005;
    - 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.

2.5 Wyong Shire Council Policies and Guidelines

Wyong Shire Council (WSC) documents and guidelines that have been considered in this assessment:

- Wyong Local Environment Plan (1991);
- Wyong Shire Council Flora and Fauna Guidelines (1999);

- Wyong Shire Council Development Control Plan 2005 (Chapter 13 - Interim Conservation Areas, Chapter 30 – Wetlands); and
- Squirrel Glider Conservation Management Plan (Smith 2002).

2.6 Other Relevant Policies and Guidelines

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 (2011a) Principles for the Use of Biodiversity Offsets in NSW Department of Environment and Climate Change, Hurstville, NSW.

Chapter 3

Existing Environment

3.1 Bioregional Context

The Project is located within the Wyong LGA, which forms part of the Sydney Basin Bioregion (SBBR). The SBBR is a large area that encompasses approximately 3,624,008 ha of the central east coast of NSW (OEH (NSW) 2011) and is one of the most diverse bioregions in Australia, characterised by high environmental heterogeneity and ecological diversity (OEH 2011c).

3.2 Conservation Reserves

Approximately 38% of the SBBR is occupied by conservation oriented tenures, particularly national parks and nature reserves. Eight conservation reserves in the Hunter-Central Rivers Catchment (Jilliby State Conservation Area (SCA), Lake Macquarie SCA, Munmorah SCA, Tuggerah SCA, Colongra Swamp Nature Reserve (NR), Palm Grove NR, Tuggerah NR, & Wyrrabalong National Park (NP)) have portions within the Wyong LGA.

There are no local conservation reserves in the immediate vicinity of the Tooheys Road and Buttonderry sites. The land within the Western Ventilation Shaft forms part of the Wyong State Forest and is therefore managed to offer a degree of protection to the fauna and flora that occur within it. Parts of the Jilliby SCA also fall within the Extraction Area of the Project Boundary.

3.3 Climate

The SBBR has a temperate climate characterised by warm summers with no dry season. The Project is located towards the northeast of the bioregion, which can experience a sub-humid climate. The area has an average annual temperature of 25.1°C (maximum annual average of 27.5°C and minimum annual average of 9.3°C) with an annual average rainfall of 1,235.5 mm (BOM 2012).

3.4 Topography

Topography across the Project Boundary is gently undulating to hilly with altitudes of between approximately five and 220 metres above sea level (ASL).

The eastern and central portions of the Project Boundary, including the Infrastructure Boundary areas at Tooheys Road and Buttonderry sites are characterised by gentle rises. The western portion of the Project Boundary, including the Western Ventilation Shaft and the Extraction Area, is hilly and rugged, consisting of steep to very steep slopes with narrow crests and ridges.

3.5 Geology and Soils

The SBBR is a geological basin filled with near horizontal sandstones and shales of Permian to Triassic age that overlie older basement rocks of the Lachlan Fold Belt (OEH 2011c).

The Project is located at the margins of a geological formation known as the Clifton Subgroup of the Narrabeen Group, which in turn forms part of the Munmorah Conglomerate Formation. These formations weather to produce moderately deep (0.5 to 1.5 m) yellow earths, yellow podsolic soils and soloths (Murphy 1993) with low usable nutrients.

The Subsidence Impact Limit, which includes almost the entirety of the Extraction Area as well as some adjacent areas outside the Project Boundary, is located above a Permian coal seam sequence that is overlain by Narrabeen Group sandstones including Gosford (sandstone, siltstone) and Clifton (softer sandstone, claystone, shales) Subgroups. Quaternary alluvial deposits (silt and sand) also occur on the valley floors and floodplains of the Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks.

The Wallarah 2 EIS and supporting material provides further detailed information on the geology and soils of the Project Boundary.

3.6 Hydrology

The Project Boundary includes a proportion of the Macquarie Tuggerah Catchment and intersects several waterways, surface drainage systems and a number of minor aquatic systems, tributaries and agricultural dams. These include:

- Wyong River (permanent water source);
- Wallarah Creek (permanent water source);
- Spring Creek (permanent water source);
- Hue Hue Creek; and
- Jilliby Jilliby Creek.

Aquifers within the Project Boundary have been mapped during work for the Project, and three principal domains have been identified:

- Unconsolidated alluvial aquifers within the Yarramalong and Dooralong valleys and coastal areas;

- Shallow weathered rock zone; and
- Regional Narrabeen Group of sedimentary rocks overlying the Wallarah / Great Northern (WGN) seam.

Further details on flooding, surface and ground water relevant to the Project are provided in the related investigations listed in **Section 1.3**.

3.7 Land Use

The Wyong LGA has been subject to a wide variety of land uses since initial European settlement in the early 1820s. The current dominant land uses within and adjacent to the Study Area include large and small scale agriculture, stud farms, turf farms, cattle grazing, orchards and rural residential areas.

Large portions of land within the Study Area have been highly modified and have undergone significant physical modification as a result of clearing for grazing purposes and pasture improvement, especially along river flats and low slopes around the Yarramalong and Dooralong Valleys. Increased erosion and soil movement has occurred as a result of tree clearance for agriculture.

Significant portions of the Study Area are composed of young forests and woodlands with scattered mature trees, as well as regenerating, fragmented woodland and grasslands with scattered trees. The regenerating woodlands and derived grasslands vary in native plant species diversity and are subject to varying degrees of weed invasion. Previously, forestry has been a major land use in the region and the majority of the remaining Wyong State Forest lies within the Project Boundary. Further details on the forests, woodlands and grassland communities are provided in **Section 5.2**.

3.8 Wildlife Corridors and Connectivity

Fauna wildlife corridors are usually associated with waterways, wetlands and riverine environments or specific continuous habitats (for example escarpments or woodlands). The Project Boundary is likely to provide a movement pathway along vegetated areas including the creeklines and rivers between remnant patches of vegetation and forests.

Although fragmented from past agricultural activities, the Project Boundary is contiguous with large tracts of land to the north, south and west, including Jilliby SCA, Ourimbah State Forest and Wyong State Forest. However, the Main Northern Rail Line, F3 Freeway and Motorway Link Road disrupt links from the Project Boundary (excluding the Western Ventilation Shaft) to other patches of remnant vegetation to the east. Land clearing on neighbouring properties augments these barriers to reduce the connectivity between populations of terrestrial animals or plants (**Figure 1.2**).

Further details on corridor pathways and environmental fragmentation in the Wyong Shire are provided in the Draft Wyong Conservation Strategy (Wyong Shire Council 2003).

Chapter 4

Methodology

This chapter presents the methodology utilised in preparing this EIA. It includes desktop reviews of information from various sources as well as descriptions of the field survey methods used by Cumberland Ecology and OzArk Pty. Ltd. (OzArk) for the detailed flora and fauna surveys and vegetation mapping.

4.1 Desktop Assessments

Desktop assessments, incorporating data from previous surveys and reports as well as information held on government databases and archives, were conducted by Cumberland Ecology to assess vegetation communities and the likelihood of occurrence of threatened species within the Project Boundary. Desktop assessments were also conducted by OzArk prior to field surveys to guide survey design.

4.1.1 Database Searches

Information on the biodiversity values of the Study Area and its surrounds were obtained by Cumberland Ecology via interrogation of BioNet, the Atlas of NSW Wildlife database (OEH 2012a, 2013) and the EPBC Protected Matters Search Tool (PMST) (SEWPaC 2012g). The PMST provided a list of MNES that are predicted to occur based on the presence of suitable habitat, within a 10 km radius of the centre of the Project Boundary. The BioNet search also provided a list of threatened species recorded within a 10 km radius of the centre of the Project Boundary. Additional searches on BioNet and PMST were also conducted for the Wyong LGA. The BioNet searches were limited to records made after 1 January 1980.

The number and age of records of threatened species recorded provided information on their distribution within the locality and the Wyong LGA, and was used to assess their likelihood of occurrence within the Study Area. Likelihood of occurrence tables for threatened flora, fauna and populations as well as migratory species recorded in the locality are provided in **Appendix B**.

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

4.1.2 Literature Review

There has been considerable ecological survey effort within the Project Boundary and the locality in recent times.

Relevant reports, some of which were commissioned by the WACJV, were reviewed by Cumberland Ecology to determine flora and fauna species recorded within and in the vicinity of the Study Area. These include:

- ERM (1998a) Flora and Fauna Assessment of Precinct 15 and Pacific Power sites;
- ERM (1998b) Flora/Fauna assessment of Precinct 15 and Pioneer Dairy Report to COAL Operations Australia Ltd.
- ERM (1999) Flora and Fauna Assessment of Proposed Surface Facilities for Wyong Areas Coal Joint Venture. Report prepared for Coal Operations Australia Limited;
- Bell (2002a, 2002b) The Natural Vegetation of the Wyong Local Government Area, Central Coast, NSW;
- BHP (2002) Wyong Coal Concept Study;
- ERM (2002) Wyong Coal Project Flora and Fauna Review (Terrestrial);
- BHP (2003) Wyong Coal Project Prefeasibility Study Section 12: Environment; and
- ERM (2003) Wyong Coal Project Flora and Fauna Summer Surveys – Western Area.

In addition to these reports, data files provided by WACJV on surveys conducted within the Project Boundary and surrounding areas were examined for threatened species. These reports and data files were also examined to identify recorded species that became listed as threatened under the TSC and/or EPBC Act subsequent to the studies being conducted. A summary table of the findings of the reports and survey data is provided in **Appendix C**. Although these reports and data files did not always provide details of the survey methods utilised or dates during which species were recorded, the data from these studies was, nonetheless, incorporated in the Likelihood of Occurrence assessments.

Some of these reports, along with several general assessment documents and species specific publications relevant to the Wyong LGA, were reviewed by OzArk to guide its field survey efforts. A list of the survey guidelines, species specific publications and reports reviewed by OzArk is provided in **Appendix D**.

4.2 Field Surveys

Terrestrial Ecology field surveys for the Project were conducted by OzArk and 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. The dates over which field surveys were completed are summarised in **Table 4.1**.

The field surveys conducted by both Cumberland Ecology and OzArk (OzArk 2012) 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). These surveys also fulfill the requirement for detailed ecological studies of areas with potential for conservation lands as listed under the Wyong Council Development Control Plan (DCP) 2005 Chapter 13 – Interim Conservation Areas.

Table 4.1 Field Survey Dates

Year	Dates	Areas Assessed	Assessors	Tasks Completed
2006	27 Sep, 29 Sep, 4 Oct, 12 Oct, 18 Oct, 1 Nov, 14 Nov, 20 Nov, 12 Dec, 19 Dec,	Buttonderry, Tooheys Road, Hue Hue Road Offset.	OzArk	Flora surveys, Targeted threatened flora species surveys, Orchid surveys, Vegetation mapping
	14 – 16 Sep, 26 Sep – 1 Oct.	Buttonderry, Tooheys Road	OzArk	Fauna surveys
2007	23 Feb, 12 Jul, 7 – 8 Aug, 29 Aug	Buttonderry, Tooheys Road, Hue Hue Road Offset	OzArk	Orchid surveys, Targeted threatened flora species surveys
	30 Aug	Tooheys Road	OzArk	Flora surveys
	6 Sep, 14 Sep, 20 Sep, 8 Oct, 22 Nov, 5 Dec	Tooheys Road, Hue Hue Road	OzArk	Orchid surveys, Targeted threatened flora species surveys
2008	11 Jan	Buttonderry, Hue Hue Road Offset	OzArk	Orchid surveys, Targeted threatened flora species surveys
2009	2 Nov, 6 Nov	Buttonderry, Hue Hue Road Offset	OzArk	Flora surveys, Targeted threatened flora species surveys, Orchid surveys, Vegetation mapping
2011	17 – 21 Oct	Buttonderry, Tooheys Road	OzArk	Orchid surveys, Targeted threatened flora species surveys
	16 – 17 Dec	Hue Hue Road Offset	OzArk	Flora surveys, Targeted threatened flora species surveys, Orchid surveys
	17 – 21 Oct, 24 – 28 Oct, 5 – 9 Dec	Extraction Area, Buttonderry, Tooheys Road, Hue Hue Road Offset	OzArk	Fauna surveys
2012	24 Jan, 20 Feb	Tooheys Road, Hue	OzArk	Orchid surveys, Targeted

Table 4.1 Field Survey Dates

Year	Dates	Areas Assessed	Assessors	Tasks Completed
		Hue Road Offset		threatened flora species surveys
	20 – 24 Feb, 27 Feb – 2 Mar	Extraction Area, Tooheys Road	OzArk	Fauna surveys
2012	9 – 10 Aug	Extraction Area, Tooheys Road, Hue Hue Road Offset,	Cumberland Ecology	Vegetation mapping verification, Fauna habitat assessment
	22 – 23 Nov	Buttonderry, Tooheys Road, Hue Hue Road Offset.		Flora surveys, Vegetation mapping, Tree Hollow assessments
	29 – 30 Nov	Extraction Area, Western Ventilation Shaft, Honeysuckle Park	Cumberland Ecology	Flora surveys, Vegetation mapping verification
	17 – 18 Dec	Buttonderry, Tooheys Road	Cumberland Ecology	Targeted threatened species searches (*Angophora inopina & Melaleuca biconvexa*), Tree Hollow assessments

4.2.1 Weather conditions

Weather during the 2006 spring and 2006 - 2007 summer survey periods (OzArk) were warm with below average rainfall following from a wet winter period. Conditions were generally wet during the 2007 winter survey period followed by relatively dry 2007 spring and summer periods. The 2011 spring and 2011 – 2012 summer survey periods (OzArk) were warm and wet, with above average rainfall resulting in flooding in parts of the state.

Weather conditions during August 2012 Cumberland Ecology surveys were wet followed by relatively hot and dry conditions during November – December 2012 survey periods.

A summary table of weather conditions, as recorded by the nearest Bureau of Meterology (BOM) weather station, for each survey date are listed in **Table 4.2** 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 4.2 Weather conditions during survey periods

Year	Day	Rainfall (mm)	Min Temp (oC)	Max Temp (oC)
2006	14-Sep	0	10.7	20.6
	15-Sep	0	11.8	21.4
	16-Sep	0	11.4	20.6
	26-Sep	0	15.7	20.5
	27-Sep	0	16.9	23.4
	28-Sep	0	15.2	20.1
	29-Sep	0	13.1	23.5
	30-Sep	0	14.6	19
	1-Oct	0	11.4	20.4
	4-Oct	0	11.5	21.9
	12-Oct	0	13.3	29.2
	18-Oct	1	16.3	31.8
	1-Nov	0	15.4	22.8
	14-Nov	0	14.8	23.1
	20-Nov	0	17.2	24.5
	12-Dec	0	16.7	18.3
	19-Dec	0	15.4	23.2
2007	23-Feb	1	19.7	27.5
	12-Jul	0	7.4	15.2
	7-Aug	0	7.3	19.2
	8-Aug	0	9.2	22.5
	29-Aug	0	14.3	19.8
	30-Aug	0	15.6	23.2
	6-Sep	2	12.9	16.2
	14-Sep	0	14.3	26.4
	20-Sep	0	15.3	18.2
	8-Oct	0	16.2	21.1
	22-Nov	30	18.4	21.1
	5-Dec	39	16.4	24.7
2008	11-Jan	0	20.2	27.7
2009	2-Nov	0	17.5	23.3
	6-Nov	23	17.7	20.6
2011	17-Oct	0	14.1	18

Table 4.2 Weather conditions during survey periods

Year	Day	Rainfall (mm)	Min Temp (oC)	Max Temp (oC)
	18-Oct	0	13.1	20.5
	19-Oct	0	13	22.6
	20-Oct	0	12.8	24.3
	21-Oct	0	14.7	26
	24-Oct	0	16.5	31
	25-Oct	0	18.8	21.4
	26-Oct	10	14.2	18.4
	27-Oct	6	14.6	20.4
	28-Oct	0	16.3	24.5
	5-Dec	3	12.4	18
	6-Dec	1	13.2	20.4
	7-Dec	0	15.8	18.7
	8-Dec	12	15.9	21.7
	9-Dec	0	17	23.7
	16-Dec	0	14.7	22.2
	17-Dec	0	17.4	22.9
2012	24-Jan	3	20.1	23.9
	20-Feb	37	19.6	25.9
	21-Feb	25	18.7	22.4
	22-Feb	2	18	23
	23-Feb	0	18.2	26.6
	24-Feb	0	19.3	28
	27-Feb	0	20.4	25.1
	28-Feb	0	20.9	28.7
	29-Feb	0	20.8	23.9
	1-Mar	5	20.7	28.2
	2-Mar	21	18.8	20.8
	9-Aug	0	12.4	19.4
	10-Aug	0	7.7	14.8
	22-Nov	0	17.2	19.6
	23-Nov	0	17.2	22.2
	29-Nov	4	20.2	28.6
	30-Nov	0	20.4	26.5

Table 4.2 Weather conditions during survey periods

Year	Day	Rainfall (mm)	Min Temp (oC)	Max Temp (oC)
	17-Dec	1	18.4	22.1
	18-Dec	0	18.6	25.1

4.3 Flora Surveys

4.3.1 Vegetation mapping

Vegetation mapping prepared by Bell (2002a) for the WSC and vegetation mapping prepared as part of the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (2000) was used by OzArk to guide mapping of vegetation communities in the field.

Prior to mapping vegetation communities, a collection of Rapid Data Points (RDPs) was undertaken by OzArk across the entire Study Area, in accordance with the methodology being developed by Bell and Driscoll (in progress). RDPs consist of recording a summary of floristic information at specific points in the field as well as Global Positioning Systems (GPS) waypoints taken at specific and regular locations. Recorded floristic information includes:

- Canopy layer dominant species;
- Shrub layer dominant species;
- Ground layer dominant species;
- Draft vegetation unit; and
- Miscellaneous notes.

Walking and driving surveys were conducted between 2006 and 2011 and records of vegetation units and boundary changes were made using handheld GPS units. Vegetation communities were described in the field by OzArk using the nomenclature of Bell (2002b). The observed species composition within these communities was then aligned to corresponding *Biometric* and, where applicable, listed NSW Endangered Ecological Communities (EECs) for the purposes of offset calculations. The resultant information was synthesised using Geographical Information Systems (GIS) to create a spatial database. Areas that were inassessable were mapped by OzArk utilising mapping conducted by Bell for the Wyong Shire Council in 2002, with updates for some communities from subsequent 2008 mapping.

The GIS data was checked by Cumberland Ecology in 2012, and utilised to produce preliminary vegetation maps of the Study Area.

Walking and driving reconnaissance surveys were then conducted across the entire Study Area. The objectives of these surveys were to:

- Verify accuracy of vegetation mapping conducted by OzArk;
- Determine vegetation communities in areas previously mapped as 'site-by-site assessment required' by OzArk; and
- Assess grassland areas previously unsurveyed by OzArk.

Vegetation mapping by Cumberland Ecology also included assessments of the general condition of the different vegetation types within the Project Boundary. 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 **Sections 5.2.3 – 5.2.15**.

Several areas, predominantly private land within the Extraction Area, were not accessible for detailed survey and mapping. WACJV has undertaken reasonable endeavours to obtain access to private land for survey work. Permission to access private property was sought through surveys and direct interviews with landowners. Despite these endeavours, WACJV was unable to obtain access to all private properties. Although it would have been desirable to survey this land, the benefit in this was outweighed by the need to maintain positive social and community relationships.

The majority of private land is agricultural in character. Based on visual observations of the general composition of these agricultural lands from public roads, the surveyed agricultural land at Honeysuckle Park (owned by WACJV) is considered to be an accurate representation of the ecological values of majority of the unsurveyed agricultural land within the Extraction Area.

Hazardous terrain and inaccessibility also prevented detailed surveys of certain areas within the Wyong SF and Jilliby SCA. Surveys of these areas were, therefore limited to visual observations from public roads and accessible paths to verify previous broad scale vegetation mapping conducted for the Wyong LGA (Bell 2002a,b).

Further GIS mapping was then completed using MapInfo Version 11.0.4 on a Windows XP platform.

4.3.2 Flora surveys

The flora assemblage within the Study Area was recorded by OzArk using quadrat sampling, random meander surveys and targeted searches for threatened species. Flora assemblage data was verified and updated by Cumberland Ecology using the same methods.

A total of 38 flora quadrats (20m x 20m) were sampled by OzArk over the course of the 2006 – 2011 survey periods. An additional 10 quadrats (20m x 20m) were sampled by Cumberland Ecology in November 2012. Quadrat locations are shown in **Figure 4.1** and the list of recorded flora species is provided in **Appendix E**.

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; and
- Geological features such as landform type, soil type, slope and aspect.

The relative abundance and cover of each species within the quadrat was approximated using a modified Braun-Blanquet cover abundance scale (Poore 1977). The scores used are provided in **Table 4.3** below.

Table 4.3 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	

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993) and Cunningham *et al.* (1992) with taxonomic and nomenclatural changes made, where known (Botanic Gardens Trust 2011). Any specimens that were not readily identifiable were lodged for identification with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney. The national conservation significance of flora

was determined by referencing the Schedules associated with the TSC Act and/or the EPBC Act. Additional significance assessments of *Rare or Threatened Australian Plants* (ROTAP) (Briggs and Leigh 2006) were conducted by OzArk.

The quadrat data collected during OzArk surveys was analysed by Bell (2012) using the PRIMER statistical package (Clarke and Gorley 2006), to assist in understanding the trends present in the vegetation so that consistency of community definitions could be achieved.

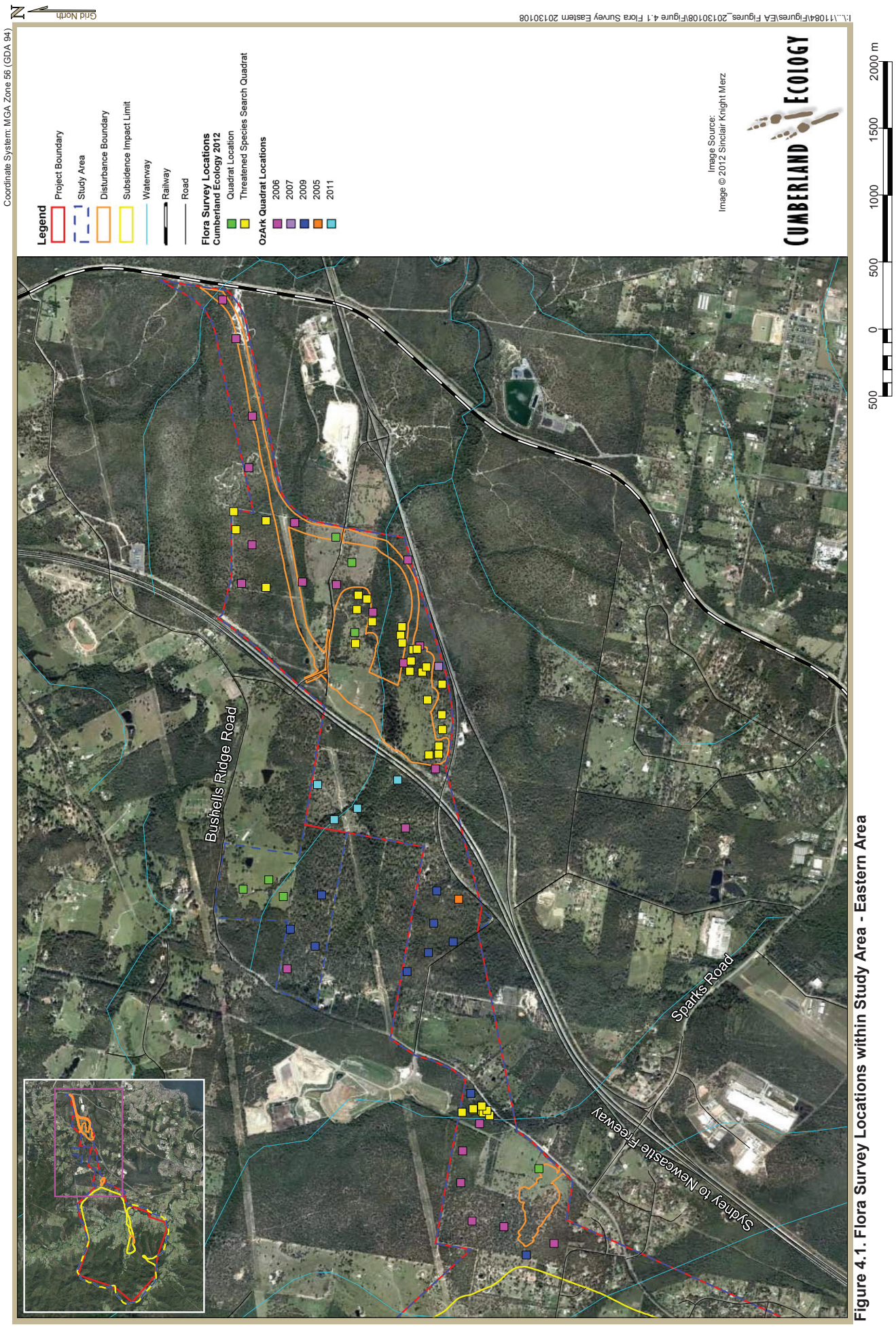

Figure 4.1. Flora Survey Locations within Study Area - Eastern Area

Figure 4.2. Flora Survey Locations within Study Area - Western Ventillation Shaft

4.3.3 Targeted Threatened Flora Surveys

i. OzArk surveys

Targeted searches were conducted by OzArk in 2006 – 2007 and again in 2011 – 2012 (see **Table 4.1**) in accordance with relevant guidelines to search for threatened orchids during relevant flowering periods. Opportunistic recordings of orchid species were also undertaken while surveying and mapping the vegetation in the Study Area.

Targeted searches for threatened non-orchid flora species likely to occur in the Study Area were incorporated within the targeted orchid surveys and general flora surveys. Targeted species included *Acacia bynoeana, Angophora inopina, Callistemon linearifolius, Eucalyptus camfieldii*, *Eucalyptus parramattensis* subsp. *parramattensis (Endangered population) Grevillea parviflora* subsp. *parviflora,* and *Tetratheca juncea.* These targeted surveys were conducted firstly through random meander surveys and then meander or transect surveys of suitable areas of habitat and met the minimum survey efforts required for transects and meanders.

ii. Cumberland Ecology surveys

Further targeted surveys for *Angophora inopina* and *Melaleuca biconvexa* were conducted by Cumberland Ecology in December 2012.

a. *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. Based on the occurrence records provided by OzArk from previous surveys, the targeted surveys for this species were limited to areas mapped as Scribbly Gum - Red Bloodwood woodland within the Tooheys Road Site. A total of 25 quadrats (20 m x 20 m) were randomly distributed among the impact and offset areas. Quadrat locations are shown in **Figure 4.1**. 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 for the impact and offset areas respectively.

In addition to the targeted survey quadrats, locations of *Angophora inopina* individuals located during random meanders of suitable habitat as well as during floristic and tree hollow assessment surveys were recorded.

b. *Melaleuca biconvexa* surveys

Melaleuca biconvexa was noted to occur along creekline areas at the Buttonderry site during vegetation mapping conducted by OzArk. As detailed counts were not conducted for this species, the focus of *Melaleuca biconvexa* surveys conducted by Cumberland Ecology were to determine the density of occurrence of this species along the area of occupancy. Based on data provided by OzArk from previous surveys, the targeted surveys for this species were limited to areas close to the creekline within the Buttonderry Site.

A total of five 400 m^2 quadrats - two 20m x 20m quadrats and three 4m x 100m quadrats – were surveyed. Each 4 x 100 m quadrat included following a 100m meandering transect along the path of the creek and recording individual stands within 2 m of either side of the creek bank. The start and end points of these quadrats are shown in **Figure 4.1**. Locations of the two 20m x 20m quadrats are shown by a single point in **Figure 4.1**.

As this species produces root suckers, resulting in vegetative growth (Bell, *pers comm,* Parsons Brinckerhoff, 2008), population size was estimated using a modification of the methodology utilised to estimate population size of *Melaleuca biconvexa* by Parsons Brinckerhoff (2008). A total stem count, age classification of each stem and a broad visual abundance assessment were conducted within each quadrat.

The visual abundance method is based on Duncan's (2001) conservation assessment of *Melaleuca biconvexa* within Wyong LGA which classifies each stand into the following categories:

1. Low: <5% cover abundance of *Melaleuca biconvexa;*
2. Medium: 5 – 50% cover abundance of *Melaleuca biconvexa;* and
3. High: >50% cover abundance of *Melaleuca biconvexa*.

Each recorded stem was classified into the following age class criteria, modified from Parsons Brinkerhoff (2008):

1. Mature: Stem Diameter at Breast Height (DBH) >200 mm and Height >2 m;
2. Young: Stem DBH <200 mm and Height >2 m;
3. Immature: Stem DBH at chest height <200 mm and Height between 1 – 2 m; and
4. Sapling: Height < 1 m.

Average densities of each age class within the area of occurrence were determined from the stem counts within quadrats sampled.

In addition to the density quadrats, GPS locations of *Melaleuca biconvexa* stands located during random meanders of the area of occupancy were recorded.

c. *Corunastylis* sp. Charmhaven

Targeted surveys for the newly listed orchid species *Corunastylis* sp. Charmhaven (Proposed Gazettal date: 05/10/12) could not be conducted due to lack of sufficient information on the appropriate survey period/flowering period for this threatened species.

This species has a very limited distribution and is described as being very similar in appearance to *Corunastylis archeri* (syn. *Genoplesium archeri*), the main difference being *Corunastylis* sp. Charmhaven having fewer, larger flowers borne on a shorter inflorescence. Several targeted orchid surveys were conducted from 2006 – 2012, during which *C. archeri* was not detected. Therefore, *Corunastylis* sp. Charmhaven is considered unlikely to occur within the Study Area. Nevertheless, targeted surveys will be conducted at the first available

opportunity, once information on appropriate survey periods/flowering periods for this species becomes available.

4.4 Fauna Habitat Assessment

Habitat condition was assessed by OzArk and Cumberland Ecology by noting ground, shrub/understorey and canopy cover, the number and size of hollows present, habitat features such as rocky outcrops and coarse woody debris, and signs of fauna usage such as nests, scats and scratches.

Fauna habitat assessments also included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, coarse woody debris, rocky outcrops and wetland areas such as creeks and soaks.

i. 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 by Cumberland Ecology during the November – December 2012 survey period.

Prior to surveys, the areas of the different vegetation communities present within the Tooheys Road and Buttonderry Impact areas as well as the Tooheys Road and Hue Hue Road offset areas were calculated from the vegetation mapping. The number of quadrats surveyed within each vegetation community in the individual impact and offset areas was adjusted to meet the minimum plot requirements for individual zones as per the *Biobanking* methodology and are listed in **Table 4.4** below.

Table 4.4 Minimum Number of Quadrats Surveyed Per Unit Area of Vegetation

Area (ha)	Minimum number of quadrats required
0 – 4	1
>4 – 20	3
>20 – 50	4
>50 – 100	5

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) for each vegetation community as well as impact and offset areas as a whole was then extrapolated utilising the mean number of individuals per quadrat for the impact and offset areas respectively.

4.5 Fauna Surveys

Fauna surveys were undertaken by OzArk over several seasons to maximise detection of fauna species. The survey methods utilised by OzArk for the fauna surveys are described in the following sections and were conducted in accordance with relevant State and Commonwealth guidelines for surveys of frogs, birds, mammals and reptiles (**Appendix D**). Fauna survey locations are shown in **Figure 4.2** and a summary of survey effort is presented in **Table 4.5**.

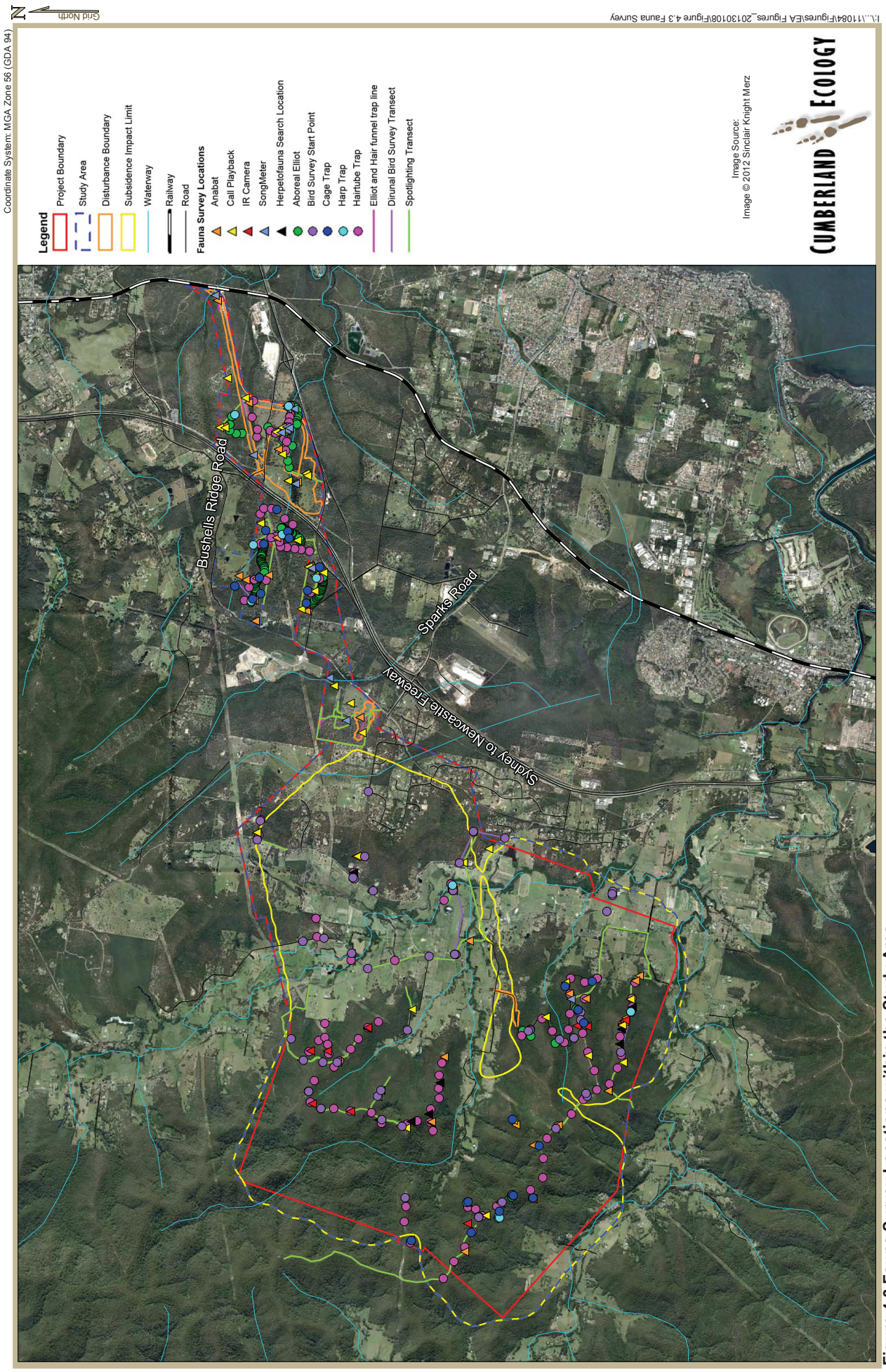

Figure 4.3 Fauna Survey Locations within the Study Area

Table 4.5 Cumulative fauna survey effort by OzArk in Study Area

Survey Methods	Location	Ecology Study		
		OzArk (2006)	OzArk (2011)	OzArk (2012)
Cage Traps	Hue Hue Road offset area	-	48 trap nights	-
	Extraction Area/Subsidence Impact Limit	-	56 trap nights	-
Elliot Traps - ground	Hue Hue Road offset area	-	276 trap nights	-
	Extraction Area/Subsidence Impact Limit	-	240 trap nights	-
	Tooheys Road Site	200 trap nights	-	120 trap nights
Elliot Traps – arboreal	Hue Hue Road offset area	-	144 trap nights	-
	Extraction Area/Subsidence Impact Limit	-	160 trap nights	-
	Tooheys Road Site	-	-	120 trap nights
Hair tube traps	Hue Hue Road offset area	-	594 trap nights	-
	Extraction Area/Subsidence Impact Limit	-	960 trap nights	81 trap nights
	Tooheys Road site	250 trap nights	-	135 trap nights
	Buttonderry	80 trap nights	-	-
Harp traps	Hue Hue Road offset area	-	8 trap nights	-
	Extraction Area/Subsidence Impact Limit	-	8 trap nights	5 trap nights
	Tooheys Road site	-	-	7 trap nights
Anabat recordings	Hue Hue Road offset area	-	89.5 hours	-
	Extraction Area/Subsidence Impact Limit	-	197 hours	83.5 hours
	Tooheys Road Site	-	-	3 hrs 20 mins
	Buttonderry Site	1 night	-	-

Table 4.5 Cumulative fauna survey effort by OzArk in Study Area

Survey Methods	Location	Ecology Study		
		OzArk (2006)	OzArk (2011)	OzArk (2012)
Infrared cameras	Hue Hue Road offset area	-	3 cameras	-
	Extraction Area/Subsidence Impact Limit	-	9 cameras	4 cameras
Call playbacks	Hue Hue Road offset area	-	6.5 hours	-
	Extraction Area/Subsidence Impact Limit	-	13 hours	3 hours
	Tooheys Road Site	3 sites	-	4.75 hrs
	Buttonderry Site	3 sites	-	-
Spotlighting	Hue Hue Road offset area	-	7.5 hours	-
	Extraction Area/Subsidence Impact Limit	-	16 hours	5 hours
	Tooheys Road Site	9 hours	3 hours	2.5 hours
	Buttonderry Site	3 hours	1 hour	-
Song Meter	Hue Hue Road offset area	-	24 hours	-
	Extraction Area/Subsidence Impact Limit	-	40 hours	40 hours
	Tooheys Road Site	70 hours		
	Buttonderry	20 hours		
Bird surveys	Hue Hue Road offset area	-	4.5 hours	20 mins
	Extraction Area/Subsidence Impact Limit	-	19.8 hours	5.8 hours
	Tooheys Road Site	30 min/site	-	50 mins
Herpetofauna surveys	Hue Hue Road offset area	-	3.5 hours	-
	Extraction Area/Subsidence Impact Limit	-	3.5 hours	2 hours

Table 4.5 Cumulative fauna survey effort by OzArk in Study Area

Survey Methods	Location	Ecology Study		
		OzArk (2006)	OzArk (2011)	OzArk (2012)
	Tooheys Road Site	10.5 hours	-	-
	Buttonderry Site	-	1 hour	-

4.5.1 Scats and Tracks

Scats and raptor pellets (owls, eagles and hawks) encountered during the course of the field survey were collected and examined to determine species presence. Scats and tracks were identified in accordance with Triggs (1996) or sent to Ms Georgeanna Story of "ScatsAbout" (Majors Creek, NSW) for analysis.

4.5.2 Trapping Surveys

Trapping was used to detect arboreal and terrestrial fauna occurring in the Project Boundary. Combinations of the following traps were utilised in fauna traplines:

- Medium Elliott (B) traps for small to medium sized arboreal fauna;
- Small Elliott (A) traps for small terrestrial fauna; and
- Wire cage traps for large terrestrial fauna.

Trapping was not conducted by OzArk within the Jilliby SCA as these areas are very similar to those within the Wyong State Forest which had recently been studied (OzArk 2012).

i. Elliott Trapping

OzArk established Elliott traps along linear transects, each trap being between 10 m and 15 m apart. Generally a pattern of one arboreal trap to two ground traps was established. However in some woodland areas, short transects, consisting of five arboreal and five ground traps were established. In these instances, the pattern was a ground trap followed by an arboreal trap.

The Elliott B arboreal traps were placed on wooden brackets attached to habitat trees at a height of 2 - 4 m. Each tree was sprayed with a honey and water mixture up to a height of 2 m above and below the brackets to attract fauna.

All traps were lined with leaf litter to protect and insulate any captured animals. Traps were baited with a standard mixture of peanut butter, honey and rolled oats and re-baited when necessary (ie traps that were sprung or held captured animals). Traps were left open for a period of four nights and checked each morning shortly after dawn. Trapped fauna were carefully handled to avoid injury and distress, identified, then released into suitable habitat.

ii. Cage Trapping

Wire mesh cages (30 cm x 30 cm x 58 cm in size), targeting medium to large ground mammals, were set at various locations along, or near, each of the Elliott trap transects. Some cages were also placed at random sites within the Project Boundary to ensure adequate sampling of those habitats. All traps were baited with a mix of meat, chicken breast, sardines and stewing steak. The same trapping period and checking procedure utilised for the Elliott traps was used for the cage traps.

iii. Hair tube traps

'Faunatech' plastic hair tubes designed to collect mammal hair were used to supplement arboreal and terrestrial traps. The traps were all established on the ground and, where possible, efforts were made to ensure a minimum distance of 100 m was present between each hairtube trap. The traps were alternately baited with either, the rolled oats, peanut butter and honey mixture or the sardines/chicken meat, and were left open for a minimum period of ten days. Any hairs collected within the hairtube traps, or scats that contained bone or hair material, were sent to Ms Georgeanna Story of "ScatsAbout" (Majors Creek, NSW) for analysis.

4.5.3 Infrared Cameras

Infra-red (IR) cameras were placed along obvious runways of native fauna, near diggings or adjacent to water bodies. The cameras were placed at a height of around 1.5 metres above ground level, angled slightly downwards and set to a high sensitivity. The cameras were left in place for a minimum of five days/four nights and were set to take still photographs at a photo interval of 3 photos in ten seconds when the motion sensor was activated.

Animals were enticed into the camera's field of view by securing lures into the ground with steel pegs at a distance of around 5 m in front of the camera. The lures were constructed from 250 mm long PVC piping, drilled with a number of holes. Foam was then placed in the piping and scented with truffle oil. Footage was later analysed to identify any fauna species recorded and in which areas they were found.

4.5.4 Call Playback and Spotlighting Surveys

Nocturnal mammals and birds were surveyed through call playback, and all groups of nocturnal fauna including amphibians and reptiles were surveyed through spotlighting.

Call playback of taped calls (Nature Sound CDs) of the Koala (*Phascolarctos cinereus*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Yellow-bellied Glider (*Petaurus australis*) were broadcasted using a loud hailer connected to an iPod. An initial ten minute listening period was conducted to determine presence of species, after which calls were broadcast for 5 minutes per species in the order listed above. A short listening period was conducted between the Koala and owl calls and a ten minute listening period followed the completion of the entire playback sequence.

As Yellow-bellied Gliders are known to respond to the broadcast calls of owls, the calls of this species were not broadcast if they responded to the owl calls. To minimise stressing and disturbing the species targeted, if an animal responded to the call playbacks, calls of this species were not broadcast during subsequent playback sessions.

Spotlighting (using 163 lumen hand-held spotlights) was undertaken either while walking or from a slow moving vehicle and focussed on tracks, clearings and access ways. Spotlighting sessions lasted 30 – 60 minutes and were conducted both concurrently with call playback sessions in separate areas, and at the completion of playback sessions. Incidental spotlighting was also conducted while travelling between call playback sites.

4.5.5 Bat Surveys

Microchiropteran bats (microbats) were surveyed using the following detection methods:

- Ultrasonic bat recordings using Anabat SDI and/or Anabat Z-CAIM units (anabats); and
- Harp traps.

i. Anabats

Anabats were used at several sites to record calls of microbats that could fly through or potentially roost or forage in different woodland habitats within the Study Area. Anabats were located in potential roosting sites (eg live hollow-bearing trees) or in potential flyways. The Anabat units were set out prior to dusk and left out for the entire evening. During adverse weather conditions, the recorders were either placed under protective covers to shield against rain or collected, depending on weather conditions. Any calls recorded were analysed by Lesryk Environmental Pty Ltd consultants using Anabat 6.3 computer software.

ii. Harp Trapping

Two Austbat harp traps were set up across gaps in vegetation (primarily vehicle tracks that had a low canopy cover) considered suitable microbat flyways. Traps were generally left in place for four nights and checked each morning, with any captured bats being held in a cloth bag till they could be released on dusk. If there were no captures by the completion of the second survey evening, the trap was relocated under the assumption that the initial location was not used as a flyway.

Trapping was not conducted by OzArk within the Jilliby SCA as these areas are very similar to those within the Wyong State Forest which had recently been studied (OzArk 2012).

4.5.6 Bird Surveys

Dedicated bird searches were conducted each morning along linear transects in all vegetation types. Visual observation and call identification of diurnal birds was carried out during each survey period which lasted from around 20 per person minutes to one person hour. Targeted bird watching was undertaken near any habitat trees to identify possible nesting or roosting areas.

The bird surveys were supplemented by recording bird calls using a Wildlife Acoustics SM2 Song Meter. The unit was placed at one location, left operating for a minimum period of four nights and set to record calls during two scheduled intervals, from 10.00pm to 12.00am; and 2am to 6am. The early morning period was reduced to recording from 2am – 4am as the latter portion of this interval coincided with the dawn chorus, thereby recording a large number of those birds detected during the bird surveys. Calls were analysed by OzArk using Cornell Laboratory of Ornithology's program "Raven Lite 1.0TM".

Additionally any incidental observations or records of birds made whilst traversing the site or conducting additional surveys were noted.

4.5.7 Herpetofauna Survey

Diurnal and nocturnal searches for reptiles and frogs were undertaken and involved lifting and looking underneath rocks, logs, ground debris, under exfoliated bark and in crevices/caves/overhangs. The herpetofauna searches lasted for a minimum period of 20 person minutes. Any reptiles or amphibians captured were identified and released at their point of capture.

4.5.8 Frog Surveys

Frog surveys were conducted during early summer, at a time when most species are likely to be detected as they are either calling or are active. The Study Area experienced rainfall before and during the surveys which is likely to have increased the chances of detecting frog species.

Initial surveys, consisting of day visits to wetlands, dams and creeks in the Study Area, were conducted to assess potential areas of habitat for threatened frog species as well as to familiarise surveyors with the terrain. Subsequent targeted frog surveys, involving active habitat searches, conducting call playback and recording frog calls, were conducted during the night. Inaccessible areas, such as wetlands on private land, were surveyed by recording calls and call playback only. Recordings of the mating call of the Wallum Froglet (*Crinia tinnula*) were broadcast using a small, portable amplifier for eight minutes. A listening period of about five minutes followed each playback session.

In accessible areas, frog surveys were supplemented by tadpole surveys. Tadpoles were caught using a long-handled dip net, transferred to a clear, plastic container along with some of the pond water, identified using Anstis (2002) and returned to the site of capture. If tadpoles could be immediately identified, they were recorded and released. Tadpoles too small to be identified were returned to the ponds without being identified.

4.6 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are defined as those that rely in some part for their survival on groundwater. Dependence ranges from complete reliance for some systems to others that rely partially on groundwater, particularly during times of drought (Hatton and Evans 1998).

Four main types of GDEs occur (Hatton and Evans 1998), as described below:

- Terrestrial vegetation – may depend on diffuse discharges of shallow groundwater to varying degrees, either to sustain transpiration and growth through a dry season or to maintain perennially lush ecosystems in otherwise arid environments;
- Wetland ecosystems – may depend on groundwater to keep them seasonally waterlogged or flooded;
- River baseflow systems – many river reaches have a baseflow component of groundwater discharge. This groundwater component may be vital to the character and composition of in-stream and near-stream ecosystems; and
- Aquifer and cave ecosystems – the biology of karst or limestone caves, particularly microorganisms and invertebrates, are heavily dependent on groundwater availability.

Of these GDEs, only the aquifer and cave ecosystems lack the potential to occur within the Study Area.

In the absence of data from detailed studies, such as stable isotope analysis and bore holes, assessment of ecosystems as groundwater dependent is generally based on the presence of particular species that are known to occur in riverine and wetland environments that are likely to contain a component of groundwater.

Cumberland Ecology conducted a desktop assessment of the vegetation communities in the Study Area utilising existing data on vegetation communities, location and topography. Potential GDEs were identified on the basis of the presence of species such as *Eucalyptus resinifera* (Red Mahogany), *Eucalyptus robusta* (Swamp Mahogany) and several *Melaleuca* species such as *M. decora*, *M. linariifolia* (Flax-leaved Paperbark) and *M. nodosa* (Prickly-leaved Paperbark). This is because floodplain and creekline communities dominated by such canopy and mid-storey species are generally found in areas that have surface expression of groundwater.

Cumberland Ecology then conducted field inspections in August 2012 to ground truth the condition of the existing environment that these vegetation communities were located in.

Chapter 5

Results

This chapter presents the results of the desktop and field investigations completed in the Study Area. It also discusses the results with respect to findings from surveys conducted in the locality to provide a comprehensive overview of flora and fauna biodiversity of the Study Area.

5.1 Desktop Assessments

5.1.1 Database Searches

The Protected Matters Search Tool and Atlas of NSW Wildlife databases indicate that 81 TSC and/or EPBC listed threatened species and communities occur or have potential to occur in the locality. This includes one TSC Act threatened flora population, 20 threatened flora species and 60 threatened fauna species. A further 11 EPBC listed migratory species have been recorded or have the potential to occur in the locality. A detailed assessment of the likelihood of these species or communities occurring within the Project Boundary is provided in **Appendix B.**

The OEH has 37 KTPs listed under the TSC Act while SEWPaC has 19 KTPs listed under the EPBC Act. KTPs of direct relevance to the Project include:

- Land clearance (EPBC Act)
- Clearing of native vegetation (TSC Act);
- Alteration of habitat following subsidence due to longwall mining (TSC Act);
- Alteration of natural flow regimes or rivers and streams and their floodplains and wetlands (TSC Act);
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomyosis (TSC 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.

Assessment of potential impacts from these KTPs has been addressed in **Chapters 6 and 7** while mitigation, monitoring and offsetting measures have been addressed in **Chapter 8.**

5.1.2 Literature Review

Several studies, which partly or completely encompass the Project Boundary, have been conducted in the locality prior to the OzArk surveys. These studies have recorded several threatened species within or with potential to occur in the Study Area. The threatened and migratory species that were recorded within the Study Area and the immediate vicinity from previous surveys are listed in **Table 5.1**. Details of the studies during which the threatened species were recorded, as well as potential species for each study, is provided in **Appendix C.**

Table 5.1 TSC and EPBC Act listed threatened species recorded within the Study area during previous surveys

Scientific Name	Common Name	TSC status	EPBC status	Location
Plants				
Angophora inopina	Charmhaven Apple	V	V	Tooheys Road Site, Hue Hue Road offset area
Melaleuca biconvexa	Biconvex Paperbark	V	V	Extraction Area
Tetratheca juncea	Black-eyed Susan	V	V	Tooheys Road Site, Hue Hue Road offset area, Extraction Area
Amphibia				
Crinia tinnula	Wallum Froglet	V		Tooheys Road Site, Hue Hue Road offset area
Litoria aurea	Green and Golden Bell Frog	E	V	Extraction Area
Litoria brevipalmata	Green-thighed Frog	V		Extraction Area
Mixophyes iterates	Giant Barred Frog	E1	E	Extraction Area
Aves				
Ardea ibis	Cattle Egret		M, C, J	Extraction Area
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Tooheys Road Site
Daphoenositta chrysoptera	Varied Sittella	V		Tooheys Road Site, Hue Hue Road offset area
Ephippiorhynchus asiaticus	Black-necked Stork	E1		Tooheys Road Site, Extraction Area
Epthianura albifrons	White-fronted Chat	V		Tooheys Road Site
Gallinago hardwickii	Latham's Snipe		M,C,J,K	Extraction Area
Glossopsitta pusilla	Little Lorikeet	V		Extraction Area
Hieraaetus morphnoides	Little Eagle	V		Hue Hue Road offset area
Ixobrychus flavicollis	Black Bittern	V		Extraction Area

Table 5.1 TSC and EPBC Act listed threatened species recorded within the Study area during previous surveys

Scientific Name	Common Name	TSC status	EPBC status	Location
Limosa limosa	Black-tailed Godwit	V	M, C, J, K	Tooheys Road Site
Ninox strenua	Powerful Owl	V		Tooheys Road Site
Plegadis falcinellus	Glossy Ibis		M, C	Tooheys Road Site
Rhipidura rufifrons	Rufous Fantail		M	Tooheys Road Site, Hue Hue Road offset area, Extraction Area
Tyto novaehollandiae	Masked Owl	V		Tooheys Road Site, Hue Hue Road offset area, Extraction Area
Tyto tenebricosa	Sooty Owl	V		Extraction Area
Mammalia				
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Subsidence Impact Limit
Falsistrellus tasmaniensis	Eastern false pipistrelle	V		Tooheys Road Site
Miniopterus australis	Little Bentwing Bat	V		Tooheys Road area, Hue Hue Road offset area
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		Tooheys Road Site
Mormopterus norfolkensis	East-coast Freetail Bat	V		Extraction Area
Myotis macropus	Southern Myotis	V		Tooheys Road Site, Extraction Area
Petaurus australis	Yellow-bellied glider	V		Tooheys Road Site, Hue Hue Road offset area, Extraction Area
Petaurus norfolcensis	Squirrel Glider	V		Tooheys Road Site, Hue Hue Road offset area, Extraction Area
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		Tooheys Road Site, Hue Hue Road offset area
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Tooheys Road Site, Hue Hue Road offset area

Key: E = Endangered; V = Vulnerable, M – Migratory, C – CAMBA, J – JAMBA, K – ROKAMBA.

5.2 Vegetation Communities of the Study Area

5.2.1 Vegetation Community Nomenclature

Vegetation community nomenclature can vary depending on the scale and origin of the mapping, and it is common for the same vegetation community to be known by several different names. The relevant vegetation nomenclature for this Project includes:

- BioMetric Vegetation Types;
- Vegetation Communities of the Wyong LGA as described by Bell (2002b);
- Definitions of EEC listed under the TSC Act/EPBC Act; and
- Vegetation Classes mapped by Keith (2004).

The vegetation communities recorded in the Study Area have been described as per the Biometric nomenclature (Gibbons et al. 2008) in this report. **Table 5.2** below aligns each Biometric community with the equivalent local (Wyong LGA) vegetation community, TSC Act listed EECs if applicable, and other relevant nomenclature. Local equivalents have been included to ensure recognition of recognised local vegetation patterns, as these do not always easily translate into the broader Biometric vegetation types.

The condition of the various vegetation communities was assessed using the *Biobanking* guidelines for assessment of moderate to good condition or low condition vegetation. Based on these guidelines, the woody native vegetation communities within the Study Area are predominantly in moderate to good condition although scattered patches near residential areas could be considered low condition due to the lack of a native understorey. The majority of the grassland areas present within the Study Area consist of exotic pasture and agricultural lands and are considered to be comprised of low quality vegetation. However, some moderate to good quality patches of DNG occur in some areas of the Tooheys Road Site and Hue Hue Road Offset Site (**see Figure 5.1**). Condition assessments of the individual vegetation communities are provided within the descriptions provided in following sections.

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Blackbutt - Turpentine open forest of the foothills of the North Coast	Alluvial Riparian Blackbutt Forest	43a	River Flat Eucalypt Forest on Coastal Floodplains	Wet Sclerophyll Forests	North Coast Wet Sclerophyll Forests	n/a	n/a
Blackbutt - Turpentine open forest of the foothills of the North Coast	Alluvial Riparian Blackbutt Forest (canopy only)	43aXr	River Flat Eucalypt Forest on Coastal Floodplains	Wet Sclerophyll Forests	North Coast Wet Sclerophyll Forests	n/a	n/a
Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin	Riverine Alluvial Gallery Rainforest-Moist Forest	40	Lowland Rainforest	Rainforests	Northern Warm Temperate Rainforests/ Subtropical Rainforests	Alluvial Tall Moist Forest	6
Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin	Narrabeen Warm Temperate-Subtropical Rainforest	42	Lowland Rainforest	Rainforests	Northern Warm Temperate Rainforests/ Subtropical Rainforests	Coastal Warm Temperate - Subtropical Rainforest	1a

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	Coastal Ranges Moist Layered Forest	35	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Hunter Range Grey Gum Forest	21
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	Coastal Ranges Moist Layered Forest	35	not currently listed	Wet Sclerophyll Forests	North Coast Wet Sclerophyll Forests	Coastal Wet Gully Forest	1
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	Narrabeen Alluvial Drainage Line Complex (Melaleuca thicket variant)	26e	Swamp Sclerophyll Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Riparian Melaleuca Swamp Woodland	42

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	Narrabeen Alluvial Drainage Line Complex (Melaleuca thicket variant) (regrowth)	26eXs	Swamp Sclerophyll Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Riparian Melaleuca Swamp Woodland	42
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin	Freshwater Wetlands	14	Freshwater Wetlands on Coastal Floodplains	Coastal Freshwater Lagoons		n/a	n/a
Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin	Alluvial Footslopes Redgum Forest	15	River Flat Eucalypt Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	n/a	n/a
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Doyalson Coastal Woodland	31	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Doyalson Coastal Woodland (canopy only)	31Xr	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Doyalson Coastal Woodland (regrowth)	31Xs	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Doyalson Coastal Woodland (frequent fire variation)	31a	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Doyalson Coastal Woodland (Black She-oak variation)	31c	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Doyalson Coastal Woodland (moist heath variant)	31d	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Narrabeen Snappy Gum Forest	32	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Scribbly Gum Woodland	31
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Narrabeen Buttonderry Footslopes Forest	28	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Smooth-barked Apple Woodland	30
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Narrabeen Buttonderry Footslopes Forest (canopy only)	28Xr	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Smooth-barked Apple	30

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
						Woodland	
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Narrabeen Buttonderry Footslopes Forest (regrowth)	28Xs	not currently listed	Dry Sclerophyll Forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Plains Smooth-barked Apple Woodland	30
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin	Narrabeen Dooralong Spotted Gum-Ironbark Forest	30	Lower Hunter Spotted Gum-Ironbark Forest	Dry Sclerophyll Forests	Hunter-Macleay Dry Sclerophyll Forests	Lower Hunter Spotted Gum - Ironbark Forest	17
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin	Narrabeen Dooralong Spotted Gum-Ironbark Forest (canopy only)	30Xr	Lower Hunter Spotted Gum-Ironbark Forest	Dry Sclerophyll Forests	Hunter-Macleay Dry Sclerophyll Forests	Lower Hunter Spotted Gum - Ironbark Forest	17

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	Narrabeen Dooralong Spotted Gum-Ironbark Forest	30	not currently listed	Dry Sclerophyll Forests	Hunter-Macleay Dry Sclerophyll Forests	Coastal Foothills Spotted Gum - Ironbark Forest	15
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	Coastal Ranges Moist Layered Forest	35	not currently listed	Wet Sclerophyll Forests	Northern Hinterland Wet Sclerophyll Forests	Coastal Ranges Open Forest	9
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Alluvial Floodplain Shrub Swamp Forest	20a	Swamp Sclerophyll Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Swamp Mahogany - Paperbark Swamp Forest	37

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Alluvial Floodplain Shrub Swamp Forest (regrowth)	20aXs	Swamp Sclerophyll Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Swamp Mahogany - Paperbark Swamp Forest	37
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Alluvial Floodplain Shrub Swamp Forest (sedge-scrub variant)	20f	Swamp Sclerophyll Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Swamp Mahogany - Paperbark Swamp Forest	37
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Narrabeen Alluvial Drainage Line Complex (shallow drainage line variant)	26b	River Flat Eucalypt Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Riparian Melaleuca Swamp Woodland	42

Table 5.2 Comparison of Vegetation Community names

BIOMETRIC	LGA (WYONG COMM)	LGA (WYONG UNIT)	NSW EEC	KEITH FORMATION	KEITH CLASS	REGION (REMS COMM)	REGION (REMS UNIT)
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Narrabeen Alluvial Drainage Line Complex (sedge woodland variant)	26d	River Flat Eucalypt Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Riparian Melaleuca Swamp Woodland	42
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Narrabeen Alluvial Drainage Line Complex (sedge woodland variant) (canopy only)	26dXr	River Flat Eucalypt Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	Riparian Melaleuca Swamp Woodland	42
Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin	Alluvial Woollybutt-Melaleuca Sedge Forest	19	Swamp Sclerophyll Forest on Coastal Floodplains	Forested Wetlands	Coastal Swamp Forests	n/a	n/a

5.2.2 Vegetation Communities Recorded from the Study Area

The major vegetation communities that occur within the Study Area and their distribution are shown in **Figures 5.1 and 5.2**. 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) and results from ground-truthing by OzArk and Cumberland Ecology.

Many of the vegetation communities in the Study Area conform to communities that are listed as EECs under the TSC Act. Recorded TSC Act listed EECs are:

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

No EPBC Act listed EECs were recorded in the Study Area.

A description of each of the vegetation communities that have been mapped within the Study Area is provided below. General structural and floristic details and community extent are based predominantly on existing community information as provided by Bell (2002b) and the regional work of NSW NPWS (2000b). Community descriptions are further supplemented with results of quadrat surveys and assessments undertaken within each community in the Study Area.

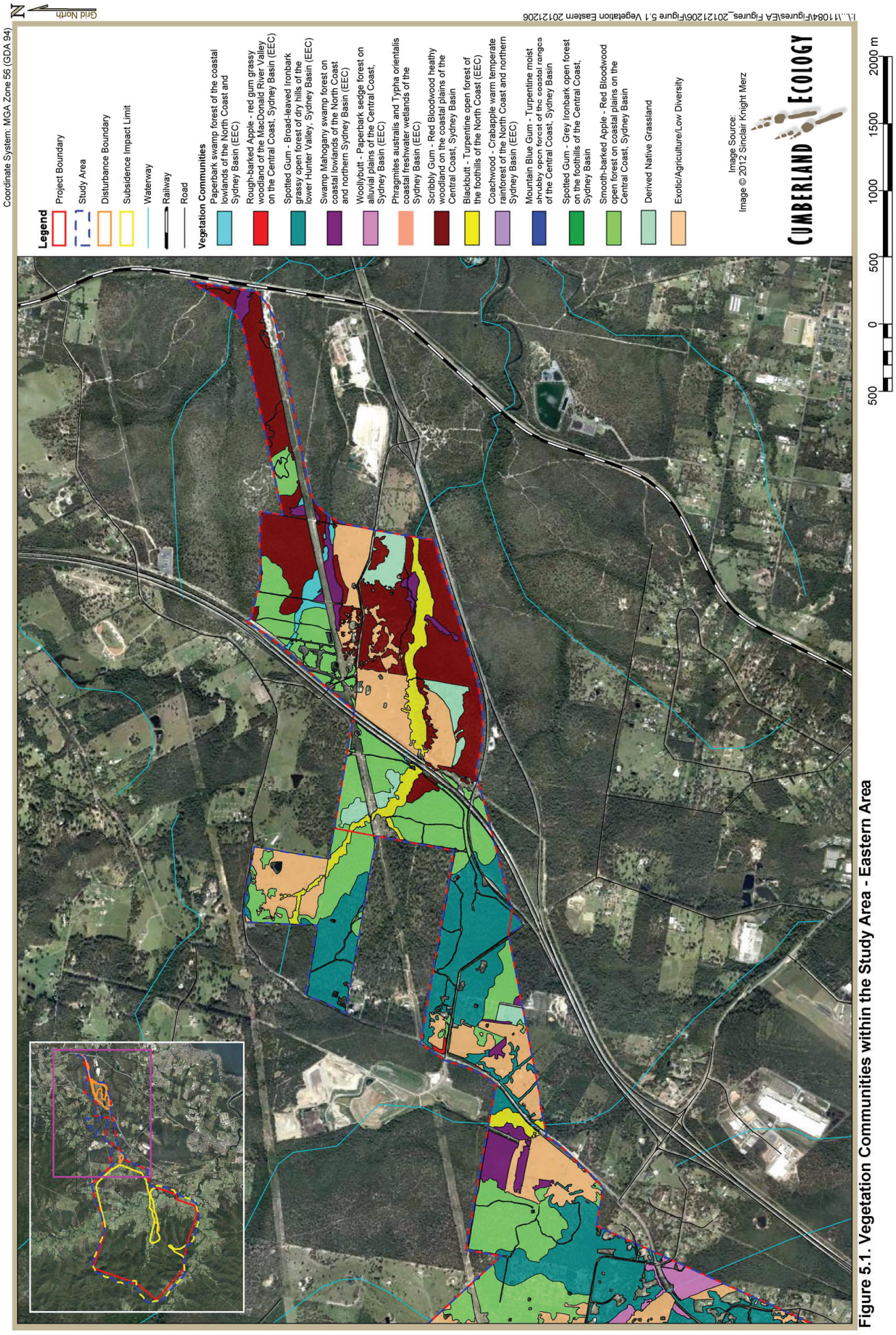

Figure 5.1. Vegetation Communities within the Study Area - Eastern Area

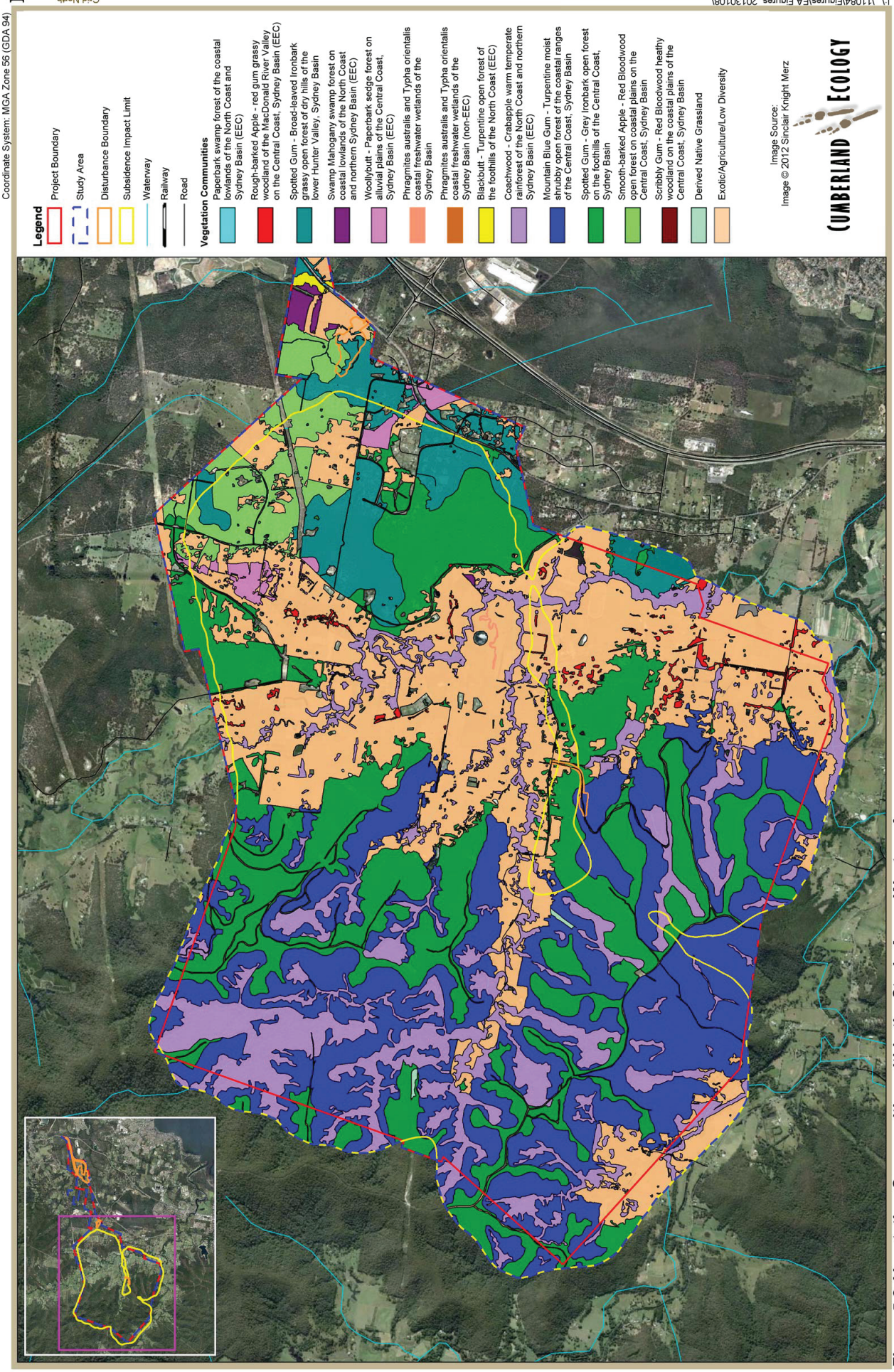

Figure 5.2. Vegetation Communities within the Study Area - Western Area

5.2.3 Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin



Photograph 5.1 **Rough-barked Apple – Red Gum grassy woodland at the Hue Hue Road Offset Site.**

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 24.6 ha

Rough-barked Apple – Red Gum grassy woodland occurs as a small area of remnant vegetation at the corner of Kiar Ridge Road and Hue Hue Road. Although partially cleared and currently utilised as a horse paddock, this stand still retains important diagnostic elements.

The canopy is dominated by *Eucalyptus tereticornis* (Red Gum), *Eucalyptus resinifera* (Red Mahogany) and *Angophora floribunda* (Rough-barked Apple) with scattered individuals of *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus capitellata* (Brown Stringybark) and *Corymbia maculata* (Spotted Gum). The mid-story is composed mainly of *Melaleuca decora, M. sieberi M. linariifolia* (Snow in Summer) and *M. nodosa* (Prickly-leaved Paperbark). The understorey is dominated by exotic grasses, such as *Axonopus fissifolius* (Narrow leaved Carpet grass) with scattered native species such as *Leptospermum juniperinum* and *Gahnia* species.

Previous vegetation mapping by Bell (2002b) also found scattered remnant stands of this community in predominantly disturbed areas within the Extraction Area, east of the Wyong State Forest. The locations of some of these remnants were verified by Cumberland Ecology during drive by surveys but the stands could not be surveyed in detail due to access restrictions.

Within Wyong LGA, Rough-barked Apple – Red Gum grassy woodland is highly restricted and has suffered from fragmentation and clearing, with estimates of 86% loss having been made (as Alluvial Footslopes Redgum Forest, Bell 2002b). Within the regional NPWS classification (NSW NPWS 2000b), this community falls into the Wyong Paperbark Swamp Forest, and is considered part of the River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (RFEFCF).

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



Photograph 5.2 **Scribbly Gum – Red Bloodwood woodland (Black She-Oak variant) at the Tooheys Road Site.**

Status: Not listed under the TSC Act or EPBC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 108.4 ha

This community occurs predominantly in the Tooheys Road Site, with a small area occurring in the Hue Hue Road offset site. It is widespread in the locality, with 4,250 ha mapped as Coastal Plains Scribbly Gum Woodland (NSW NPWS 2000B) in the region. Over 3,100 ha of this community, mapped as Narrabeen Doyalson Coastal Woodland (Bell 2002b) is present in the Wyong LGA.

Scribbly Gum - Red Bloodwood heathy woodland is characterised by a canopy of *Eucalyptus haemastoma* (Scribbly Gum), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus capitellata* (Brown Stringybark), with occasional occurrences of *Angophora costata* (Smooth-baked Apple) and *Banksia serrata* (Old-man Banksia). The understorey includes *Lambertia formosa* (Mountain Devil), *Hakea laevipes* subsp. *laevipes, Persoonia linearis* (Narrow-leaved Geebung), *Bossiaea heterophylla* (Variable Bossiaea), *Leptospermum trinervium* (Flaky-barked Tea-tree), *Epacris pulchella* (Wallum Heath), *Pimelia linifolia* subsp. *linifolia* (Slender Rice Flower), *Isopogon anemonifolius* (Broad-leaved Drumstick), *Tetratheca juncea* (Black-eyed Susan; Vulnerable under the EPBC Act and TSC Act), *Hibbertia vestita* (Hairy Guinea Flower), *Pultenaea paleceae* (Chaffy Bush-pea), *Ptilothrix deusta , Melichrus procumbens* (Jam Tarts), *Aristida warburgii, Entolasia stricta* (Wiry Panic), and *Xanthorrhoea latifolia* subsp. *latifolia*. *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 patches of this vegetation within the Tooheys Road site (impact and offset areas) are characterised by a modified understorey but are still considered to be in moderate to good condition as per the *Biobanking* guidelines. These patches are generally adjacent to the grassland areas within the Tooheys Road site. Areas of grassland adjacent to Scribbly – Gum woodland areas vary in condition from Derived Native Grassland to Exotic pasture and are described in further detail in **Section 5.2.15**.

The Wyong LGA equivalent of this Biometric community also has a number of local variants. These include:

- Frequent fire (MU31a of Bell 2002b) – This variant, originates following frequent fires which cause localised extinctions of sensitive species and promote graminoid growth, and thus has a higher proportion of grasses and graminoids in the ground layer vegetation. Woody shrubs such as *Banksia spinulosa* var. *collina, Hakea laevipes* subsp. *laevipes* and *Lambertia formosa* have a sporadic occurrence.

- Black She-oak (MU31c of Bell 2002b) – 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. The rapidly growing *Allocasuarina* often forms monospecific stands in these situations, with little understorey vegetation present apart from grasses such as *Microlaena stipoides* var. *stipoides* (weeping Meadow Grass), and the herbs *Pratia purpurascens* (Whiteroot), *Goodenia hederaceae* (Forest Goodenia) and *Dichondra repens* (Kidney Weed). This variant occurs only in the Tooheys Road property, partially on the site of the proposed storage dam and coal stockpile.

- Moist heath (MU31d of Bell 2002b) - This variant is known only from the Wallarah Creek area, and is similar to its parent community except for a greater proportion of sedges (*Lepyrodia scariosa, Leptocarpus tenax*) and other moisture loving shrubs (e.g. *Hakea teretifolia* (Dagger Hakea), *Banksia oblongifolia* (Fern-leaved Banksia), *Melaleuca sieberi*) in the understorey. In addition, this area supports often mallee-form and stunted threatened *Angophora inopina*. This variant has been mapped only for the southern area of the Tooheys Road portion, where the proposed rail loop and waste water dam occur.

- Snappy Gum (MU32 of Bell 2002a) – This vegetation community is described as a separate unit within Wyong LGA, and occurs in close proximity to the parent community in the northern parts of the Shire. *Eucalyptus racemosa* (Snappy Gum) is normally present as a characteristic component of the canopy, with other species such as *Angophora costata, Corymbia gummifera*, and *Eucalyptus capitellata* co-dominating. Understorey vegetation comprises a relatively dense shrub layer of *Acacia longifolia* (White Wattle), *Dodonaea triquetra* (Large-leaf Hop Bush), *Acacia myrtifolia* (Myrtle Wattle), *Banksia spinulosa* (Candlestick Banksia), *Allocasuarina littoralis, Pultenaea paleacea, Pteridium esculentum* (Bracken Fern), *Pimelea linifolia*, and *Persoonia levis* (Broad-leaved Geebung). Grasses such as *Themeda australis* (Kangaroo Grass) and *Entolasia stricta* are important components of the ground layer, together with *Dianella caerulea* (Blue Flax-lily), *Lomandra obliqua*, and *Lindsaea linearis* (Screw Fern). A single occurrence of this variant is present on Darkinjung land adjacent to the Main Northern Railway adjacent to the Tooheys Road Site.

5.2.5 Blackbutt - Turpentine open forest of the foothills of the North Coast



Photograph 5.3 Blackbutt open forest in the Tooheys Road Site.

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 23.7 ha

The Wyong LGA community, Alluvial Riparian Blackbutt Forest, supports vegetation that can only be accommodated within Blackbutt – Turpentine open forest community of the Biometric classification. This is not an ideal match, but is the most appropriate given the dominant trees present. This community is present along the bulk of Buttonderry Creek, including where it passes through the Study Area on the Tooheys Road, Buttonderry and Hue Hue Road properties.

Canopy species include *Eucalyptus pilularis* (Blackbutt), *Corymbia maculata* (Spotted Gum), *Syncarpia glomulifera* (Turpentine) and, in some places, *Eucalyptus saligna* (Sydney Blue Gum) with a well developed sub-canopy of *Melaleuca linariifolia* (Flax-leaved Paperbark). Buttonderry Site also has a well developed sub-canopy of *Melaleuca biconvexa* (Biconvex Paperbark) a listed Vulnerable species under the EPBC and TSC Acts. A variety of sedges and herbs occur in the understorey with *Gahnia clarkei* (Tall Saw-sedge) being the prominent species. Some areas, predominantly around the borders with adjacent grassland at both the Tooheys Road Site and Hue Hue Road Offset Area are characterised by the presence of only the canopy species.

This vegetation type occupies a limited habitat niche, mainly along major creek lines on the Wyong sub-coastal plain. Narrow bands of Blackbutt, Turpentine and Spotted Gum are generally restricted to Wyong LGA, with only 237 ha extant being mapped in Bell (2002b). While the Biometric community, Blackbutt-Turpentine, is not associated with any State listed Endangered Ecological Community (EEC), due to the limited distribution and regional significance of this local vegetation community, a conservative approach has been taken and this community has been included within the River Flat Eucalypt Forest on Coastal Floodplains EEC.

5.2.6 Coachwood – Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin



Photograph 5.4 Coachwood – Crabapple rainforest in the Extraction Area.

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 525.8 ha

Coachwood - Crabapple rainforest is found only within the Extraction Area of the Project Boundary. The community was not studied in detail throughout its full extent during Cumberland Ecology or OzArk surveys due to access restrictions. Vegetation mapping by Bell (2002b) was verified by Cumberland Ecology from visual observations of walking surveys along the eastern border of Honeysuckle Park, field reconnaissance trekking of the lower section of Little Jilliby Jilliby Creek in the Wyong SF/Jilliby SCA and drive by surveys from public roads where possible. Definitions for this community have been limited to descriptions in the Wyong LGA vegetation mapping by Bell (2002b).

This vegetation occurs predominantly in sheltered hilly terrain in the Extraction Area. Vegetation along the eastern edges of Honeysuckle Park retains diagnostic canopy species but has a disturbed understorey. The area is characterised by alluvial soils which provide adequate moisture retention. This community occurs as two variants MU40 - Riverine Alluvial Gallery Rainforest-Moist Forest (Alluvial soil variant) and MU42 - Narrabeen Warm Temperate-Subtropical Rainforest (sheltered gully variant) (Bell 2002b).

Descriptions of these variants, as per Bell (2002b) are provided below:

- Alluvial soil (MU40 of Bell 2002b) – The deeper alluvial soils along the Wyong River and its tributaries support remnants of a rich, moist forest with a diverse composition of rainforest species. Typical emergent species include *Eucalyptus saligna* (Sydney Blue Gum), *Syncarpia glomulifera* (Turpentine) and occasionally *Eucalyptus deanei* (Mountain Blue Gum), over a smaller tree layer of species such as *Acmena smithii* (Lilly Pilly), *Alphitonia excelsa* (Red Ash), *Cryptocarya glaucescens* (Jackwood), *Cryptocarya microneura* (Murrogun), *Alectryon subcinereus* (Native Quince), *Guioa semiglauca* (Guioa), *Choricarpa leptopetala* (Brown Myrtle), *Melicope micrococca* (White Euodia), *Daphnandra sp. A, Ehretia acuminata* (Koda), *Symplocos stawellii* (Buff Hazelwood), *Symplocos thwaitesii* (Buff Hazelwood), *Glochidion ferdinandi var. Ferdinandi* (Cheese Tree), *Wilkea huegeliana* (Wilkiea), *Acacia irrorata subsp. Irrorata* (Green Wattle), *Archontophoenix cunninghamiana* (Bangalow Palm), *Endiandra discolor* (Rose Walnut), and *Stenocarpus salignus* (Scrub Beefwood). Understorey vegetation is usually sparse, but the climbers *Morinda jasminoides, Dioscorea transversa* (Native Yam), *Cissus antarctica* (Native Grape), and *Geitonoplesium cymosum* (Scrambling Lily) are normally present. Regionally, NPWS (2000) have identified this vegetation type as a specific form of their Coastal Wet Gully Forest. Much of the remaining examples of this variant are weed infested and restricted to the immediate river channels.

- Sheltered gully (MU42 of Bell 2002b) - the sheltered gullies in the west of the Study Area support rainforest vegetation that is largely warm temperate but with subtropical influences also occurring. These influences are generally in the form of epiphytic species (e.g.: *Arthropteris tenella, Microsorum pustulatum (*Kangaroo Fern), *Hymenophyllum australe, Asplenium australasicum forma australasicum* (Birds Nest Fern), *Microsorum scandens* (Fragrant Fern), *Platycerium bifurcatum var. bifurcatum* (Elkhorn), *Pyrrosia rupestris* (Rock Felt Fern), *Hymenophyllum cupressiform* (Common Filmy Fern), *Plectorrhiza tridentata* (Tangle Orchid), *Sarcochilus olivaceus* (Green Tree Orchid), *Bulbophyllum exiguum, Dendrobium tetragonum* (Tree Spider Orchid), tree ferns (*Cyathea leichhardtiana* (Prickly Treefern), *Cyathea australis* (Rough Tree-fern), *Cyathea cooperi* (Straw Treefern) and palms (*Archontophoenix cunninghamiana (*Bangalow Palm*), Livistona australis* (Cabbage Tree Palm)). A variety of tree species co-dominate these rainforests, although the more typical ones include *Acmena smithii* (Lillypilly), *Doryphora sassafras* (Sassafras*), Cryptocarya glaucescens* (Jackwood), *Ceratopetalum apetalum* (Coachwood), *Eucalyptus saligna* (Sydney Blue Gum), *Alphitonia excelsa* (Red Ash), *Syncarpia glomulifera* (Turpentine), *Guioa semiglauca* (Guioa), *Neolitsea dealbata* (White Bolly Gum), *Synoum glandulosum* (Scentless Rosewood), *Sloanea australis* (Maidens Blush), *Syzygium oleosum* (Blue lillypilly), *Wilkea huegeliana* (Wilkiea), *Caldcluvia paniculosa* (Soft Corkwood), *Polyosma cunninghamii* (Featherwood), *Dysoxylon rufum* (Hairy Rosewood), and *Syzygium australe* (Brush Cherry). Understorey vegetation is typically sparse although ferns and climbers are normally prominent.

Coachwood - Crabapple rainforest has a restricted distribution within the Wyong LGA. While the Biometric community, Coachwood - Crabapple, is not associated with any state listed EEC, due to the restricted distribution of this local vegetation community, a conservative approach has been taken and this community has been included within the Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions.

5.2.7 Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin



Photograph 5.5 **Mountain Blue Gum forest in the Western Ventilation Shaft Area (Extraction Area).**

Status: Not listed under the EPBC Act or TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 983.2 ha

Mountain Blue Gum – Turpentine moist shrubby open forest is found on sheltered slopes and in gullies in the hilly western sections of the Extraction Area, including a small area occurring within the Western Ventilation Shaft Area.

The community within the Western Ventilation Shaft area is characteristed by a canopy of *Eucalyptus deanei* (Mountain Blue Gum) and *Syncarpia glomulifera* (Turpentine) with scattered individuals of *Eucalyptus acmenoides* (White Mahogany) over a midstory canopy consisting of mainly of *Choricarpia leptopetala* (Brown Myrtle). The understorey consists of shrubs such as *Breynia oblongifolia* (Coffee Bush), *Glochidion ferdinandi* (Cheese Tree) and *Pittosporum spinescens* (Wallaby Apple) and ferns such as *Adiantum aethiopicum* (Common Maidenhair), *Adiantum hispidulum* (Rough Maidenhair) and *Pellaea paradoxa.* Dominant climbers include *Smilax australis* (Barbwire Vine), *Cissus hypoglauca* (Water Vine) and *Morinda jasminoides* (Sweet Morinda).

Large areas mapped as Mountain Blue Gum could not be surveyed in detail by Cumberland Ecology or OzArk (OzArk 2012) due to access restrictions and definitions for this community within the wider Extraction Area are based on the descriptions in the Wyong LGA vegetation mapping by Bell (2002b).

The equivalent Wyong LGA community has been mapped by Bell (2002b) as Coastal Range Moist Layered Forest. This community occurs on both moist, sheltered gullies and exposed slopes and ridges with the canopy varying between sheltered and exposed areas. Only the moist/sheltered gully vegetation is considered to be equivalent to the *Biometric* Mountain Blue Gum – Turpentine community. The vegetation on the exposed slopes was subsequently reclassified as a variant of Narrabeen Dooralong Spotted Gum - Ironbark Forest (Bell 2012, *pers. comm*.) and is addressed below in **Section 5.2.12**.

Mountain Blue Gum – Turpentine areas consist of tall forests with a moist mesic understorey. Long term disturbance, mainly from forestry operations has resulted in simple shrub components and well developed herbaceous ground cover in many areas. Canopy species are highly variable, but those most consistent in moist areas include *Syncarpia glomulifera* subsp*. glomulifera* (Turpentine), *Allocasuarina torulosa* (Forest Oak), and *Eucalyptus acmenoides* (White Mahogany). Areas close to drainage lines consist of *Eucalyptus deanei* (Mountain Blue Gum) or *Eucalyptus saligna* (Sydney Blue Gum*)* while *Eucalyptus agglomerata* (Blue-leaved Stringybark) or *Angophora floribunda* (Rough-barked Apple) may occur on moister slopes.

Understorey species include the shrubs *Rhodamnia rubescens* (Brush Turpentine)*, Acacia schinoides, Glochidion ferdinandi* (Cheese Tree)*, Trochocarpa laurina* (Tree Heath)*, Synoum glandulosum* (Scentless Rosewood)*, Choricarpa leptopetala* (Brown Myrtle)*, Rapania variabilis, Breynia oblongifolia* (Coffee Bush)*, Polyscias sambuccifolia* (Elderberry Panax) and *Maytenus silvestris*, the grasses *Entolasia stricta* (Wiry Panic)*, Imperata cylindrical* (Blady Grass)*, Oplismenus imbecillus* and *Microlaena stipoides* var. *stipoides (*Weeping Rice Grass*)*, and the herbs *Pratia purpurascens (*Whiteroot)*, Pseuderanthemum variabile* (Pastel Flower)*, Desmodium varians* and *Viola hederacea* (Ivy-leaved Violet).

This vegetation community is widespread across the western half of the Wyong LGA, with the majority being contained in State Forests. This vegetation community is not considered to be equivalent to any State or Commonwealth listed EEC.

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



Photograph 5.6 **Paperbark swamp forest adjacent to a modified paddock in the Tooheys Road Site.**

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 5.1 ha

This vegetation community is limited to a small drainage line within the Tooheys Road Site and is located partially within a 7(g) zoned wetland of local significance under the Wyong LEP.

Detailed floristic surveys were not conducted for this community but mapping by Bell (2002b), which distinguished these stands as a variant (MU 26e) of the parent swamp forest complex (Narrabeen Alluvial Drainage Line Complex), was confirmed during meandering surveys by Cumberland Ecology.

The vegetation consists largely of young, regrowth vegetation composed mainly of thickets of *Melaleuca* species, predominantly *Melaleuca linariifolia (*Flax-leaved Paperbark*)*, under scattered emergents of *Angophora costata* (Smooth-barked Apple), *Eucalyptus resinifera* (Red Mahogany) and *Eucalyptus robusta*. The understorey consists primarily of *Gahnia* species There are indications that this community may have developed from within a wider *Eucalyptus robusta* (Swamp Mahogany) swamp forest in response to past agricultural clearing.

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.

5.2.9 Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin



Photograph 5.7 **Coastal freshwater wetlands within Honeysuckle Park (Extraction Area).**

Status: EEC listed under the TSC Act

Predominant Condition: Low condition

Area of Occupancy within Project Boundary: 1.2 ha

This community was recorded by Cumberland Ecology in a modified grassland/paddock area known as Honeysuckle Park within the Dooralong Valley section of the Extraction Area. Surrounding paddocks could not be assessed due to access restrictions but it is assumed that further patches of this community occur as scattered billabongs and farm dams in the Dooralong Valley floodplain.

The Freshwater Wetland surveyed was characterised by dense growth of *Azolla pinnata* on the water surface along with aquatic species such as *Persicaria strigosa* (Spotted Knotweed), *Triglochin procera* (Water ribbons), *Triglochin rheophilum, Ludwigia peploides* (Water Primrose) and *Spirodela* sp.. The banks are dominated by *Carex appressa*, *Juncus* continuus and *Cyperus eragrostis*.

This community conforms to the Freshwater Wetlands (MU16) mapped by Bell (2002) and is considered to be part of the Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC.

5.2.10 Smooth-barked Apple – Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin



Photograph 5.8 **Smooth-barked Apple – Red Bloodwood forest in the Hue Hue Road Offset Site.**

Status: Not listed under the TSC Act or EPBC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 229.9 ha

This community occurs in extensive stretches in the Tooheys Road and Buttonderry sites as well as the Hue Hue Road Offset area. Small patches also occur within the north-eastern parts of the Extraction Area.

Smooth-barked Apple – Red Bloodwood open forest within the Tooheys Road, Buttonderry and Hue Hue Offset sites is characterised by canopy species such as *Angophora costata* (Smooth-barked Apple), *Eucalyptus capitellata* (Brown Stringybark), *Corymbia gummifera* (Red Bloodwood), *Melaleuca decora,* and occasionally *Eucalyptus fibrosa* (Broad Leaved Ironbark).

Understorey vegetation typically includes species such as *Banksia spinulosa (*Hairpin Banksia*), Melaleuca nodosa* (Ball Honey Myrtle)*, Bossiaea obcordata* (Spiny Bossiaea)*, Daviesia squarrosa, Epacris pulchella* (NSW Coral Heath)*, Leptospermum trinervium* (Flaky-barked Tea-tree)*, Goodenia heterophylla* (Variable Leaved Goodenia)*, Lomandra obliqua* (Twisted Mat-rush)*, Themeda australis* (Kangaroo Grass)*,* and *Entolasia stricta* (Wiry Panic). In areas with more sandstone-based soils the local understorey composition more typically includes species such as *Banksia spinulosa* (Hairpin Banksia)*, Lomandra obliqua* (Twisted Mat-rush), *Grevillea sericea* (Pink Spider Flower), *Comesperma ericinum* (Matchheads). Some locations with evidence of past clearing support dense thickets of regrowth vegetation, predominantly *Allocasuarina littoralis* (Black She-oak),

Stands of this community within the Extraction Area occur largely along roadways and amongst developed residential areas and is largely characterised by canopy species only. The majority of the understorey for this community in the Extraction Area is either highly modified or has been cleared for grazing.

Smooth-barked Apple – Red Bloodwood is considered to be the equivalent of Narrabeen Buttonderry Footslopes Forest Wyong LGA community (Bell 2002b). This vegetation community is not considered to be equivalent to any State or Commonwealth listed EEC.

5.2.11 Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin



Photograph 5.9 **Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road Offset Site.**

Status: EEC listed under the TSC Act.

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 285.5 ha

This community occurs predominantly in the low lying lands in the eastern parts of the Study Area, mainly in the Hue Hue Road offset area and parts of the Buttonderry Site. Some scattered patches also occur in the eastern parts of the Extraction Area.

This community is an open forest dominated by *Corymbia maculata* (Spotted Gum) and Ironbarks, mainly *Eucalyptus fibrosa* (Broad-leaved Ironbark). The understorey is sparse and consists of shrubs such as *Daviesia ulicifolia* (Gorse Bitter Pea) and *Podolobium ilicifolium* (Prickly Shaggy Pea), and grasses such as *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Imperata cylindrica* var. *major* (Blady Grass), and *Microlaena stipoides* var. *stipoides* (Weeping Rice Grass). Several areas, predominantly within the Buttonderry site, have been impacted by clearing or under-scrubbing which has greatly reduced the understorey and groundcover, although canopy species still persist. These cleared and/or under-scrubbed areas also support dense thickets of *Melaleuca nodosa* (Ball Honey Myrtle).

Stands of this community within the Extraction Area occur largely along roadways and amongst developed residential areas. The vegetation in these areas is largely characterised by canopy species with a highly modified understorey, mostly garden species (see **Photo 5.10** below).



Photograph 5.10 **Modified Spotted Gum – Broadleaved Ironbark forest in residential areas within the Extraction Area.**

This community is equivalent to a variant of the Wyong LGA community Narrabeen Dooralong Spotted Gum-Ironbark Forest (Bell 2002b). Based on the ongoing work on the classification of communities dominated by Spotted Gum in the region, the Warnervale area in particular (Bell submitted), this community is considered to be part of the Lower Hunter Spotted Gum – Ironbark Forest EEC. Although areas within the Extraction Area have been highly modified, these areas are still considered to be part of the EEC.

5.2.12 Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin



Photograph 5.11 **Grey Ironbark forest in the Western Ventillation Shaft Area (Extraction Area).**

Status: Not listed

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 945.5 ha

Spotted Gum – Grey Ironbark Forest is predominantly found on exposed slopes and ridges in the hilly western sections of the Extraction Area, including a small stretch within the Western Ventilation Shaft Area. Further stands are present in the north to north-east boundary of the Subsidence Impact Limit (SIL) near Smith Street and to the east of Dickson Road, near the eastern boundary of the SIL.

The community within the Western Ventilation Shaft area is characteristed by a canopy of *Corymbia maculata* (Spotted Gum), *Eucalyptus paniculata* (Grey Ironbark) and *Eucalyptus acmenoides* (White Mahogany) over a midstory canopy consisting mainly of regenerating *Syncarpia glomulifera* (Turpentine) and *Allocasuarina torulosa* (Forest Oak). The understorey consists of shrubs such as *Breynia oblongifolia* (Coffee Bush), *Leucopogon juniperinus* (Prickly Beard-heath), *Persoonia linearis* (Narrow-leaved Geebung), *Daviesia ulicifolia* (Gorse Bitter Pea), *Daviesia squarrosa* and *Zieria smithii* (Sandfly Zieria). Ferns include species such as *Cheilanthes sieberi* (Poison Rock Fern) and *Pteridium esculentum* (Common Bracken) while grasses and sedges are dominated by *Entolasia stricta* (Wiry Panic), *Imperata cylindrica* (Blady Grass), *Microlaena stipoides* (Weeping Rice Grass) and *Lomandra multiflora* (Many-flowered Mat-rush).

Large areas mapped as Spotted Gum Grey Ironbark could not be surveyed in detail by Cumberland Ecology or OzArk (OzArk 2012) due to access restrictions and definitions for this community within the wider Extraction Area is based on descriptions in the Wyong LGA vegetation mapping by Bell (2002b).

The equivalent Wyong LGA community for this Biometric community was initially classed as a drier variant of the Wyong LGA vegetation unit Coastal Range Moist Layered Forest (Bell, 2002b), however this variant was subsequently reclassified in 2008 as a variant of Narrabeen Dooralong Spotted Gum-Ironbark Forest (Bell 2012*, pers. comm.*).

Spotted Gum – Grey Ironbark open forest is a moist forest characterised by canopy species such as *Corymbia maculata* (Spotted Gum)*, Eucalyptus propinqua* (Small Fruited Grey Gum)*, Eucalyptus umbra* (Broad-leaved White Mahogany)*, Eucalyptus siderophloia* (Northern Grey Ironbark)*, Eucalyptus paniculata* (Grey Ironbark)*, Allocasuarina torulosa* (Forest Oak) and *Syncarpia glomulifera* (Turpentine). The understorey includes species such as *Daviesia ulicifolia* (Gorse Bitter Pea)*, Persoonia linearis* (Narrow-leaved Geebung)*, Podolobium aciculiferum* (Needle Shaggy Pea)*, Maytenus silvestris, Breynia oblongifolia* (Coffee Bush), *Bursaria spinosa* (Blackthorn), *Podolobium ilicifolium* (Prickly Shaggy Pea)*, Polyscias sambuccifolia* (Elderberry Panax)*, Pratia purpurascens* (Whiteroot), *Goodenia heterophylla* (Variable Leaved Goodenia), *Vernonia cinerea, Pseuderanthemum variabile* (Pastel Flower)*, Cheilanthes sieberi* (Poison Rock Fern)*, Entolasia stricta* (Wiry Panic), *Themeda australis* (Kangaroo Grass), *Microlaena stipoides* var. *stipoides* (Weeping Rice Grass) and *Lomandra multiflora* subsp. *multiflora* (Many-flowered Mat-rush).

Stands of this community within the north-eastern (near Smith Street) and eastern parts (near Dickson Road) parts of the Extraction Area occur largely along roadways and amongst developed residential areas. The vegetation in these areas is largely characterised by canopy species with either a cleared/grazed understorey or a highly modified understorey, mostly garden species (**see Photograph 5.12**).

This vegetation community is widespread across the western half of the Wyong LGA, with the majority being contained in State Forests and the Jilliby SCA. This vegetation community is not considered to be equivalent to any State or Commonwealth listed EEC.



Photograph 5.12 **Modified Spotted Gum – Grey Ironbark forest near residential areas within the Extraction Area.**

5.2.13 Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin



Photograph 5.13 **Swamp Mahogany Swamp Forest along a creekline in the Tooheys Road Site.**

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 24.2 ha

Swamp Mahogany swamp forest predominantly occurs in two locations within the Study Area – Tooheys Road and Buttonderry sites.

The vegetation community at the Tooheys Road Site occurs along a broad drainage line and is mainly located within a 7(g) zoned wetland of local significance under the Wyong LEP.

This community supports vegetation dominated by the canopy species *Eucalyptus robusta* (Swamp Mahogany), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus resinifera* (Red Mahogany). The sub-canopy mainly consists of species such as *Melaleuca linariifolia* (Flax-leaved Paperbark) and *Melaleuca decora* along with a scattered shrub layer of *Leptospermum juniperinum* (Prickly Tea-tree), and juvenile *Melaleuca* and *Eucalyptus* species. The understorey is characterised by a dense layer of sedges *Gahnia clarkei* (Tall Saw-sedge), *Empodisma minus,* and grasses such as *Entolasia stricta* (Wiry Panic), *Hemarthia uncinata* (Matgrass), *Panicum simile* (Two Colour Panic).

Vegetation at the Buttonderry Site occurs in the north-eastern corner of the property and is dominated by the canopy species *Eucalyptus robusta* (Swamp Mahogany), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus tereticornis* (Forest Red Gum) with scattered individuals of *Angophora costata* (Smooth-barked Apple), *Eucalyptus capitellata* (Brown Stringybark) and *Eucalyptus resinifera* (Red Mahogany) near cleared areas of grassland. Sub-canopy species include *Melaleuca linariifolia, Melaleuca nodosa* and *Melaleuca sieberi*. The understorey is dominated by *Lomandra longifolia* (Spiky-headed Mat-rush) and various grasses such as *Dichelachne micrantha, Paspalidium distans* and *Themeda australis.* Areas subject to past light-to-moderate grazing pressure over the years are characteristed by regrowth vegetation.

Swamp Mahogany swamp forest community is considered the equivalent of two Wyong LGA vegetation units – Alluvial Floodplain Shrub Swamp Forest (MU 20) and Narrabeen Alluvial Drainage Line Complex (MU 26). Both local communities have locally recognised variants, depending on depth to water table, soil type and other factors. The main local variants include:

- Alluvial Floodplain Shrub Swamp Forest - Sedge-scrub (MU20f of Bell 2002b): This variant occurs in two small areas at Tooheys Road and supports low, scrubby heath vegetation. At this site, the low canopy is dominated by *Angophora inopina* (Charmhaven Apple), *Melaleuca sieberi,* and *Leptospermum trinervium* (Flaky-barked Tea-tree), over a sedge-dominated understorey. Although these areas show evidence of past clearing, the vegetation recovery has been good.

- Narrabeen Alluvial Drainage Line Complex - Shallow drainage line (MU26b of Bell 2002b): This variant occurs along Spring Creek at Tooheys Road and is characteristed by scattered *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus resinifera* (Red Mahogany) occur over a moderately dense understorey of *Acacia longifolia* (Sydney Golden Wattle), and various *Melaleuca* species. A small tributary of Wallarah Creek, south of the Tooheys Road is also characterised by this variant although *Eucalyptus robusta* (Swamp Mahogany) is absent.

- Narrabeen Alluvial Drainage Line Complex - Sedge-woodland (MU26d of Bell 2002b): This variant is characterised by a very undulated ground surface and occurs along broad, shallow drainage lines at Buttonderry and Tooheys Road. The canopy is dominated by *Angophora costata* (Smooth-barked Apple)*, Eucalyptus resinifera* (Red Mahogany)*, Melaleuca sieberi*, and *Melaleuca linariifolia* (Flax-leaved Paperbark) with the occassional *Eucalyptus robusta* (Swamp Mahogany). Ground layer vegetation includes *Banksia spinulosa* var. *collina* (Hairpin Banksia)*, Melaleuca thymifolia* (Thyme Honey Myrtle)*, Acacia longifolia* (Sydney Golden Wattle)*, Leprodia scariosa* (Scale Rush)*, Chorizandra cymbaria* (Heron Bristle Rush), *Hemarthria uncinata* var*. uncinata* (Matgrass)*, Schoenus brevifolius (*Bog-rush), *Entolasia stricta* (Wiry Panic), *Gahnia clarkei* (Tall Saw-sedge), *Leptospermum juniperinum* (Prickly Tea-tree), *Pseudoraphis paradoxa* (Slender Mudgrass)*, Empodisma minus, Deyeuxia quadriseta* (Reed Bent Grass)*, Plinthanthesis paradoxa,* and *Baumea teretifolia* (Wrinkle-nut Twig Rush).

Swamp Mahogany swamp forest is considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC.

5.2.14 Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin



Photograph 5.14 Woollybutt sedge forest in the Extraction Area.

Status: EEC listed under the TSC Act

Predominant Condition: Moderate to good

Area of Occupancy within Project Boundary: 34.8 ha

Woollybutt – Paperbark sedge forest is found only within the Extraction Area in the upper areas of Porters Wetland catchment. The community was not studied during Cumberland Ecology or OzArk surveys due to access restrictions (OzArk 2012). Vegetation mapping by Bell (2002b) was verified by Cumberland Ecology during drive by surveys from public roads where possible and definitions for this community have been limited to descriptions in the Wyong LGA vegetation mapping by Bell (2002b).

This community has been mapped as the Wyong LGA community Alluvial Woollybutt-Melaleuca Sedge Forest (MU19) (Bell 2002b). It is characterised by the presence of Woollybutt (Eucalyptus longifolia) and various Melaleuca species such as *Melaleuca decora, Melaleuca linariifolia* (Flax-leaved Paperbark), *Melaleuca nodosa* (Ball Honey Myrtle), *Melaleuca sieberi, Melaleuca ericifolia* (Swamp Paperbark), *Melaleuca thymifolia* (Thyme Honey Myrtle) in the canopy or shrub layer. Associated canopy species often include *Eucalyptus resinifera* (Red Mahogany), *Eucalyptus robusta* (Swamp Mahogany) or *Angophora costata* (Smooth-barked Apple).

The understorey predominantly consists of sedges such as *Gahnia clarkei* (Tall Saw-sedge), *Schoenus brevifolius* (Bog-rush), *Lepidosperma quadrangulatum, Juncus prismatocarpus* (Branching Rush) and *Chorizandra cymbaria* (Heron Bristle Rush).

Woollybutt – Paperbark sedge forest is considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

5.2.15 Grasslands



Photograph 5.15 Naturally regenerating DNG within the Tooheys Road site.



Photograph 5.16 Exotic grassland within the impact area at the Buttonderry Site.

Status: Not listed.

Predominant Condition: Low

Area of Occupancy within Project Boundary: Derived Native Grassland – 23.7 ha; Exotic/Agricultural/Low Diversity Grassland – 1159.4 ha

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

DNGs occur at the Tooheys Road and 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 moderate to good condition and shows signs of naturally occurring regeneration of canopy species such as *Corymbia gummifera*. The DNG at Hue Hue Road offset occurs adjacent to Smooth-barked Apple – Red Bloodwood open forest and is dominated by understorey species such as *Lomandra obliqua* (Twisted Mat-rush)*, Themeda australis* (Kangaroo Grass)*,* and *Entolasia stricta* (Wiry Panic).

Exotic, Agricultural and Low Diversity Grasslands are spread 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 Buttonderry, Tooheys Road and Hue Hue Road Offset sites 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*.

The majority of the grasslands within the Extraction Area occur on private lands within the Dooralong Valley floodplain. Therefore, detailed surveys by Cumberland Ecology within the Extraction Area were largely limited to a large representative alluvial floodplain property owned by WACJV known as Honeysuckle Park.

The area is a highly modified paddock dominated by exotic grasses such as *Axonopus fissifolius* and *Paspalum dilatatum.* Other prominent exotic species include *Cinnamomum camphora (*Camphor Laurel), *Cirsium vulgare* (Spear Thistle), *Plantago lanceolata* (Lamb's Tongue), *Sida rhombifolia* (Paddy's Lucerne) and *Senecio madagascariensis.* The area has scattered occurrences of remnant native trees such as *Acacia decurrens* (Green Wattle), *Eucalyptus deanei* (Mountain Blue Gum), *Eucalyptus saligna* (Sydney Blue Gum) and *Eucalyptus tereticornis* (Forest Red Gum).

The Honeysuckle Park area also has scattered occurrences of semi-natural billabongs and EEC wetlands (**see Section 5.2.9**) and damp, artificial depressions (**see Section 5.2.16**).

Visual observations of other grassland areas, made from public roads within the Extraction Area determined that these grassland areas consist of a mix of pastures/paddocks, turf farms and gardens within residential areas.

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

5.2.16 Artificial Dams/Water bodies

There are several occurrences of small artificial dams and water bodies scattered across the Tooheys Road and Hue Hue Road Offset Sites and the Extraction Area.

Common species along the banks of these water bodies within the Tooheys Road and Hue Hue Road Offset areas include *Eleocharis sphacelata*, *Lepyrodia scariosa* and *Phylidrum lanuginosum* (Frogs mouth) while *Spirodela* sp. is common on the water surface.

The grassland area within Honeysuckle Park has scattered, ephemeral depressions. Species occurring along the banks of these areas include trees such as *Melaleuca linariifolia* (Flax-leaved Paperbark), *Melaleuca styphelioides* (Prickly-leaved Tea Tree) and *Acacia implexa* (Hickory wattle) and understorey species such as *Commelina cyanea* (Native Wandering Jew), *Centella asiatica* and *Juncus continnus*. Common species on the water surface or submerged along the banks include *Azola pinnata*, *Spirodela* sp. *Ludwigia peploides* (Water Primrose) and *Ottelia ovalifolia* (Swamp Lily).

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

5.3 Groundwater Dependent Ecosystems (GDEs)

This section discusses the potential for GDEs to occur in the Study Area. Initially the definition of what constitutes a GDE is discussed, followed by a discussion of the areas that potentially conform to the description of GDE in the Study Area and subsequently an assessment is made of the likelihood of occurrence of GDEs and an estimation of their extent.

5.3.1 Definition of a Groundwater Dependent Ecosystem

GDEs are defined as those that rely in some part for their survival on groundwater. Dependence ranges from complete reliance for some systems to others that rely partially on groundwater, particularly during times of drought. The degree and nature of dependency influences the extent to which ecosystems are affected by changes to groundwater aquifers, both in quality and quantity (DECCW 2009). In general, the majority of Australian ecosystems have little dependence on groundwater, however, there are some localised or extensive ecosystems in Australia with at least a high dependence on groundwater (Hatton and Evans 1998). Knowledge of GDEs and their sustainability is relatively low and little is known about their location or condition (Eamus and Froend 2006). For most wetlands and terrestrial ecosystems, it is unknown what the critical depth to the water tables is, and the characteristic dynamics (Hatton and Evans 1998).

Four main types of GDEs have been identified (Hatton & Evans 1998), as described below:

- Terrestrial vegetation – may depend on diffuse discharges of shallow groundwater to varying degrees, either to sustain transpiration and growth through a dry season or to maintain perennially lush ecosystems in otherwise arid environments;
- Wetland ecosystems – may depend on groundwater to keep them seasonally waterlogged or flooded;
- River baseflow systems – many river reaches have a baseflow component of groundwater discharge. This groundwater component may be vital to the character and composition of in-stream and near-stream ecosystems; and
- Aquifer and cave ecosystems – the biology of karst or limestone caves, particularly micro-organisms and invertebrates, are heavily dependent on groundwater availability;

Two potential GDEs types occur in the Project Boundary: Terrestrial Vegetation and Wetland ecosystems. No permanently flowing rivers with a baseflow rate maintained by groundwater occur, and no limestone or karst environments occur. The potential GDEs that occur in the Study Area are considered in more detail below.

5.3.2 Potential Groundwater Dependent Ecosystems in the Study Area

The Jilliby Jilliby Creek and Wallarah Creek flow through the Study Area and there is potential for there to be a groundwater component to the flows. Although much of the originally existing riparian vegetation along both creeks has been removed, what remains has potential to be at least partially dependent on river baseflow.

Several areas of swamp / wetland are present within the Study Area, and this vegetation may comprise a GDE. These vegetation communities form on low lying areas in close proximity to water, and are often waterlogged, and these may comprise GDEs. Vegetation communities present in the Study Area that have potential to comprise GDEs include the following (see **Figure 5.3**):

- Blackbutt – Turpentine open forest of the hills of the North Coast;
- Coachwood – Crabapple warm temperate rainforest of the North Coast and Northern Sydney Basin;
- Paperbark Swamp forest of the coastal lowlands of the North Coast and Sydney Basin;
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin;
- Swamp Mahogany 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.

Of these communities, the riparian Blackbutt – Turpentine forest and Coachwood – Crabapple rainforest are likely to be dependent on groundwater only during periods of drought whereas the wetland and swamp communities are likely to have a higher dependence on groundwater.

Figure 5.3. Potential Groundwater Dependent Ecosystems recorded within the Study Area

5.4 Wetlands

The Study Area contains several areas of wetland, including the following as identified in the Wyong DCP 30 – Wetland:

Remnant Wetlands – Small wetlands less than one hectare that possess a number of conservation values which must be considered in the development process.

Drainage Lines - Drainage channels in floodplains which contain narrow bands of wetland or riparian vegetation. These bands of vegetation often play an important role in providing habitat linkages between isolated areas of wetland vegetation.

Wet Meadows - Wet meadows resemble pastures and are characterised by the presence of poorly drained soils. These areas may have contained wetland vegetation which has been converted to pasture by historic agricultural pursuits. These areas frequently occupy low lying positions in floodplains and provide important feeding areas for wetland birds.

Drainage Depressions - Channel-form remnants of past flow paths or temporary lagoons in floodplains. These lands often contain small wetlands which provide habitat for amphibians and have some value for wetland birds.

All of these wetland types occur in the Study Area. They have variable ecological value, related to the degree of degradation they have experienced. Many of these areas support threatened species of flora and fauna, and EECs. Some of the drainage lines in predominantly cleared pasture land are likely to have relatively low ecological significance, however where riparian vegetation is present, these areas are likely to provide a wide range of habitat and ecological services.

No large areas of wetland habitat occur. However, an area of 7(g) Wetlands Management zone, containing EEC listed Paperbark and Swamp Mahogany vegetation, occurs at the Tooheys Road site which is subject to specific provisions which are outlined in *Wyong Development Control Plan 2005 (Chapter 30)* and the *Wyong Local Environmental Plan 1991*. The majority of the area zoned as 7(g) wetland falls within the proposed Tooheys Road Southern Offset. Assessment of impacts to these wetland areas have been addressed in **Sections 6.5i and 6.6** while offset measures, in accordance with OEH regulations, for these areas have been addressed in **Section 8.4.1**.

5.5 Flora of the Study Area

Over 450 plant species (94% native, 6% exotic), including threatened species listed under the EPBC Act and TSC Act and rare species (Rare and Threatened Australian Plant (ROTAP)) were recorded within the 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 E** (**Table E1**).

5.5.1 Threatened Flora Species

Six threatened flora species listed under the TSC Act and EPBC Act have been recorded within the Study Area (**Table 5.3**). The locations of the threatened species are shown in **Figure 5.4.** and a summary of numbers of recorded specimens are provided in **Appendix E** (**Table E2**).

Table 5.3 Threatened Flora Species recorded within the Study Area

Scientific name	Common name	EPBC status	TSC status	Extraction Area	Buttonderry Site	Tooheys Road Site	Hue Hue Road Offset Site
Acacia bynoeana	Bynoe's Wattle	V	E			x	
Angophora inopina	Charmhaven Apple	V	V			x	
Cryptostlis hunteriana	Leafless Tongue Orchid	V	V			x	
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V				x
Melaleuca biconvexa	Biconvex Paperbark	V	V		x		
Tetratheca juncea	Black-eyed Susan	V	V			x	x

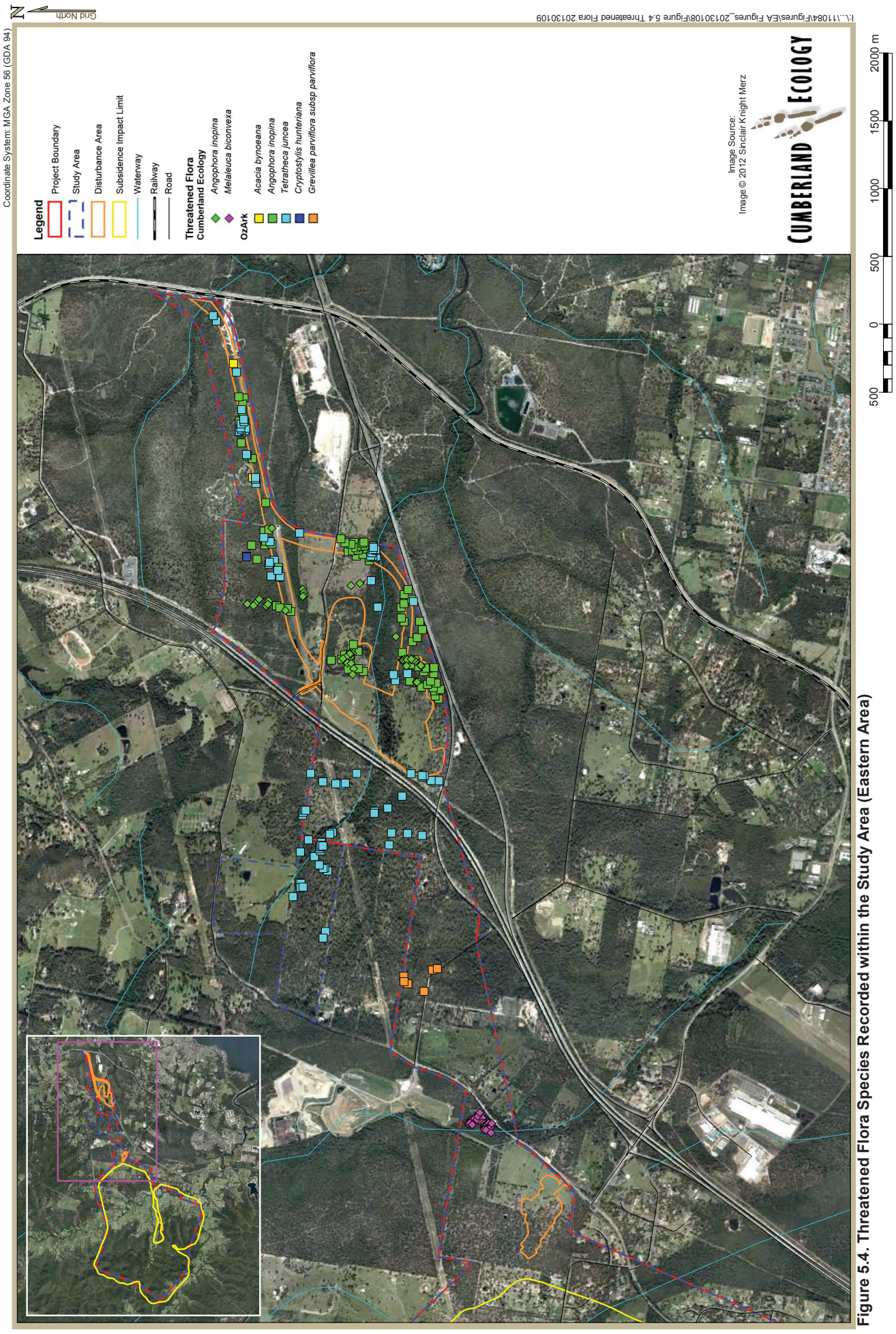

Figure 5.4. Threatened Flora Species Recorded within the Study Area (Eastern Area)

The threatened species known to occur within the Study Area are discussed below.

i. *Acacia bynoeana* (Bynoe's Wattle)

Status: Vulnerable (EPBC Act); Endangered (TSC Act).

Acacia bynoeana (Bynoe's Wattle) is a decumbent shrub, spreading up to 50 cm across and 1 m high. The shrub has stiff, shiny phyllodes and hairy brachlets (OEH 2012j) . This species produces few flowers, seed production is minimal and seedlings are rare (NSW NPWS 1999).

Acacia bynoeana occurs mainly in heath and dry sclerophyll forest, typically in sand and sandy clay substrates, often with ironstone gravels, which are usually very infertile and well-drained. The species seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds (from grading) and in recently burnt open patches (NSW NPWS 1999).

Acacia bynoeana was recorded at two locations, in Scribbly Gum Red Bloodwood woodland and in Smooth-barked Apple – Red Bloodwood forest, at the Tooheys Road Site. Several individuals have been recorded near the Study Area, on the eastern side of the F3 freeway (OzArk 2012). There are 26 records of this species in the locality (OEH 2012a).

The locations of recorded *Acacia bynoeana* within the Study Area are shown in **Figure 5.4.**

ii. *Angophora inopina (Charmhaven Apple)*

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Angophora inopina (Charmhaven Apple) is a small to large tree, up to 8 m high and is often multi-stemmed. The bark is grey to grey-brown and consists of short fibres while the leaves are slightly glossy and leathery (OEH 2012l). The flowers are creamy white (Benson and McDougall 1998). Flowering is poor and sporadic and generally occurs between mid-December and mid-January.

Angophora inopina is found in open dry sclerophyll woodland of *Eucalyptus haemastoma* and *Corymbia gummifera* with a dense shrub understorey. The woodland occurs on deep white sandy soils over sandstone, often with some gravelly laterite (NSW Scientific Committee 1998a).

Large numbers of this small tree occur within the Tooheys Road Site, predominantly in Scribbly Gum Red Bloodwood woodland with some scattered individuals in cleared areas, Swamp Mahogany forest, or Paperbark Swamp forest. Density estimates for *Angophora inopina* within the Impact areas of Tooheys Road was calculated at approximately 14 individuals per hectare whereas that for the Offset areas was calculated at approximately 22 individuals per hectare (approximately 31 and 13 individuals per hectare in the Tooheys Road South and Tooheys Road North offsets respectively).

Further individuals have been recorded in adjacent private properties outside the Project Boundary in previous studies (OzArk 2012). There are 105 records of this species in the locality (OEH 2012a).

The locations of recorded *Angophora inopina* within the Study Area are shown in **Figure 5.4.**

iii. *Cryptostylis hunteriana* (Leafless Tongue Orchid)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Cryptostylis hunteriana is a small perennial terrestrial orchid. This species lacks leaves and has a 10 – 45 cm long flowering stem, usually with five to 10 flowers. The distinctive labellum for *Cryptostylis hunteriana* is erect, dark red with a wide central black band that becomes four black lines, and is covered with dense glandular hairs on the upper surface (SEWPaC 2012f).

This species inhabits a range of habitats, mostly coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest in soils that include moist sands or moist to dry clay loam (Jones 2006, OEH 2012~).

A single *Cryptostylis hunteriana* individual was recorded within the Project Boundary, north of the Tooheys Road Site in Scribbly Gum Red Bloodwood woodland. There are two records of this species within the locality (OEH 2012a).

The location of recorded *Cryptostylis hunteriana* within the Study Area is shown in **Figure 5.4.**

iv. *Grevillea parviflora subsp. parviflora* (Small-flower Grevillea)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Grevillea parviflora subsp. *parviflora* is a low open to erect shrub, 0.3-1m tall. Major branches are ascending to erect and leaves are narrow, mostly 0.8-1.3 mm wide. Flowers are small, spider-like and clustered in groups of 6–12, and are white or pinkish with rusty-brown hairs (NSW NPWS 2002) .

It occurs in heathy associations or shrubby woodland, in sandy or light clay soils, usually over thin shales often with lateritic ironstone gravels which are often infertile and poorly drained. Most populations are found in open, slightly disturbed sites, particularly close to roads and tracks (OEH 2012^).

Grevillea parviflora subsp. *parviflora* was recorded at six locations within the Hue Hue road offset site in Spotted Gum – Broadleaved Ironbark. Some patches of this species are also present outside Project Boundary, east of the F3 Freeway (OzArk 2012). There are 119 records of this species in the locality (OEH 2012a).

The locations of recorded *Grevillea parviflora* subsp. *parviflora* within the Study Area are shown in **Figure 5.4.**

v. Melaleuca biconvexa (Biconvex Paperbark)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Melaleuca biconvexa is a shrub to small tree, up to 10 m tall, with papery bark. The leaves are small with a centre-vein in a groove and leaf blades curving upwards on either side of the centre-vein. The flowers are white and usually clustered in dense heads. Flowering occurs over 3 – 4 weeks in September and October (OEH 2012d).

The species grows in damp places, often near streams and rivers or low-lying areas on alluvial soils of low slopes or sheltered aspects. Dense, narrow stands, often in association with other *Melaleuca* species, can occur adjacent to watercourses (NSW Scientific Committee 1998b, OEH 2012d).

Several stands of *Melaleuca biconvexa* were recorded within the Project Boundary, east of Buttonderry impact site in Blackbutt – Turpentine forest. Stands were largely confined to within 4 m of creeklines and wet depressions except between the eastern side of the creek and Hue Hue Road where the species was found in areas damp from surface runoff. The species showed variable abundance within the area of occupancy, ranging from scattered stems to dense thickets. Overall cover abundance was medium and included mature, young and immature stems as well as saplings. A comparison of numbers of the different stem ages within the area of occupancy is provided in **Table 5.4**.

Previous studies have also recorded *Melaleuca biconvexa* individuals in the Extraction Area (ERM 2003) but these stands were not located within accessible areas surveyed. There are 279 records of this species in the locality (OEH 2012a).

The locations of recorded *Melaleuca biconvexa* within the Study Area are shown in **Figure 5.4**.

Table 5.4 *Melaleuca biconvexa* stem counts

	Total # of stems	# of mature stems	# of young stems	# of immature stems	# of saplings
Total # of stems	144	35	16	74	19
Mean /ha	720	175	80	370	95

vi. *Tetratheca juncea* (Black-eyed Susan)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Tetratheca juncea is a low shrub that grows in clumps of single or multiple stems. Stems are usually leafless with two or three narrow wings that give them an angular appearance. Plants are usually sprawling and can be difficult to detect amongst other vegetation when not flowering. The flowers face downwards and range in colour from white to pink to dark purple with a dark centre (OEH 2012e).

The species is usually occurs on ridges but is also found on upper slopes, midslopes and occasionally in gullies (NSW NPWS 2000a). It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover (OEH 2012e). It is found in sandy, occasionally moist heath and in dry sclerophyll vegetation communities, in sandy skeletal soil on sandstone, sandy-loam soils and clayey soil from conglomerates.

Numerous patches and diffuse occurrences of this species were recorded within the Tooheys Road Site and Hue Hue Road offset site, predominantly in Scribbly Gum Red Bloodwood woodland and Smooth-barked Apple – Red Bloodwood forest but with some occurrences in Swamp Mahogany Forest and Blackbutt – Turpentine forest. There are 121 records of this species in the locality (OEH 2012a).

The locations of recorded *Tetratheca juncea* within the Study Area are shown in **Figure 5.4.**

5.5.2 ROTAP Species

Three plants considered under the Rare or Threatened Australian Plants (ROTAP) criteria have also been recorded within the Study Area. Whilst there is no legal requirement to take measures to protect them unless they are also listed under the TSC Act or EPBC Act, their significance is noted in this ecological assessment.

The following ROTAP species have been recorded within the Study Area:

- *Callistemon shiressii* (3RC-);
- *Eucalyptus fergusonii subsp. dorsiventralis* (2RC-); and
- *Macrozamia flexuosa* (2K).

The table below provides a definition of the ROTAP codes.

Table 5.5 ROTAP Coding System for Plants

Category	Coding	Definition
Plant Distribution	1	Known only from the type* collection
	2	Restricted distribution - range extending over less than 100km
	3	Range more than 100km but in small populations
Conservation Status	X	Presumed extinct - not collected for 50 years or the only known populations destroyed
	E	Endangered - at serious risk in the short term (one or two decades) **
	V	Vulnerable - at risk over a longer period (20-50 years) **
	R	Rare but with no current identifiable threat
	K	Poorly known species suspected of being at risk
Reservation Status	C	Species is known to occur within a proclaimed reserve
	a	Species is considered to be adequately reserved. 1000 or more plants occur within a proclaimed reserve
	i	Species is considered to be inadequately reserved. Less than 1000 plants occur within a proclaimed reserve
	-	Species is recorded from a reserve but the population size is unknown
	t	Total known species population is within a reserve

Table 5.5 ROTAP Coding System for Plants

Category	Coding	Definition
	Px	Western Australian Department of Conservation and Land Management (CALM) Priority Flora Code. Range from P1 (highest priority) to P4 (lowest priority).
	+	Species also occurs outside of Australia

* The "type" is the plant specimen used to originally describe a species.

** Species considered to be either Endangered or Vulnerable are classified as "Threatened".

Callistemon shiressii and *Eucalyptus fergusonii subsp. dorsiventralis* were recorded near the Western Ventilation Shaft while *Macrozamia flexuosa* was recorded at the Buttonderry Site.

5.5.3 Exotic Flora Species

Thirteen exotic flora species were recorded by OzArk within the Study Area. Of these, three species, *Ageratina adenophora* (Crofton Weed), *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush) and *Lantana camara* (Lantana) are declared as noxious under the *Noxious Weeds Act 1993* for the Wyong LGA. Bitou Bush and Lantana are also declared Weeds of National Significance (WONS) under the *National Weed Strategy 1997.* All three 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.

A further five exotic species have been recorded in the Study Area during ERM surveys and Cumberland Ecology recorded a further 13 exotic species during surveys of Tooheys Road, Buttonderry and Hue Hue Road Offset sites and the Extraction area (Honeysuckle Park). While surveys of the remaining grassland areas in the Extraction Area were not possible due to access restrictions, it is highly likely that several more exotic species are present as the surrounding areas are composed largely of pasture/paddock areas, turf farms and ornamental gardens.

5.5.4 Potentially Occurring Threatened Flora Species and Populations

This section describes threatened flora species and threatened flora populations that were not recorded within the Study Area during Cumberland Ecology and OzArk surveys but are considered to have potential to occur based on a combination of suitable habitat within the Study Area, distribution and frequency as indicated by the Atlas records (OEH 2012a) and EPBC PMST records (SEWPaC 2012g) for the locality and the wider Wyong LGA, and confirmed sightings in the locality from other commissioned studies.

For a comprehensive overview, threatened species known from, and predicted to occur in the locality and the Wyong LGA have been analysed for their likelihood of occurrence in the Study Area. This analysis is presented in **Appendix B** and includes:

- TSC Act listed threatened flora species recorded from the locality and Wyong LGA (OEH 2012a);
- EPBC Act listed species predicted to occur based on availability of habitat in the locality and Wyong LGA (SEWPaC 2012g); and
- Threatened species recorded in the locality from other surveys by ERM (1998a, 1998b); ERM (1999); BHP (2002); ERM (2002); BHP (2003) and ERM (2003).

The species which are considered to have potential to occur within the Study Area are described below.

i. Asterolasia elegans

Status: Endangered (EPBC Act)

Asterolasia elegans is a tall, slender shrub, up to 3 m high. The narrow leaves are lanceolate or elliptical, with dark green upper surfaces and white to rusty stellate hairs. Flowers are terminal, occur in clusters and are white in colour (OEH 2011b).

This species grows in wet sclerophyll forest on moist hillsides and is known from only seven populations, north of Sydney.

This species has not been recorded within the Study Area and there are no records in the locality or wider Wyong LGA. However it was recorded on the EPBC Protected Matters Search Tool and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

ii. Caladenia tessellata (Thick Lip Spider Orchid)

Status: Vulnerable (EPBC Act); Endangered (TSC Act).

Caladenia tessellata is a perennial orchid that sprouts annually from an underground tuber. This species generally flowers from September – November and has a single, hairy 30 cm tall flowering stem (SEWPaC 2012e). The flower is characterised by five long spreading cream coloured petals with reddish stripes and a broad down-curled labellum with darker stripes (OEH 2012□).

This species favours dry, sclerophyll woodland with a heathy or sometimes grassy understorey on clay loams or sandy soils (SEWPaC 2012e).

The species has not been recorded in the locality. However there are six records for this species in the Wyong LGA (OEH 2012a) and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

iii. Callistemon linearifolius (Netted Bottle Brush)

Status: Vulnerable (TSC Act)

Callistemon linearifolius is a shrub, about 3-4 m tall, with linear to linear-lanceolate leaves with a sharp tip, thickened margins, and distinct lateral veins. Flowers are clustered into the typical "bottlebrushes" of Callistemons. The brushes are red and usually 9 - 10 cm long and approximately 50 mm in diameter. The stem upon which the filaments occur are covered in a soft downy hair at flowering (OEH 2012†).

This species grows in dry sclerophyll forest on the coast and adjacent ranges (OEH 2012†).

There are 4 records for this species in the locality and a total of 8 records for the Wyong LGA (OEH 2012a), with most individuals occurring within Munmorah SCA. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

iv. Eucalyptus camfieldii (Camfield's Stringybark)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Eucalyptus camfieldii is a mallee shrub/small tree ranging from 4 – 9 m in height. The bark is greyish-brown, rough, fibrous and stringy. The flowers are white while the fruit is flattened and globe-shaped. This species occurs mostly in exposed areas of on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heaths or low open woodland (OEH 2012k).

This species occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (OEH 2012k). It grows in shallow sandy soils overlying Hawkesbury sandstone or Coastal heath, on exposed sandy ridges (SEWPaC 2012h).

There are 7 records for this species in the locality and a further 36 records for the Wyong LGA (OEH 2012a), with most individuals occurring on the eastern side of Tuggerah Lake. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

v. Genoplesium insignis (Variable Midge Orchid)

Status: Endangered (TSC Act)

Genoplesium insignis is a terrestrial orchid with a solitary cylindrical leaf about 6 to 15 cm long that encloses the flowering stem, which is about 9 to 18 cm tall. The leaf is dark green with a reddish base. The flowering stem bears 5 to 12 dark purple flowers in a moderately dense spike. The flowering period is from September to October (OEH 2012‘).

This species grows in patches of *Themeda australis* (Kangaroo Grass) amongst shrubs and sedges in heathland and forests. Associated vegetation is described as dry sclerophyll woodland dominated by *Eucalyptus haemastoma* (Scribbly Gum), *Corymbia gummifera* (Red Bloodwood), *Angophora costata* (Smooth-barked Apple) and *Allocasuarina littoralis* (Black She-oak).

There is 1 record for this species in the locality and a total of 3 records for the Wyong LGA (OEH 2012a). All records occur east of the F3 freeway, with 2 occurring within Munmorah SCA. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

vi. Maundia triglochinoides

Status: Vulnerable (TSC Act)

Maundia triglochinoides is an erect rhizomatous perennial herb that grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, with low nutrients. It is restricted to coastal NSW and extends into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct (OEH 2012…).

There is one record for this species in the locality and a further two records from the Wyong LGA (OEH 2012a). No individuals were recorded within the Study Area but are considered to have potential to occur based on the availability of suitable habitat in the Study Area.

*vii. Rhizanthella slateri (*Eastern Underground Orchid*)*

Status: Endangered (EPBC Act)

Rhizanthella slateri is a saprophytic herb with a fleshy underground stem. The stem is whitish, often branching, with prominent, fleshy, overlapping bracts (NSW Scientific Committee 2005b). Flowering heads consist of about 25 to 35 tubular, purplish flowers arranged in a flat spiral which extend up to 2 cm above the ground. This species is known to grow in eucalypt forests but there are no informative assessments of the likely preferred habitat for the species (SEWPaC 2012r)

This species has not been recorded within the Study Area and there are no records in the Wyong LGA. However it was recorded on the Protected Matters Search Tool and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

viii. *Rutidosis heterogama* (Heath Wrinklewort)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

Rutidosis heterogama is a perennial herb with decumbent to erect stems, 30 cm high, growing from a woody base. The leaves are narrow and stalkless with curved edges and a rough texture. This species mainly flowers in Autumn (March – April) but occasionally from November – January. The flower heads are tiny and yellow. The species mostly inhabits heath, and is often found along disturbed roadsides (OEH 2012{).

There are 66 records for this species in the locality and a total of 183 records in the Wyong LGA in two disjunct locations, Munmorah State Conservation Area (SCA) and around the Woongarrah area, south east of the Study Area (OEH 2012a). The species was previously recorded in the vicinity of the Study Area but was not recorded during OzArk surveys (OzArk 2012). However it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

ix. *Syzygium paniculatum* (Magenta Lilly Pilly)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

This rainforest species can form a tree to 15 m tall, but is generally 3–8 m high and shrubby in form. The stem is without conspicuous buttresses. The bark is flaky to almost tessellated, with the outer blaze cream, pale brown or pink, and fibrous in texture leaves are lanceolate to obovate, 4.5–10 cm long. Leaves are generally dark green and glabrous (smooth) on the upper surface and paler underneath (OEH 2012*f*).

This species is found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (SEWPaC 2012t). Rainforests are often remnant stands of littoral or gallery rainforest.

There are eight records for this species in the locality and a total of 70 records for the Wyong LGA (OEH 2012a). The species has not been recorded in the Study Area but has been assessed as potentially occurring based on the similarity of available habitats in the study area to recorded locations elsewhere within the Wyong LGA (BHP 2002). It is therefore considered to have potential to occur based on the availability of suitable habitat in the Study Area.

x. *Thelymitra sp. adorata (*Wyong Sun Orchid*)*

Status: Critically Endangered (TSC Act)

Thelymitra sp. adorata is a hairless terrestrial herb. A single, erect, linear to linear-lanceolate leaf, emerges from the ground in about May and dies back annually around November to a tuberous rootstock. The leaf is green with a purplish base and sheathes the dark bluish-purple flowering stem at its base (NSW Scientific Committee 2008). Flowers are borne on slender stalks 1-14 mm long. Individual flowers are 15-27 mm across, pale to dark blue and only open in warm, sunny weather (OEH 2012•).

The species is restricted to the Wyong area and occurs in woodland with grassy understorey in well-drained clay loam or shale derived soils. The majority of populations occur in vegetation described regionally (Bell 2002a) as Dooralong Spotted Gum - Ironbark Forest (OEH 2012•).

There are 18 records in the locality, (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xi. *Eucalyptus parramattensis subsp. parramattensis* (*Eucalyptus parramattensis* C. Hall. *subsp. parramattensis* in Wyong and Lake Macquarie local government areas*)*

Status: Endangered population (TSC Act)

Eucalyptus parramattensis subsp. parramattensis is a small to medium sized tree, growing up to 15 m high. The bark is white or grey, smooth and sheds in large plates or flakes. Leaves are lanceolate and dull green, 7 – 20 cm long. Flowers are white and grow in clusters of 7. The species is locally frequent alongside drainage lines and adjacent to wetlands, on sandy soils in low, often moist woodland sites (OEH 2012q).

The population of *Eucalyptus parramattensis* subsp. *parramattensis* in Wyong and Lake Macquarie local government areas is at the north eastern limit of the species range and is disjunct from other known populations of the subspecies (NSW Scientific Committee 2003).

There are 58 records in the locality, mostly from the Porters Creek and the Wallarah Creek catchments. Trees in the vicinity of the Study Area are predominantly clustered between the F3 Freeway and Main Northern Railway along Sparks Road (OEH 2012a). No individuals were recorded within the Study Area but are considered to have potential to occur based on the availability of suitable habitat in the Study Area.

5.6 Fauna Habitat

Fauna habitat is considered a species-specific concept (Fischer and Lindenmayer 2007) and is broadly defined as the range of environments that a particular species utilises to successfully maintain a viable population. Notwithstanding this, there are general environment types and landscape features in the Study Area that are recognised as providing habitat for a range of fauna species.

Vegetation clearing has removed considerable amounts of the original habitats within the Project Boundary and surrounding locality. Much of the remaining woodland vegetation has either regenerated from clearing and is very young and structurally simple; or has been modified from its original state through degradation by fragmentation, ongoing agriculture and structural simplification (i.e. by clearing or thinning activities). A lack of large old growth trees has limited the number and size of hollows available in the Study Area. Despite the modified nature, the Study Area still provides habitat for fauna.

Key habitat features present within the Study Area include:

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

A description and general discussion of the various habitat types available in the Study Area is provided below.

i. Remnant Forest and Woodland

Remnant forest and woodland habitats are scattered across the entire the Study Area. These vegetated areas are relatively mature and/or at a later stage of regeneration such that they represent mixed-aged stands, which support a reasonably complex understorey and overstorey structure to make them valuable to a range of fauna species. For more mobile species, the remnant woodland patches within the Study Area provide good connectivity to surrounding remnant patches outside of the Study Area. Ground cover vegetation provides habitat for many reptiles and smaller terrestrial mammals such as the Bush Rat (*Rattus fuscipes*) and Brown Antechinus (*Antechinus stuartii*).

A number of the woodland patches were comprised of mature remnant trees, many with various sized hollows, scattered amongst younger regenerating trees and some small shrubs that provide habitat for a range of commonly-occurring and threatened arboreal mammals, bats and birds. Cover and densities of habitat features such as stags, fallen logs, woody debris including bark, and thick leaf litter varied between patches but overall offer shelter and forage habitat for small terrestrial fauna and birds.

Additionally, the wetter sclerophyll habitats contain trees with decorating bark, which can provide suitable habitat for microchiropteran bats and some reptiles such as geckos.

ii. Riparian habitats

Riparian vegetation represents valuable habitat as it contains mature trees with hollows, a grassy understorey and fallen timber and rocks in relatively close proximity to creeks and other water sources. Riparian vegetation also represents movement corridors in some parts of the Study Area where they connect to large patches of vegetation in the wider locality.

The riparian forest vegetation present within the Study Area occurs along Wallarah Creek and its tributaries. The riparian vegetation in the Study Area has been highly modified from its original state and typically persists as very narrow and interrupted corridors along the creeklines. It is considered to provide low to moderate fauna habitat but if restored and

rehabilitated, it can provide good quality seasonal flowering resources, foraging habitat, movement corridors and roosting and nesting habitat for small arboreal mammals and birds.

iii. Swamp forests and open wetlands

Swamp forest areas exhibit similar habitat elements as the remnant forest and woodlands, albeit with a greater degree of habitat complexity, partly due to the higher abundance of dead and down timber. This environment provides suitable habitat for small insectivorous and nectar feeding birds, frogs and reptiles (especially snakes and goannas) as well as ground dwelling native mammals and small skinks.

The open wetland areas are characterised by farm dams with varying degrees of wetland vegetation such as rushes and sedges. These areas are highly disturbed, mainly due to de-silting in recent years. Despite this, these habitats support a variety of frog species. These areas are also potential feeding resources for reptiles such as snakes.

iv. Regenerating Vegetation

Several of the forest and woodland communities occur as patches of regenerating forest/woodland scattered across the Study Area. These vegetation patches have limited habitat value because they are largely even-aged stands, have simple structures, little ground cover, limited species diversity and contain few stags or hollows that are typical of older stands of vegetation. Nevertheless, they add additional flowering resources to the Study Area as well as sheltering sites for woodland birds. These shrublands also provide "stepping stone" connections among larger vegetated patches, which facilitate the movement of species that have limited mobility.

v. Grasslands

Grassland habitat generally provides low fauna habitat due to a lack of vegetation and debris for cover. Most native species are found in treed habitats, however, grasslands grazed by cattle offer sparse habitat for most native fauna species.

Upper storey layers are generally non-existent except for a few scattered trees that do not conform to woodland. The composition and diversity of native species varies as a result of ongoing grazing; however a large portion of grassland is derived from the understorey of woodland and forest communities that have been cleared in the past. Some areas of grassland include woody debris and leaf litter cover; however other areas that were cropped or grazed are devoid of such habitat features.

These open areas provide suitable foraging habitat for large mammals, including macropods such as the Eastern Grey Kangaroo (*Macropus giganteus*) and Red-necked Wallaby (*Macropus rufogriseus*). Grassland can also provide shelter and forage habitat for small mammals in areas with a dense grass layer, and microhabitats exist under timber and rocks for reptiles. Large open areas provide ample foraging habitat for insectivorous and granivorous birds, and hunting resources for raptors, owls and some bat species.

vi. Tree Hollows

The majority of the forest and woodland vegetation within the Study Area consists of young regrowth vegetation with scattered mature trees. Hollows were found in a variety of vegetation communities although they were largely absent from scattered trees present in grassland areas. The most frequent hollow bearing tree species included *Angophora costata*, *Corymbia maculata* and *Eucalyptus capitellata*. While hollows were found mainly in *Eucalyptus* species, occasional mature *Melaleuca* individuals also had hollows.

Hollow densities were estimated for both impact and offset areas and are presented in **Table 5.6**. Details of hollow densities for each vegetation community in the impact and offset areas are presented in **Appendix F**.

Table 5.6 Tree Hollow densities in impact and offset areas

	Total # Hollows	# large hollows	# medium hollows	# small hollows
Impact Mean/ha	7.1	1.0	3.3	2.9
Offset Mean/ha	15.3	0.7	6.4	8.2

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 is likely to be present in the Study Area is expected to be much lower than that observed during habitat assessments. Therefore, the availability of tree hollows in the Study Area is likely to be very limited and in high demand by hollow-using fauna.

Hollow specificity is likely to increase the pressure on the remaining hollows in the Study Area for hollow-using fauna because the number of serviceable hollows for any individual species is much less than the number that is actually present. Different fauna species typically have specific hollow requirements that depend on surrounding vegetation community; tree species; habit; height; crown spread and fire scars; number and height of hollows from the ground; minimum entrance width and depth; and landscape factors such as aspect, topographic position and slope (Lindenmayer et al. 1990, Gibbons et al. 2002, Remm et al. 2008). Competition for remaining functional hollows would thus place more pressure on this resource.

5.7 Fauna of the Study Area

The results of past and present fauna field studies show that there is a suite of native fauna species that use the habitats in the Study Area. More than 300 fauna species have been recorded within the Study Area, of which 29 are listed under the TSC Act and/or the EPBC Act. A large proportion of the recorded species are represented by avifauna and microbats, which are highly mobile species. Reptiles, arboreal mammals and terrestrial mammals, which are less mobile, are not as well represented. Many of the mammals recorded are represented by stock and exotic species such as cattle, horses, rabbits and mice.

A comprehensive list of fauna species is provided in **Appendix G (Table G1)**. It is a cumulative list of survey results since 1998 and comprises fauna recorded (observed, trapped or identified from scats or call playback) by ERM (1998 – 2003), OzArk (2006 – 2012) and Cumberland Ecology (2012).

5.7.1 Threatened Fauna Species

Twenty-one TSC Act listed fauna species have been recorded within the Study Area during OzArk surveys (**Table 5.7**). Two of these species, the Giant Barred Frog (*Mixophyes iteratus*) and the Grey-headed Flying Fox (*Pteropus poliocephalus*) are also listed under the EPBC Act. The locations of the threatened species are shown in **Figure 5.5**. Details of the survey methods and dates for when threatened fauna species were recorded are proved in **Appendix G** (**Table G2**).

Table 5.7 Threatened Fauna species recorded within the Study Area during OzArk surveys

Scientific Name	Common Name	EPBC Status	TSC Status	Extraction Area	Buttonderry Site	Tooheys Road Site	Hue Hue Road Offset Site
Crinia tinnula	Wallum Froglet		V			x	
Mixophyes iteratus	Giant Barred Frog	E	E1	x			
Calyptorhynchus lathami	Glossy Black Cockatoo		V			x	x
Daphoenositta chrysoptera	Varied Sittella		V		x	x	x
Glossopsitta pusilla	Little Lorikeet		V				x
Hieraaetus morphnoides	Little Eagle		V	x			

Table 5.7 Threatened Fauna species recorded within the Study Area during OzArk surveys

Scientific Name	Common Name	EPBC Status	TSC Status	Extraction Area	Buttonderry Site	Tooheys Road Site	Hue Hue Road Offset Site
Ninox strenua	Powerful Owl		V	x	x	x	
Tyto novaehollandiae	Masked Owl		V			x	
Tyto tenebricosa	Sooty Owl		V	x			
Cercartetus nanus	Eastern Pygmy Possum		V	x			
Petaurus norfolcensis	Squirrel Glider		V			x	
Petaurus australis	Yellow-bellied Glider		V	x			x
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	x			
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat		V			x	
Mormopterus norfolkensis	East-coast Freetail Bat		V	x			
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	x		x	
Kerivoula papuensis	Golden-tipped Bat						x
Miniopterus australis	Little Bentwing Bat		V	x			
Miniopterus orianae oceanensis (formerly Miniopterus schreibersii oceanensis)	Eastern Bentwing Bat		V	x			
Myotis macropus (formerly Myotis adversus)	Southern Myotis		V	x		x	
Scoteanax rueppellii	Greater Broad-nosed Bat		V	x		x	

Key: E/E1 = Endangered; V = Vulnerable

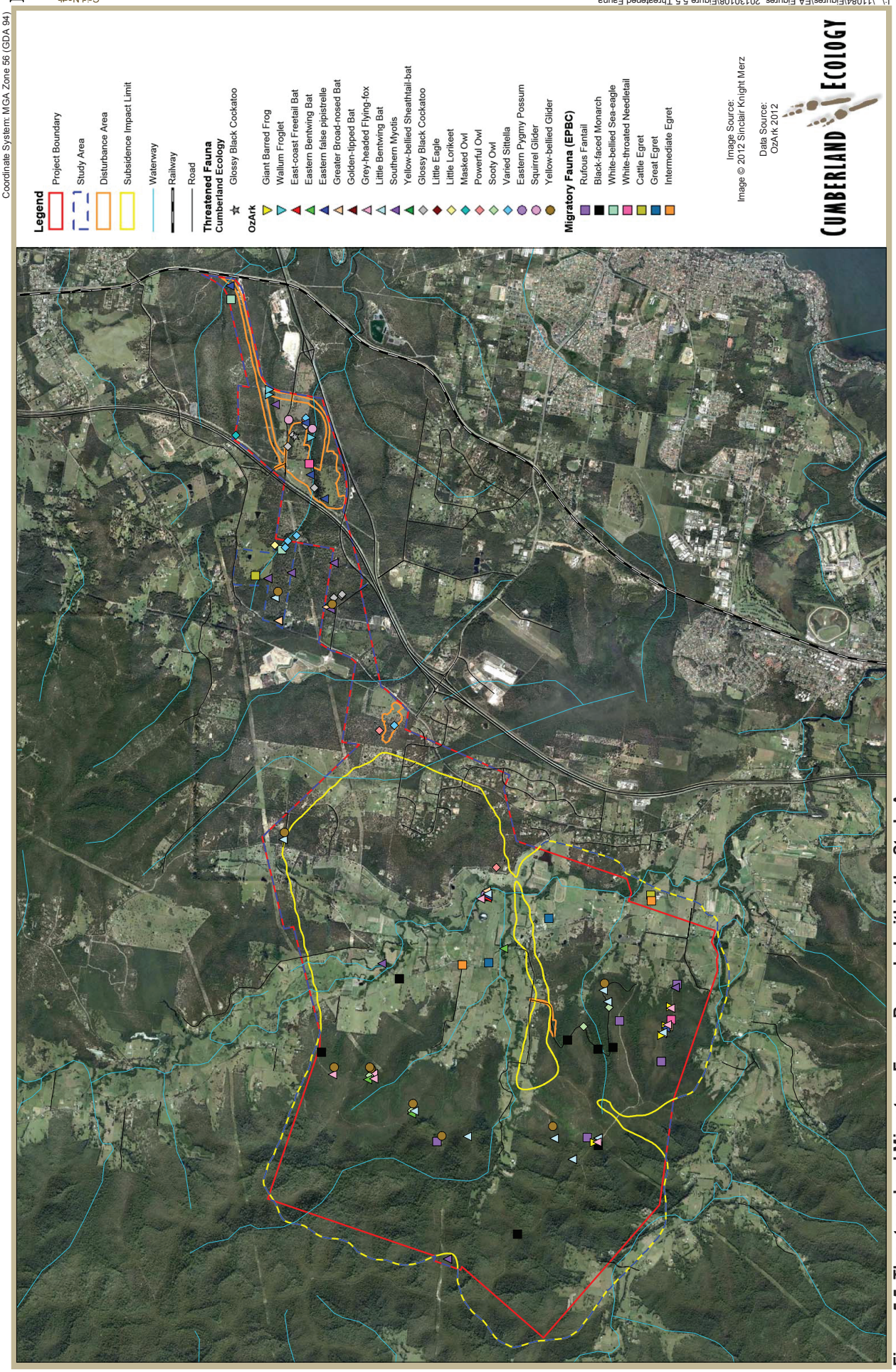

Figure 5.5. Threatened and Migratory Fauna Recorded within the Study Area

Descriptions of threatened species recorded within the Study Area are provided below, along with a brief summary of their preferred habitats.

i. Wallum Froglet (Crinia tinnula)

Status: Vulnerable (TSC Act).

Wallum Froglet is a small frog species, usually less than 15 mm long. Their colour varies from brown to light or dark grey above and cream to dark grey below. The species' distinctive feature is a fine white line on the underside extending from the tip of the snout to the base of the abdomen (OEH 2012").

This species is found only in sedge swamps and acid paperbark swamps of the coastal 'wallum' country (OEH 2012").

Wallum Froglets were recorded at three locations in Swamp Mahogany/Paperbark swamp forests and Blackbutt – Turpentine forest at the Tooheys Road Site. Previous studies have also recorded Wallum Froglets in the vicinity of the Project Boundary (ERM 1998b, 1999, 2002, 2003, BHP 2003). There are 46 records of the species in the locality. Further records for the Wyong LGA (OEH 2012a), indicate occurrences predominantly on the eastern side of the F3 Freeway, including within Munmorah SCA.

ii. Giant Barred Frog (Mixophyes iteratus)

Status: Endangered (EPBC Act); Endangered (TSC Act).

Giant Barred Frogs are large frogs, reaching lengths of up to 115 mm. The skin is finely granular. The dorsal surfaces are olive to dark brown with paler or darker blotches while the ventral surface is usually cream to pale yellow. Their distinguishing feature among barred frogs are the black thighs with smaller yellow spots, distinct barring on the limbs, dark blotches on the sides and absence of a creamy stripe on the upper lip (OEH 2012s).

This species is found amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest (OEH 2012s). This species is a stream-breeding species with eggs deposited out of the water, under overhanging banks or on steep banks of large pools (SEWPaC 2012n).

Giant Barred Frogs were recorded at four locations within the Extraction Area in Mountain Blue Gum – Turpentine Forest. Two to three individuals were visually recorded at one location while individuals were heard calling at the other locations. Previous studies have also recorded Giant Barred frogs within the Extraction Area (ERM 2003). There are 10 records of the species within the locality (OEH 2012a), with most occurring within Jilliby SCA.

iii. Green and Golden Bell Frog (Litoria aurea)

Status: Vulnerable (EPBC Act); Endangered (TSC Act).

The Green and Golden Bell Frog is a stout frog, ranging in size from about 45 mm - 100 mm snout to vent length. Body colour is generally a vivid pea-green, with blue or bluish-green thighs and splotchy golden-brown markings that vary in their level of coverage. Their distinctive features are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye (OEH 2012y).

This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.) (OEH 2012y).

There are 8 records for the Green and Golden Bell Frog in the locality and a total of 10 for the Wyong LGA, with most occurring on the eastern side of the F3 Freeway. Although recent OzArk surveys did not locate this species, previous studies have recorded this species in the vicinity of the Extraction Area (BHP 2002, 2003) and historic records have located this species within the Hue Hue Road area (OEH 2012a).

iv. Green-thighed Frog (Litoria brevipalmata).

Status: Vulnerable (TSC Act).

The Green-thighed Frogs are small frogs reaching lengths of up to 40mm. The body colour varies from rich brown to chocolate brown on the back, occasionally with small black flecks, and a broad black stripe running from the snout to the flank. The distinguishing feature is the bright green or blue-green colour on the groin and back of the thighs (OEH 2012x).

This species occurs in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain (OEH 2012x).

There are 6 records in the locality and a total of 22 records in the Wyong LGA, with most occurring within Ourimbah SF (OEH 2012a). Previous studies have recorded this species in the Extraction Area (BHP 2002) and historic records have located this species within the Hue Hue Road area (OEH 2012a).

v. Glossy Black Cockatoo (Calyptorhynchus lathami)

Status: Vulnerable (TSC Act).

The Glossy Black-Cockatoo is a dusky brown to black cockatoo about 50 cm in length. It has a small crest, a large, bulbous bill and a broad red band with yellow edges and black bars along the tail (OEH 2012u). They are usually seen in pairs or small groups feeding quietly in she-oaks.

This species is found along the coast and tablelands in eucalypt open forest and woodland with hollow-bearing trees and stands of she-oak species (Birds Australia 2011). The species feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species) (OEH 2012u).

Glossy Black-Cockatoos were recorded at five locations in the Study Area by OzArk – three in Spotted Gum – Broad Leaved Ironbark Forest in the Hue Hue Road offset area and two in Scribbly Gum - Red Bloodwood woodland in the Tooheys Road Site. A further two incidental observations in Scribbly Gum - Red Bloodwood woodland within the Tooheys Road Site were made by Cumberland Ecology during the November and December survey periods. Two mated pairs (four birds in total) were recorded during the December observation. Previous studies have also recorded this species within the Project Boundary (ERM 1999, 2002). There are 47 records of the species in the locality (OEH 2012a). In the Wyong LGA, this species has been recorded predominantly from Watagans/Olney SF and Jilliby SCA (OEH 2012a).

vi. Varied Sittella (Daphoenositta chrysopter)

Status: Vulnerable (TSC Act).

The Varied Sittella is a small (10 cm) songbird with a sharp, slightly upturned bill, grey head, yellow eyes and feet, and streaked dark brown. It has a white rump and orange wing-bar with are prominent during flight (OEH 2012').

This species is sedentary and inhabits eucalypt forests and woodlands. It prefers rough-barked tree species and mature smooth-barked gums with dead branches where it feeds on arthropods (OEH 2012').

Varied Sittellas were recorded at five locations in the Study Area – three in Smooth-barked Apple - Red Bloodwood forest in the Hue Hue Road offset area, one in cleared area within the Tooheys Road Site and one in Spotted Gum – Broadleaved Ironbark open forest at Buttonderry. Previous studies have also recorded this species within the Project Boundary (ERM 1999). There are 18 records of the species within the locality (OEH 2012a). In the Wyong LGA, this species is widely distributed among Jilliby SCA, Olney SF, Ourimbah SF and around Budgewoi, Mannering and Munmorah Lakes (OEH 2012a).

vii. Little Lorikeet (Glossopsitta pusilla)

Status: Vulnerable (TSC Act).

The Little Lorikeet is a small parrot about 16-19 cm long. It is bright green with a red face, black bill, olive-yellow undertail and a mantle imbued with light brown (OEH 2012□).

This species occurs mostly in dry, open eucalypt forests and woodlands but also moves into riparian habitats to forage. The species is partly nomadic (Higgins 1999), with movements occurring primarily in response to food availability (OEH 2012□).

The Little Lorikeet was recorded from a single location in Smooth-barked Apple - Red Bloodwood forest at the Hue Hue Road offset area. Previous studies have also recorded this species within the Extraction Area (ERM 2003). There are 8 records of the species in the locality and 38 for the Wyong LGA (OEH 2012a), with majority occurring on the eastern side of the F3 Freeway, near Tuggerah, Budgewoi and Munmorah Lakes.

viii. Little Eagle (Hieraaetus morphnoides)

Status: Vulnerable (TSC Act).

The Little Eagle is a small to medium sized raptor uncommon but with widespread distribution across mainland Australia (Birds Australia 2011). Body colour can either be a dark brown dorsal surface, rusty head, and pale undersurface with a distinctive rufous underwing pattern or a pale brown body with obscure underwing patterning. Both forms have a black-streaked head with a slight crest, a pale shoulder band on the upperwings, feathered legs and a rather short and square-tipped barred tail (OEH 2012□).

The species is most commonly found in open eucalypt forest and woodland, She-oak or acacia woodlands and riparian woodlands with abundant prey availability (NSW Scientific Committee 2010).

The Little Eagle was recorded at one location near Coachwood – Crabapple rainforest in the Extraction Area. There are 5 records of the species in the locality and 8 within the Wyong LGA (OEH 2012a), with most occurring near Tuggerah Lake.

ix. Powerful Owl (Ninox strenua)

Status: Vulnerable (TSC Act).

The Powerful Owl is Australia's largest owl reaching lengths of 60 cm. The dorsal surface is dark, greyish-brown with indistinct off-white bars while the ventral surface is whitish with dark greyish-brown V-shaped markings. It has staring yellow eyes with no facial discs (OEH 2012‡).

This species inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It requires large hollows up to 1 m wide and 2 m deep in large remnant trees for nesting (NSW Scientific Committee 2004e, Soderquist and Gibbons 2007).

Powerful Owls were recorded at three locations in the Study Area – in Scribbly Gum – Red Bloodwood woodland at the Tooheys Road Site, Smooth-barked Apple – Red Bloodwood forest at Buttonderry and in Spotted Gum – Grey Ironbark forest in the Extraction Area.

Previous studies have also located this species within the Tooheys Road Site (ERM 2002). There are 43 records of the species in the locality and a total of 90 for the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, Munmorah SCA, Olney SF, Ourimbah SF, and on the eastern side of the F3 Freeway towards Tuggerah Lake.

x. Masked Owl (Tyto novaehollandiae)

Status: Vulnerable (TSC Act).

The Masked Owl is medium-sized owl, reaching lengths of 40 - 50 cm. It has dark eyes set in a prominent flat, heart-shaped facial disc that is encircled by a dark border. The legs are feathered up to the toes and the feet are large. The plumage colouration varies from grey to dark brown upperparts and white to rufous-brown underparts. The upperparts generally have fine, pale spots and/or buff to rufous mottling while the underparts have variable dark spotting (OEH 2012„).

This species occurs in dry eucalypt forests and woodlands but often hunts along the edges of forests, including roadsides (OEH 2012„).

A single Masked Owl was recorded in Scribbly Gum - Red Bloodwood woodland at the Tooheys Road Site. Previous studies have also recorded this species at Tooheys Road, Hue Hue Road, Buttonderry (ERM 1999) and the Extraction Area (BHP 2002). There are 19 records of the species in the locality and 27 within the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, the western shores of Tuggerah Lake and along the F3 Freeway.

xi. Sooty Owl (Tyto tenebricosa)

Status: Vulnerable (TSC Act).

The Sooty Owl is medium-sized owl, reaching lengths of 45 cm. It has dark eyes set in a prominent flat, heart-shaped facial disc. The plumage is dark sooty grey with fine white spots. The face is also grey whereas the abdomen is pale (OEH 2012‰).

This species mainly occurs in rainforest areas, including dry rainforest, subtropical and warm temperate rainforest, but is also found in moist eucalypt forests (OEH 2012‰).

Sooty Owls were recorded in Spotted Gum – Grey Ironbark forest at five locations within the Extraction Area. Previous studies have also recorded this species within the Project Boundary (BHP 2002, 2003). There are 43 records of the species in the locality and 110 within the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, Olney SF, Ourimbah SF, and along the F3 Freeway near the southern edge of Wyong LGA.

xii. Black-necked Stork (Ephippiorhynchus asiaticus)

Status: Endangered (TSC Act).

The Black-necked Stork is a large bird about 1.3 m tall with a wingspan of around 2 m, and a massive, strong, black bill. The head and neck are black with an iridescent green and purple gloss while the rest of the body is white. The folded wings are largely black and cover much of the upperparts. The tail is short and black and the long legs are orange-red to bright red (OEH 2012f).

This species is mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, extending into adjacent grasslands, paddocks and open savannah woodlands (OEH 2012f).

There are 29 records in the locality and 37 for the Wyong LGA, concentrated mainly on the eastern side of the F3 Freeway, particularly around the southern area of Tuggerah Lake (OEH 2012a). Previous studies have recorded this species in the vicinity of Tooheys Road Site (ERM 1999) and within the Extraction Area (BHP 2002, 2003; ERM 2002, 2003).

xiii. White-fronted Chat (Epthianura albifrons)

Status: Vulnerable (TSC Act).

The White-fronted Chat is classified as a honeyeater and is similar in form to close relatives such as the Orange Chat, Yellow Chat and Crimson Chat. It has a distinguishing black and white colouration, short slender bill, long spindly legs, a short square-tipped tail and rounded wings (OEH 2012").

This species occurs mostly in the southern half of NSW, in damp open habitats along the coast, and near waterways in the western part of the state. In coastal areas, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas (OEH 2012").

There are no recent records for this species within the locality or wider Wyong LGA. Although recent OzArk surveys did not locate this species, previous studies have recorded this species in the vicinity of Tooheys Road Site (ERM 1999).

xiv. Black Bittern (Ixobrychus flavicollis)

Status: Vulnerable (TSC Act).

The Black Bittern is a dark grey to black coloured heron with buff streaks on the throat and characteristic yellow streaks on the sides of the head and down the neck (OEH 2012h).

This species inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. It is often found in flooded grassland, forest, woodland, rainforest and mangroves (OEH 2012h).

There are seven records in locality and a total of 19 in the Wyong LGA, with most occurring near Tuggerah Lake (OEH 2012a). Although recent OzArk surveys did not locate this species, previous studies and historic records have recorded this species within the Extraction Area (BHP 2002, 2003; ERM 2002, 2003).

xv. Black-tailed Godwit (Limosa limosa)

Status: Vulnerable (TSC Act), Migratory (EPBC Act).

The Black-tailed Godwit is a large wader with a distinctive long, straight pink bill with a black tip. There is a sharp demarcation between the white rump and the black tail. The wing has a white wing-bar across the dark flight feathers, and white underwing coverts. The non-breeding plumage, observed in Australia, is greyish-brown above and white below, and a grey breast (OEH 2012g).

It is primarily a coastal species and is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. In inland areas, it can found on mudflats or in water less than 10 cm deep, around muddy lakes and swamps. Individuals have been recorded in wet fields and sewerage treatment works (OEH 2012g).

There are 2 records for this speices in the Wyong LGA, near Tuggerah Lake (OEH 2012a). Although recent OzArk surveys did not locate this species, previous studies have recorded this species in the vicinity of Tooheys Road Site (ERM 1999).

xvi. Eastern Pygmy Possum (Cercartetus nanus)

Status: Vulnerable (TSC Act).

Eastern Pygmy-possums is a small, active climber, with large, forward pointing ears and, a head and body length range of 70 – 110 mm. The tail is prehensile, almost bare and reaches lengths of up to 105 mm. They have a light brown dorsal surface and a white ventral surface (OEH 2012p).

They are found in a broad range of habitats such as rainforests, sclerophyll forests, woodlands and heath with a preference for woodlands/heath appear (OEH 2012p).

Eastern Pygmy Possum was recorded at a single location in Coachwood – Crabapple rainforest within the Extraction Area. There are no previous records for this species in the locality but there are 16 records of the species within the Wyong LGA (OEH 2012a), with one occurring in Munmorah SCA and the others within Olney SF.

xvii. Squirrel Glider (Petaurus norfolcensis)

Status: Vulnerable (TSC Act).

Adult Squirrel Gliders are medium sized gliders, reaching head-body lengths of 20 cm. The fur is blue-grey to brown-grey on the dorsal surface and white on the belly. The tail is soft and busy, with black fur on the end third and reaches lengths of up to 27 cm. They have a dark stripe starting from between the eyes extending to the mid-back and distinct facial markings (OEH 2012Œ).

Squirrel Gliders commonly inhabit Blackbutt-Bloodwood forest with heath understorey in coastal areas with a preference for mixed species strands with an open or shrubby understorey (OEH 2012Œ).

Squirrel Gliders were recorded at 3 locations in the Tooheys Road Site, in Scribbly Gum – Red Bloodwood woodland and Blackbutt – Turpentine forest.

Previous studies have also recorded this species in the Tooheys Road Site and Hue Hue Road offset area (ERM 1998a, 1998b, 1999; 2002; BHP 2002, 2003). There are 93 records of the species in the locality and 147 within the Wyong LGA (OEH 2012a), predominantly concentrated on the eastern side of the F3 Freeway but with scattered records within Jilliby SCA and Olney SF.

xviii. Yellow-bellied Glider (Petaurus australis)

Status: Vulnerable (TSC Act).

The Yellow-bellied Glider is a large, active, glider, reaching head-body lengths of about 30 cm. It has a large bushy tail which is about 45 cm long. The fur is grey to brown on the dorsal surface with a cream to yellow belly and a characteristic dark stripe down the back. It has a large, gliding membrane that extends from the wrist to the ankle (OEH 2012–).

They generally occur in tall mature eucalypt forest, usually in areas with high rainfall and nutrient rich soils (OEH 2012–).

Yellow Bellied gliders were recorded at nine locations within the Extraction Area in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest and one location in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road offset area. Previous studies have also recorded this species in the Tooheys Road Site (ERM 2002) and the Extraction Area (BHP 2002, 2003). There are 139 records of the species in the locality and 270 within the Wyong LGA (OEH 2012a), with most occurring on the western side of the F3 Freeway, distributed among Jilliby SCA, Olney SF and Ourimbah SF.

xix. Grey-headed Flying-Fox (Pteropus poliocephalus)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

The Grey-headed Flying-fox is a large bat, with a head and body length of 23 - 29 cm and a wingspan of up to 1 m. It has black wing membrane, dark grey fur on the body and lighter grey fur on the head with a russet collar encircling the neck. A distinguishing feature is the leg fur which extends to the ankle (OEH 2012z).

This species occurs in a variety of habitats, ranging from subtropical and temperate rainforests to tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. They have roosting camps, often in gullies with dense vegetation and nearby water, which are generally located within 20 km of a regular food source. Individual camps may have tens of thousands of animals and are used for mating, giving birth and rearing young (OEH 2012z).

Grey-headed Flying-foxes were recorded at eight locations within the within the Extraction Area in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest. There are 30 records of the species in the locality and 66 within the Wyong LGA (OEH 2012a), with most occurring on the eastern side of the F3 Freeway, mainly around the Tuggerah Lake area and in Munmorah SCA.

xx. Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris)

Status: Vulnerable (TSC Act).

Yellow-bellied Sheathtail-bat is a large, insectivorous bat, growing up to 87 mm long. It has a glossy, jet-black back, a white to yellow belly extending to the shoulders and long, narrow wings. The tail is covered with an extremely elastic sheath and it has a distinctive flattened head with a sharply-pointed muzzle (OEH 2012—).

This species is primarily a tree-hollow roosting species although it will roost in buildings. It forages in a wide range of habitats, both with and without trees, and appears to defend an aerial territory (NSW Scientific Committee 2004h).

The Yellow-bellied Sheathtail-bat was recorded at 1 location in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road Site. Previous studies have also recorded this species in the within the Tooheys Road Site and Hue Hue Road offset area (ERM 1999). There are 3 records of the species in the locality (OEH 2012a), located on the eastern side of the F3 Freeway, near Sparks Road.

xxi. East-coast Freetail Bat (Mormopterus norfolkensis)

Status: Vulnerable (TSC Act).

The East-coast Freetail-bat is a solitary, insectivorous bat (Churchill 2008) with dark brown to reddish brown fur on the back and slightly paler underparts. It has a long bare tail protruding from the tail membrane which can be about 3 – 4 cm long (OEH 2012o).

This species is most commonly found in open spaces in dry sclerophyll forests, woodland and swamp forests in eastern NSW (NSW Scientific Committee 2004a). The species mainly roost in spout hollows of large mature trees and sometimes under bark or in man-made structures. It is also known to forage in gaps in upper-slope vegetation and over larger waterways (OEH 2012o).

The East-coast Freetail-bat was recorded from three locations in Coachwood Crabapple rainforest and Spotted Gum – Grey Ironbark forest within the Extraction Area and three locations in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road Offset area. Previous studies have recorded this species in the Extraction Area (ERM 2003) and there are 28 records of the species in the locality. Records for the Wyong LGA (OEH 2012a) indicate that this species mostly occurs on the eastern side of the F3 Freeway, distributed from Ourimbah up to Chain Valley Bay.

xxii. Eastern False Pipistrelle (Falsistrellus tasmaniensis)

Status: Vulnerable (TSC Act).

The Eastern False Pipistrelle is a relatively large microbat with a head-body length of about 65 mm. The fur on the dorsal surface is dark to reddish-brown and pale grey on the underside. The long, slender ears are set well back on the head and there is some sparse hair on the nose (OEH 2012n).

This species prefers moist habitats, with trees taller than 20 m. It usually roosts in eucalypt hollows, but can also be found under loose bark on trees or in buildings (OEH 2012n).

The Eastern False Pipistrelle was recorded at 15 locations within the Study Area – 4 at the Tooheys Road Site, 3 at the Hue Hue Road Offset site and 8 within the Extraction Area. Individuals in the Tooheys Road Site were found in Scribbly Gum – Red Bloodwood woodland or Blackbutt – Turpentine Forest, in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road offset while those in the Extraction Area were found either in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine Forest. Previous studies have also recorded this species in the Extraction Area (BHP 2002). There are 16 records of the species in the locality and 49 within the Wyong LGA (OEH 2012a), with most occurring along the F3 Freeway but with some sightings in Olney SF.

xxiii. Golden-tipped Bat (Kerivoula papuensis)

Status: Vulnerable (TSC Act).

The Golden-tipped Bat is a large bat with a wingspan of about 25 cm. It has dark brown, curly fur with bright golden tips which extends along the wings, legs and tail. It has a short, pointed, over-hanging muzzle and pointy, funnel-shaped ears (OEH 2012v).

This species is found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. It has also been recorded in tall open forest, Casuarina dominated riparian forest and coastal Melaleuca forests. It mainly roosts in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests but is also found in tree hollows, dense foliage and epiphytes; located in rainforest gullies on small first and second-order streams (OEH 2012v).

The Golden-tipped bat was recorded from 1 location in Smooth-barked Apple – Red Bloodwood open forest within the Hue Hue Road Offset. There are 24 records in the locality and 48 records in the Wyong LGA, distributed among Jilliby SCA, Olney SF and Ourimbah SF (OEH 2012a).

xxiv. Little Bentwing Bat (Miniopterus australis)

Status: Vulnerable (TSC Act).

The Little Bentwing Bat is a small insectivorous bat with a body length of about 45 mm. It has long, thick fur, especially around the neck and crown, which is dark chocolate brown on the back and lighter on the belly. The muzzles are short and the ears are rounded and roughly triangular in shape. The tip of the wing is formed by a particularly long joint of the third finger, folded back and bent under the wing while the bat is at rest (OEH 2012□).

The species inhabits a variety of habitats ranging from moist eucalypt forest, rainforest, wet and dry sclerophyll forests and vine thickets to *Melaleuca* swamps, dense coastal forests and Banksia scrub. It is generally found foraging in densely vegetated habitats and roosts in a variety of places such as caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings (OEH 2012□).

The Little Bentwing Bat was recorded at 17 locations in the Study Area – 13 in the Extraction Area and four in the Hue Hue Road Offset. Individuals in the Extraction Area were found either in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest while those in the Hue Hue Road Offset were found either in Spotted Gum – Broadleaved Ironbark forest or Smooth-barked Apple – Red Bloodwood open forest. Previous studies have also recorded this species in the vicinity of the Tooheys Road and Hue Hue road offset areas (ERM 1998a, 1998b, 1999). There are 17 records of the species in the locality and 47 within the Wyong LGA (OEH 2012a), with most occurring on the eastern side of the F3 Freeway, distributed from the Ourimbah up to Chain Valley Bay and some scattered records within Jilliby SCA and Ourimbah SF.

xxv. Eastern Bentwing Bat (Miniopterus orianae oceanensis)

Status: Vulnerable (TSC Act).

The Eastern Bentwing Bat has a head and body length of about 6 cm and a wingspan of 30 - 35 cm. The fur on the back varies from chocolate to reddish-brown with slightly lighter coloured fur on its belly. It has a short snout and a high, domed head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the species its characteristic 'bentwing' appearance (OEH 2012m).

This species is insectivorous and almost exclusively roosts in caves and artificial constructions such as mines along the east coast of Australia (Churchill 2008). In south eastern Australia the species hibernates in underground sites, usually large caves with a constant microclimate, during winter. It requires very specific conditions in terms of temperature and humidity for maternity sites. The species changes roosts in response to seasonal needs, and in turn long-distance movements occur (OEH 2012m).

The Eastern Bentwing Bat was recorded at five locations in the Extraction area, predominantly in Mountain Blue Gum Turpentine forest with one recording near Honeysuckle Park. Previous studies have also recorded this species in the vicinity of the Tooheys Road area (ERM 1998b). There are 52 records of the species in the locality and a total of 118 within the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, Olney SF, Ourimbah SF and areas east of the F3 Freeway up to Tuggerah and Budgewoi Lakes.

xxvi. Southern Myotis (Myotis macropus)

Status: Vulnerable (TSC Act).

The Southern Myotis (formerly Large-footed Myotis) is a cave-dwelling, fishing bat with a wingspan of about 28 cm. It has disproportionately large feet; more than 8 mm long, which are distinctly hairy with widely-spaced toes and long, curved claws. The fur on the back varies from dark-grey to reddish brown and becomes paler on the belly (OEH 2012Š).

This species has a primarily coastal distribution along the east coast to the Kimberley, and along major rivers in south eastern Australia (Churchill 2008). They generally roost in groups of 10 - 15 in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Roosting sites are often close to water as the species forages over streams and pools catching insects, prawns and small fish by raking their feet across the water surface (NSW Scientific Committee 2004d).

The Southern Myotis was recorded at eight locations within the Study Area – one at Tooheys Road, four at Hue Hue Road Offset and three in the Extraction Area. The recording at Tooheys Road occurred in Scribbly Gum – Red Bloodwood woodland, in Spotted Gum – Broadleaved Ironbark forest or Smooth-barked Apple – Red Bloodwood open forest at Hue Hue Road and either in Mountain Blue Gum Turpentine forest or Spotted Gum – Grey Ironbark forest in the Extraction Area. Previous studies have also recorded this species in the vicinity of the Tooheys Road (ERM 1998b 1999) and the Extraction Area (ERM 2003). There are 26 records of the species in the locality and 48 within the Wyong LGA (OEH 2012a), mostly in areas east of the F3 Freeway but with scattered records within Jilliby SCA and near Wyong SF and Ourimbah SF.

xxvii. Greater Broad-nosed Bat (Scoteanax rueppellii)

Status: Vulnerable (TSC Act).

The Greater Broad-nosed Bat is a large, insectivorous bat, up to 95 mm long, with a broad head and a short square muzzle. The fur on the dorsal surface varies from dark reddish-brown to mid-brown and becomes slightly paler on the under parts (OEH 2012w).

The species is found in a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest. It mainly roosts in tree hollows and cracks or fissures in trunks and branches (NSW Scientific Committee 2004c). It is also known to prey on other microbat species (Churchill 2008).

The Greater Broad-nosed Bat was recorded at seven locations within the Study Area – three in Spotted Gum Broadleaved Ironbark forest in the Hue Hue road offset site and four in Spotted Gum – Grey Ironbark forest in the Extraction Area. Previous studies have also recorded this species within the Tooheys Road and Hue Hue road areas (ERM 1999, 2002). There are 34 records of the species in the locality and 72 within the Wyong LGA (OEH 2012a), mostly concentrated in areas along and to the east of the F3 freeway but with some scattered records to the north-west within Olney SF.

xxviii. Spotted-tailed Quoll (Dasyurus maculatus)

Status: Endangered (EPBC Act); Vulnerable (TSC Act).

The Spotted-tailed Quoll is about the size of a domestic cat. It has rich-rust to dark-brown fur on the dorsal side with irregular white spots on the back and tail, and a pale belly. The spotted tail is a distinguishing feature which is indistinct on juveniles (OEH 2012‹).

This species is found across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (OEH 2012‹).

There are 14 records of the species in the locality and 42 records in the Wyong LGA, spread across the LGA (OEH 2012a). Previous studies have recorded this species within the Extraction Area (BHP 2002, 2003).

5.7.2 Migratory Species

Six EPBC listed migratory bird species were recorded within the Study Area during OzArk surveys (**Table 5.7**) and their locations are shown in **Figure 5.6**. 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.

Table 5.8 Migratory bird species recorded within the Study Area during OzArk surveys

Scientific Name	Common Name	EPBC Status	Extraction Area	Buttonderry Site	Tooheys Road Site	Hue Hue Road Offset Site
Monarcha melanopsis	Black-faced Monarch	B	x			
Ardea ibis	Cattle Egret	C, J	x			

Table 5.8 Migratory bird species recorded within the Study Area during OzArk surveys

Scientific Name	Common Name	EPBC Status	Extraction Area	Buttonderry Site	Tooheys Road Site	Hue Hue Road Offset Site
Ardea alba	Great Egret	C, J	x			
Rhipidura rufifrons	Rufous Fantail	B	x			
Haliaeetus leucogaster	White-bellied Sea-eagle	C		x	x	x
Hirundapus caudacutus	White-throated Needletail	C,J,K	x			

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

Descriptions of migratory species recorded within the Study Area are provided below, along with a brief summary of their preferred habitats.

i. Black-faced Monarch (Monarcha melanopsis)

The Black-faced Monarch has a distinctive black face that does not extend across the eyes, grey upperparts, wings and upper breast, contrasting with a rufous (red-orange) belly (Australian Museum 2011).

The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. It is resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter. The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. The Black-faced Monarch forages for insects among foliage, or catches flying insects on the wing (Australian Museum 2011).

The Black-faced Monarch was recorded at 12 locations in either Spotted Gum – Grey Ironbark forest, Mountain Blue Gum Turpentine forest or over exotic grassland in the Extraction Area. There are no other confirmed records of the species in the Study Area, locality or within the Wyong LGA.

ii. Cattle Egret (Ardea ibis)

The Cattle Egret is small, stocky and mostly white with a short neck and stout yellow-red bill. During breeding and courtship the species has a heavy jowl, orange-buff crown, neck, breast and mantle. There is a marked seasonal variation in plumages during the breeding and non-breeding seasons. The name Cattle Egret comes from its association with cattle; namely its habit of eating ticks and flies off the backs of livestock (SEWPaC 2012c).

The Cattle Egret is a cosmopolitan species that occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass (SEWPaC 2012c).

This species was recorded at two locations: one in Blackbutt – Turpentine forest at Hue Hue Road and one over exotic grassland in the Extraction Area. This species has also been previously recorded in the Extraction Area and Tooheys Road areas (ERM 2003, ERM survey data files). There are 57 records for the Wyong LGA (OEH 2012a).

iii. Great Egret (Ardea alba)

Status: Migratory and Marine (EPBC Act)

The Great Egret is a moderately large bird with white plumage, a black or yellow bill and long reddish and black legs (SEWPaC 2012d).

The Great Egret has been reported in a wide range of wetland habitats including swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs (SEWPaC 2012d).

iv. This species was observed flying at two locations over exotic grassland in the Extraction Area. This species has also been previously recorded within the Study Area (ERM survey data files). There are no previous records of this species in the locality or the Wyong LGA.Rufous Fantail (Rhipidura rufifrons)

The Rufous Fantail is a medium sized bird, generally ranging from 14.5cm - 18.5cm in length. The forehead is a richly reddish-brown colour across the eyes, which have a white arc just below them. The top of the head, back of the neck and the upper back, transition from an olive to reddish-brown colour, which then blends into a blackish-brown, long, fan-shaped tail. This blackish-brown tail, contrasts with the base of the tail, which is tipped with a paler colour, often white (Thomas et al. 1996, Higgins et al. 2006).

The Rufous Fantail inhabits moist and moderately dense habitats. Within these areas, it has large variations in habitat requirements and can be found in eucalyptus forests, (usually near a river or swamp). Rarely, they have been found in dry sclerophyll forests (Higgins et al. 2006).

Rufous Fantails were recorded at five locations in Coachwood – Crabapple rainforest, Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest within the Extraction Area. This species was also previously recorded in the Tooheys Road area (ERM 1998a) and the Extraction Area (ERM 2003). There are no other confirmed records of the species within the locality or the Wyong LGA.

v. White-bellied Sea-eagle (Haliaeetus leucogaster)

The White-bellied Sea-Eagle is a large raptor, reaching lengths of 75–85 cm in length and wingspans of 180–220 cm. Plumage on dorsal surfaces and upper surfaces of the wings is grey while the head underparts and the feathering on the legs are white. The undersurface of the wings are greyish black while the wing tips are black. The tail is wedge-shaped, grey at the base and white at the tip (SEWPaC 2012j).

Within Australia, the White-bellied Sea Eagle is distributed mainly along the coastlines of mainland Australia and Tasmania, but can be found along some of the larger inland waterways. Preferred habitats characterised by large areas of open water (larger rivers, swamps, lakes, the sea) but individuals have been recorded in (or flying over) a variety of terrestrial habitats (SEWPaC 2012j).

White-bellied Sea Eagles were recorded over cleared areas at two locations within the Study Area – 1 each at Tooheys Road Site and Hue Hue Road offset area. This species has previously been observed passing over the Project Boundary near Hue Hue Road (ERM survey data file). There are a total of 105 records for the Wyong LGA (OEH 2012a), with most occurring on the eastern side of the F3 Freeway and concentrated along the coastline and shores of Tuggerah and Budgewoi Lakes.

vi. White-throated Needletail (Hirundapus caudacutus)

The White-throated Needletail is a large swift, reaching lengths of about 20 cm. It has a thickset, cigar-shaped body, stubby tail and long pointed wings. The face, head and neck are dark-olive with an iridescent gloss on the crown, a narrow, white band across the forehead and lores, and a white patch on the chin and throat. The mantle and back are pale grey, the underparts are generally dark-olive and the tail is black with a greenish gloss (SEWPaC 2012k).

This species is a regular non-breeding, summer migrant to eastern Australia. It is an insectivorous, tree roosting swift that is almost exclusively aerial in Australia (Pizzey and Knight 2003). The species commonly forages on insects in the airspace above forests, woodland, farmland and lakes (SEWPaC 2012k).

The White-throated Needle-tail was recorded at two locations, one in Spotted Gum – Grey Ironbark forest in the Extraction Area and 1 in Scribbly Gum – Red Bloodwood woodland at Tooheys Road. This species has previously been observed passing over the Project Boundary (ERM survey data files). There are 51 records for the Wyong LGA (OEH 2012a), occurring mostly along the coastline and shorelines of Tuggerah and Budgewoi Lakes but with scattered records in Jilliby SCA and Ourimbah SF.

vii. Glossy Ibis (Plegadis falcinellus)

The Glossy Ibis is the smallest ibis known in Australia. The neck is reddish-brown and the body is a bronze-brown with a metallic iridescent sheen on the wings. The Glossy Ibis has a distinctive long, downwards curved bill that is olive-brown in colour (SEWPaC 2012p).

The Glossy Ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Within Australia, the largest contiguous area of prime habitat is inland and northern floodplains. The Glossy Ibis is commonly in largest numbers in drying Top End grass/sedge swamps and Channel Country grass/forb meadows. The species is sometimes recorded in wooded swamps, artificial wetlands (such as irrigated fields), and in mangroves for breeding (SEWPaC 2012p).

This species was not recorded during OzArk surveys but has been sighted in the Study Area in previous studies (ERM survey data files). There are a total of 4 records for the Wyong LGA (OEH 2012a).

viii. Lathams Snipe (Gallinago hardwickii)

Latham's Snipe is a medium sized wader, and the largest snipe in Australia, It has a long straight bill, rather short broad pointed wings, a long tail and short legs. The cryptic plumage is intricately marked with barring and chevrons of buff, black and various shades of brown, with blackish-brown stripes across the crown and cream streaks down the back. The belly and parts of the head are white, and the tail is rufous with a white tip (SEWPaC 2012i).

Latham's Snipe breeds in northern Japan and Russia and migrates to Australia for winter. It occurs in a wide variety of permanent and ephemeral wetlands. They usually occur in open, freshwater wetlands that have some form of shelter (usually low and dense vegetation) nearby. They generally occupy flooded meadows, seasonal or semi-permanent swamps, or open waters, but various other freshwater habitats can be used including bogs, waterholes, billabongs, lagoons, lakes, creek or river margins, river pools and floodplains. The structure and composition of the vegetation that occurs around these wetlands is not important in determining the suitability of habitat (SEWPaC 2012i).

This species was not recorded during OzArk surveys but tentative sightings have been made in the Extraction Area in previous studies (ERM 2003, ERM survey data files). There are a total of 17 records for the Wyong LGA (OEH 2012a).

5.8 Potentially Occurring Threatened and Migratory species

This section describes threatened fauna species and migratory species that were not recorded within the Study Area during the various studies conducted but are considered to have potential to occur based on a combination of suitable habitat within the Study Area, distribution and frequency as indicated by Atlas locality and LGA records (OEH 2012a) and EPBC locality and LGA records (SEWPaC 2012g), and confirmed sightings in the locality from other commissioned studies.

A comprehensive assessment of the likelihood of occurrence in the Study Area of threatened and migratory fauna species, known from and predicted to occur in the locality and Wyong LGA, has been conducted and is presented in **Appendix B.** This analysis includes:

- TSC Act listed threatened fauna species recorded from the locality and Wyong LGA (OEH 2012a);
- EPBC Act listed species predicted to occur based on availability of habitat in the locality and Wyong LGA (SEWPaC 2012g); and
- Threatened species recorded in the locality from other surveys by ERM (1998a, b); ERM (1999); BHP (2002); ERM (2002); BHP (2003) and ERM (2003).

Descriptions of threatened and migratory species with potential to occur within the Study Area are provided below, along with a brief summary of their preferred habitats.

i. Giant Burrowing Frog (Heleioporus australiacus)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

The Giant Burrowing Frog is a large, powerfully built frog, growing to about 10 cm long. It has muscular hind limbs and enlarged tubercles on the feet which are well adapted to burrowing. Colouration varies from a steely blue grey to black on the limbs and upper body with paler sides. The body surface is granular and adorned with creamy white to yellow warts. The underside is generally white but occasionally with a tinge of bluish grey or brown (OEH 2012t).

This species is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based (OEH 2012t).

There are 47 records in the Wyong LGA, with most occurring within Ourimbah SF (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

ii. Littlejohn's Tree Frog (Litoria littlejohni)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

The Littlejohn's Tree Frog is a small frog reaching snout-vent lengths of about 55 – 60 mm. The body is generally pale brown, with dark speckles and a broad, dark band down its back while the belly is white or cream. The groin, armpit and back of the thighs have large orange patches and a brown bar runs from the tip of the snout through the nostrils to the top of the arm (SEWPaC 2012l).

This species is found in heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground (OEH 2012,).

There are 15 records in the Wyong LGA, with most occurring within Jilliby SCA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

iii. Stuttering Frog (Mixophyes balbus)

Status: Vulnerable (EPBC Act); Endangered (TSC Act).

The Stuttering Frog is a relatively large, muscular frog growing up to lengths of about 8 cm. The body colour is brown to olive-green, usually in an irregular blotchy pattern, with a creamy-white underside, barred hind legs and a black line from the snout, through the eye, and above the 'ear'. The eyes are large and black eyes with vertical pupils and a distinctive pale-blue crescent across the upper half (OEH 2012□).

This species is found in rainforest and wet, tall open forest in foothills and escarpments on the eastern side of the Great Dividing Range. In non-breeding periods adults live in deep leaf litter and thick understorey vegetation on the forest floor (OEH 2012□).

There are 69 records for this species in the locality and 107 for the Wyong LGA, distributed between Jilliby SCA, Olney SF and in the vicinity of Ourimbah SF (OEH 2012a). Previous studies have located suitable habitat for this species in the Extraction Area (ERM 2003) and historic records have located this species in the Extraction Area (OEH 2012).

iv. Stephens' Banded Snake (Hoplocephalus stephensii)

Status: Vulnerable (TSC Act)

Stephens' Banded Snake is a medium-sized partly tree-dwelling snake up to one metre long. It is brown or yellow-brown above, with a series of irregular, broad, dark crossbands (OEH 2012□).

It is a partly tree-dwelling snake that inhabits rainforest and eucalypt forests and rocky areas up to 950 m in altitude. It is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day (OEH 2012□).

There are two records of this species in the locality and a total of eight records for the Wyong LGA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

v. Australasian Bittern (Botaurus poiciloptilus)

Status: Endangered and Migratory (EPBC Act); Vulnerable (TSC Act)

The Australasian Bittern is a large, stocky, heron-like bird with camouflage-like plumage. The upperparts are brown and dark brown to black, mottled buff in complex patterns that aid the bird's concealment in swamp vegetation; the underparts are streaked and scalloped brown and buff (OEH 2012b).

In Australia, the Australasian Bittern mainly occurs in terrestrial wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours

permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (OEH 2012b).

There are two records of this species in the locality with a total of seven for the Wyong LGA (OEH 2012a) and suitable habitat for this species has been recorded within the Study Area (ERM 2003).

vi. Australian Painted Snipe (Rostratula australis)

Status: Vulnerable and Migratory (EPBC Act); Endangered (TSC Act)

The Australian Painted Snipe is a stocky wading bird with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye, and a white crown stripe, and metallic green back and wings, barred with black and chestnut (SEWPaC 2012s).

The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (SEWPaC 2012s).

There are no records of this species in the Wyong LGA but it was listed on the EPBC Protected Matters Search Tool. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

vii. Barking Owl (Ninox connivens)

Status: Vulnerable (TSC Act).

The Barking Owl is a medium-sized owl, about 42 cm long. It has bright yellow eyes and no facial-disc. The dorsal parts are brown or greyish-brown, and the white breast is vertically streaked with brown. The talons are large and yellow (OEH 2012c).

This species inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. Hunting can extend in to closed forest and more open areas (OEH 2012c).

There are two records in the locality and three records in the Wyong LGA, distributed around Tuggerah Lake (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

viii. Bush Stone-curlew (Burhinus grallarius)

Status: Endangered (TSC Act).

The Bush Stone-curlew is about 55 cm tall with a grey to light brown back, marked with black blotches, and a streaked rump. The underparts are buff and white with dark streaks, and a

black band that runs from near its eye down its neck. It has large, bright yellow eyes and a hunch-shouldered stance on long spindly legs (OEH 2012i).

This species inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber (OEH 2012i).

There is one record in the locality and three records in the Wyong LGA, distributed among Jilliby SCA, Ourimbah SF and the southern shores of Tuggerah Lake (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

ix. Fork-tailed Swift (Apus pacificus)

Status: Migratory and Marine (EPBC Act)

The Fork-tailed Swift is a medium-sized Swift, with a slim body with long scythe-shaped wings that taper to finely pointed tips. It is characterized by a long and deeply forked tail. The Fork-tailed Swift is mainly blackish with a white band across the rump and a white patch on the chin and throat. The body, tail and upperwings are black-brown and they have a faint pale scaling to the saddle and white scalloping to the underbody (SEWPaC 2012b).

In NSW, the Fork-tailed Swift is recorded in all regions. It is an aerial feeder that mostly occurs over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found above rainforests, wet sclerophyll forest or open forest or plantations of pines (SEWPaC 2012b).

There are 11 records in the Wyong LGA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

x. Gang-gang Cockatoo (Callocephalon fimbriatum)

Status: Vulnerable (TSC Act).

Gang-gang Cockatoos range in length from 32 to 37 cm, with a wingspan of 62 to 76 cm and are mostly slate-grey. Males have a distinctive scarlet head and wispy crest, while females have a grey head and crest and feathers edged with salmon pink on the underbelly (OEH 2012r).

They are generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests but can migrate to lower altitudes, drier more open eucalypt forests and woodlands in winter. They are often found in urban areas (OEH 2012r).

There are 10 records in the locality and 53 records in the Wyong LGA, with most occurring within Olney SF but with some records within Jilliby SCA and Ourimbah SF (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xi. Rainbow Bee-eater (Merops ornatus)

Status: Migratory and Marine (EPBC Act)

The Rainbow Bee-eater is a medium-sized bird with green or blue-green colouring on the forehead and chestnut on the back of the head. There is a bold black stripe across the eye that is bordered below by a narrower blue stripe and bright yellow colouring on the chin and cheeks that changes to chestnut around the throat and is bordered by a conspicuous, crescent-shaped black patch on the front of the neck (SEWPaC 2012m).

The Rainbow Bee-eater occurs in a wide variety of habitats, mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats. It often occurs in habitats located in close proximity to permanent water. It has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches, in riparian, floodplain or wetland vegetation assemblages (SEWPaC 2012m).

There are four records of this species in the Wyong LGA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

xii. Regent Honeyeater (Anthochaera phrygia)

Status: Endangered (EPBC Act); Critically Endangered (TSC Act)

The Regent Honeyeater has a black head, with a patch of warty, dirty yellowish to pinkish skin around its dark red-brown eye, and a sturdy, decurved, black bill. The upperparts of its body are black, but heavily scalloped with pale yellow, and the wings each have three conspicuous panels that are predominantly darker yellow. The upper tail, when closed, is black with a yellow tip and edge (SEWPaC 2012a).

This species inhabits temperate woodland and dry open forest; Box-Ironbark woodland and riparian forests of River Sheoak. It sometimes occurs in coastal forest, especially in stands dominated by Swamp Mahogany, Spotted Gum, and Southern Mahogany (SEWPaC 2012a).

There are seven records of this species in the locality with a total of 14 for the Wyong LGA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

xiii. Satin Flycatcher (Myiagra cyanoleuca)

Status: Migratory (EPBC Act)

The Satin Flycatcher is characterised by an upright posture, short erectile crest, and a distinctive habit of quivering the tail when perched. Males are glossy blue-black above, with a blue-black chest and white below, while females are duskier blue-black above, with an orange-red chin, throat and breast, and white underparts and pale-edged wing and tail feathers (SEWPaC 2012o).

Satin Flycatchers 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 (SEWPaC 2012o).

There are no records of this species in the Wyong LGA and it has not been recorded within the Study Area. However it was recorded on the EPBC Protected Matters Search Tool and it is considered to have potential to occur based on the availability of suitable habitat.

xiv. Swift Parrot (Lathamus discolor)

Status: Endangered (EPBC Act); Endangered (TSC Act).

The Swift Parrot is a small parrot about 25 cm long with a distinctive thin, long tail, about 12 cm. The body is bright green with a blue-purple crown, red tail, and red around the bill, throat and forehead. The red on its throat is edged with yellow and there are bright red patches under the wings (OEH 2012□).

This species migrates to the Australian south-east mainland between March and October and is found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Their favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*) (OEH 2012□).

There are 12 records in the locality and 118 records in the Wyong LGA, concentrated completely along the eastern side of the F3 Freeway, from the southern edge of Tuggerah Lake to the northern shores of Lake Munmorah (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xv. Large-eared Pied Bat (Chalinolobus dwyeri)

Status: Endangered (EPBC Act); Vulnerable (TSC Act).

The Large-eared Pied Bat is a small to medium-sized bat with long, prominent ears and glossy black fur. This species is a wattled bat, having small lobes of skin between the ears and corner of the mouth. The lower body has broad white fringes running under the wings and tail-membrane, meeting in a V-shape in the pubic area (OEH 2012}).

This species roosts in caves entrances, crevices in cliffs, gullies, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*) in dry open forest and woodland. Maternity roosts are generally found in roof domes in sandstone caves and overhangs (OEH 2012}).

There are three records in the locality and four records in the Wyong LGA, with one occurring near the F3 Freeway and others distributed among Olney SF and Jilliby SCA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to

occur based on the availability of suitable habitat in the Study Area and the proximity of the historic records to the Project Boundary.

xvi. Koala (Phascolarctos cinereus)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

The Koala is an arboreal marsupial with fur ranging from grey to brown above, and white on the belly. It has large furry ears, a prominent black nose and no tail. It has long, sharp claws, adapted for climbing and spends most of its time in trees (OEH 2012|).

Koalas inhabit eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species. They develop preferences for some species in any one area. They are generally inactive for most of the day, feeding and moving mostly at night (OEH 2012|).

There are 11 records in the locality and 36 records in the Wyong LGA, spread across the LGA (OEH 2012a). It has not been previously recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Chapter **6**

Impact Assessment

This Chapter considers the ecological impacts of the Project on the biodiversity values of the Study Area and surrounding landscape.

The Study Area is located within a region that has already been substantially altered by long-term vegetation clearing for agriculture, farms, forestry and infrastructure. This has resulted in a highly disturbed and fragmented landscape. Despite this, the Study Area has been shown to support a high diversity of threatened flora and fauna and ecological communities, as described in **Chapter 5**.

The ecological impacts of the Project are largely related to direct habitat loss from vegetation clearing and indirect impacts from subsidence. The loss of native vegetation and habitat that is necessitated by the Project will directly and indirectly impact on flora and fauna assemblages. The potential impacts upon threatened species are discussed below, and focus upon flora and fauna that are known to occur in the Study Area. It also applies to the species discussed in **Chapter 5** that, although not confirmed as being present on site, are regarded to have potential to occur. Cumulative impacts to flora and fauna within the locality, the duration and timing of impacts, and the permanence and reversibility of impacts are also discussed.

Assessments of Significance have been prepared for populations and species that have been recorded or which have a high potential to occur within the Study Area to determine the potential impacts of the Project on these species (**Appendix H**).

6.1 Direct Loss of Vegetation and Habitat

The largest direct impact of the Project is the removal of native vegetation that, in addition to providing habitat for native flora and fauna, also 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.

Approximately 89 ha of vegetation comprising remnant and regenerating forest and woodland and large areas of open grassland (exotic and DNG) with scattered trees will be removed over the life of the Project within the Disturbance Boundary. These vegetation communities provide habitat for a range of flora and fauna, including species listed as threatened or migratory under the EPBC Act and/or TSC Act.

The direct removal of forest and woodland communities will impact the vegetation communities of the Study Area, both threatened and non-listed, by reducing their overall extent. This includes various communities that conform to the TSC Act listed EECs. The areas to be cleared 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 **Table 6.1** and **Figure 6.1**.

Table 6.1 Vegetation communities to be removed from the Infrastructure areas

Vegetation Community	Area of vegetation to be removed			
	Tooheys Road	Buttonderry	Western Shaft	Total Area
Blackbutt - Turpentine open forest of the foothills of the North Coast **(EEC)**	5.9	0.0	0.0	5.9
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	0.0	0.0	1.7	1.7
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin **(EEC)**	1.1	0.0	0.0	1.1
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	33.8	0.0	0.0	33.8
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	1.8	2.0	0.0	3.8
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin **(EEC)**	0.0	4.5	0.0	4.5
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	0.0	0.0	0.8	0.8
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin **(EEC)**	1.8	0.0	0.0	1.8
Derived Native Grassland	7.3	0.0	0.0	7.3
Exotic/Agricultural/Low Diversity Grassland	24.2	3.6	0.2	28.0
Water/Farm Dam	0.5	0.1	0.0	0.6

Table 6.1 Vegetation communities to be removed from the Infrastructure areas

Vegetation Community	Area of vegetation to be removed			
	Tooheys Road	Buttonderry	Western Shaft	Total Area
Cleared	13.2	0.2	0.5	13.9

The direct removal of vegetation communities is likely to result in the following impacts to remaining habitat by:

- 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 (**Section 6.1.1**);
- Exacerbating fragmentation and isolation of already patchy woodland areas. (**Section 6.1.2**); and
- Increasing edge effects, particularly along linear patches (**Section 6.1.3**)

The woodland and forest areas to be cleared range from young, regrowth vegetation with native understorey to areas characterised predominantly by the presence of canopy species with modified understorey. Areas with modified understorey occur predominantly around the fringes of the vegetation patches adjacent to low condition exotic grassland areas at the Tooheys Road and Buttonderry Sites but are still considered to be in moderate to good condition. Offset strategies have been developed to address and counter such predicted impacts. These are discussed in **Chapter 8.**

6.1.1 Loss of Important Habitat Features

Fauna habitats supply various resources for species to survive such as sufficient territory for a home range; macro- and micro-physical habitat features; and the availability of food, water, nest and/or den sites (Bookhout 1996). The quality of these resources is dependent upon location and past land use. Remnant vegetation supports a higher diversity and abundance of habitat features than areas which have been cleared and subsequently regrown as they generally lack many habitat features. This is mainly because they are too young to support features like hollows and stags that require a lot of time to form.

Although the condition and nature of the fauna habitats within the Study Area have been altered by existing and historical land uses, large areas of remnant native vegetation remain in Wyong State Forest that contain high value habitat for the native fauna that were recorded in the Study Area. A relatively small area required to accommodate the Western Ventilation Shaft within the Infrastructure Boundary will be located in Wyong State Forest. However, the majority of the vegetation removal that will take place will be in more disturbed habitats to the east. Important fauna habitat features that will be removed by the Project include:

- **Mature forest and woodland** – loss of structural diversity from mature vegetation that provide more niche habitats for various animals to shelter, forage and nest;
- **Understorey vegetation** – loss of shelter and foraging habitat for amphibians, reptiles, small birds and terrestrial mammals;
- **Fallen logs, woody debris and leaf litter** – loss of shelter habitat for amphibians, reptiles and terrestrial mammals, and forage habitat for woodland bird species;
- **Hollow-bearing trees and stags** – loss of habitat for a range of fauna species which may rely on them for shelter, breeding or roosting;
- **Nectar-producing trees and shrubs** – loss of food resources for blossom-dependant birds, arboreal mammals and flying-foxes;
- **Shrubs and grasses** – loss of food resources for a range of passerine birds and herbivorous mammals;
- **Ecotonal (edge) communities** – loss of foraging habitat for many species, particularly birds such as raptors;
- **Ephemeral drainage lines** – loss of foraging, shelter and breeding habitat for amphibians, aquatic reptiles, wetland birds and aquatic mammals; and
- **Constructed farm dams with aquatic vegetation** – loss of foraging and breeding habitat for amphibians, aquatic reptiles and wetland birds.

Remnant paddock trees and the hollow resources provided by these trees are valuable characters that are often in high demand in fragmented landscapes such as that of the Study Area and are discussed in further detail below.

i. Remnant Trees and Associated Hollows

Scattered remnant trees are considered to be keystone habitat features in cleared landscapes such as are found in the central and eastern parts of the Study Area that can promote natural regeneration of native woodland, facilitate fauna dispersal and provide some connectivity between remnant habitat patches (Manning et al. 2006, Rawlings et al. 2010). Larger, older eucalypts are more dependable forage habitat as they flower more regularly, intensely and for longer than smaller regrowth and regenerating trees (Lindenmayer et al. 2005). They also provide habitat in the form of fallen woody debris, hollows and stags. However, this does not reduce the importance of younger trees as they secure habitat, seed and other habitat resources for the future and replace older remnant trees as they begin to die (Rawlings et al. 2010).

Cleared parts of the Study Area contain scattered paddock trees of varying ages. Field observations determined that very few are of an age to have hollows. Furthermore it is possible that only a small proportion of available hollows are likely to be functional (Cockle et al., 2008) and so the importance of this limited resource in the Study Area is likely to be

quite high. The isolated and scattered nature of hollow-bearing remnant trees in the Study Area increases their value and significance in providing a limiting resource for many threatened fauna species. For example, the Powerful and Barking Owls have shown to be negatively impacted by the loss of remnant trees (ECC 2001) due to the nature and size of hollow requirements. Loss of large trees and associated nectar resources has also been identified as a significant threat to several hollow-specialist bird species including the EPBC-listed winter migrants Regent Honeyeater and Swift Parrot (ECC 2001, Gibbons and Lindenmayer 2002, Gibbons et al. 2002). Offset strategies have been developed to address and counter such predicted impacts. These are discussed in **Chapter 8.**

6.1.2 Habitat Fragmentation

Impacts of habitat loss can be exacerbated by fragmentation of vegetation that is not cleared (Lindenmayer et al. 1999). Fragmentation is the process whereby once continuous areas of habitat are divided into multiple smaller and discrete patches usually isolated from each other by significantly different environment. This is typically non-woodland or forest land such as grass or agricultural land, or artificial infrastructure (Primack 1993, Fahrig 2003, Manning et al. 2006). Animals are often unable to cross the intervening land, thereby causing so-called “barrier effects”. Fragmentation and barrier effects can adversely impact on daily movements of species; disrupt the successful dispersal of juveniles (Cooper and Walters 2002); and in extreme circumstances, affect large-scale migratory patterns (Lindenmayer et al. 1999, Fischer and Lindenmayer 2002). Those most vulnerable to barrier effects include smaller ground-dwelling species, those with low mobility and rare species as even a small reduction in movements can negatively affect genetic continuity within a population. Species least vulnerable to barrier effects tend to be those that are highly mobile (e.g. birds and bats), although even these species can vary in their response to barriers (Bennett 1990). In many cases, fragmentation and barrier effects can result in similar biodiversity outcomes to direct habitat removal (Bennett 1990, Reid 1999).

The fauna habitat within the Study Area is currently fragmented, particularly in the lower relief central part of the Study Area (the Extraction Area) along Jilliby Jilliby Creek and associated tributaries that have been cleared for grazing. These cleared areas effectively fragment the vegetated habitats that are present in Wyong SF and Jilliby SCA to the west from other vegetated habitats to the east of the Study Area and nearby habitats in Olney SF. The Main Northern Rail Line, F3 Freeway and Motorway Link Road disrupt links from the Project Boundary (excluding the Western Ventilation Shaft) to other patches of remnant vegetation to the east.

The Project may exacerbate the existing effects of fragmentation in the Study Area by the clearance of vegetated habitat for surface infrastructure; however this is expected to be minor. The Infrastructure Boundary locations are all located in and adjacent to existing cleared areas, and the additional clearing will not substantially affect remaining areas of native vegetation.

Areas of vegetation cleared for pasture and paddocks occur within parts of the offsets at both Tooheys Road and Hue Hue Road offsets. Furthermore, a maintained powerline easement and Tooheys Road bisect parts of the offset areas at Hue Hue Road and Tooheys Road. Clearing for the project is unlikely to exacerbate fragmentation that currently exists within these offset areas. In addition, grasslands within the offsets will be revegetated, thus decreasing the current fragmenataion within the offset areas. The offset strategies that have been developed to address and counter predicted impacts are discussed in **Chapter 8**.

6.1.3 Edge Effects

Edge effects refer to changes in physical and biological conditions that occur at an ecosystem boundary or interface between adjacent ecosystems (Fischer and Lindenmayer 2007), particularly between natural habitats such as forests and disturbed or developed land (Yahner 1988). Edge effects include microclimatic changes in light, temperature, humidity and wind, which can favour a suite of different species, including exotics, and therefore cause significant changes to the ecology of the patch (Lindenmayer and Fischer 2006).

The size and shape of a remnant patch determines its susceptibility to further degradation as fragmentation increases the ratio of disturbed “edge” habitat to more intact “interior” habitat (Manu et al. 2007). Edges are typically warmer, drier and exposed to more wind than remnant interiors and they increase the area of exposure to invasion by exotic and invasive flora and fauna (Bryson and Carter 2004), fire, erosion (Pimentel and Kounang 1998), loss of structural diversity, increased nutrient loading and pollution (Yahner 1988, Fischer and Lindenmayer 2007).

Much of the habitat within the Study Area is currently fragmented and subject to variable levels of edge effects. Some of it, particularly in Wyong State Forest to the west, is relatively intact with low levels of fragmentation and edge effects. The Project will result in the creation of additional areas of edge for the Infrastructure Boundary, however these are relatively small. The Infrastructure Boundary is mostly located in relatively degraded areas and will not cause significant edge effects. The Western Ventilation Shaft is located in Wyong State Forest, and this area has the highest quality vegetation in the Study Area. Nevertheless, the edge effects experienced are expected to be minor due to the small size of the proposed Disturbance Area and are unlikely to have long term effects on the ecology of this area.

There is potential for edge effects to impact upon parts of Offset areas at Tooheys Road due to the proximity of maintained powerline easements to the Infrastructure area. Assessment of the vegetation condition determined that current vegetation along these easement areas is in a moderate to good condition despite current edge effects. Nonetheless, a vegetation buffer zone is proposed for the offsets to reduce impacts from edge effects. The offset strategies that have been developed to address and counter predicted impacts are discussed in **Chapter 8**.

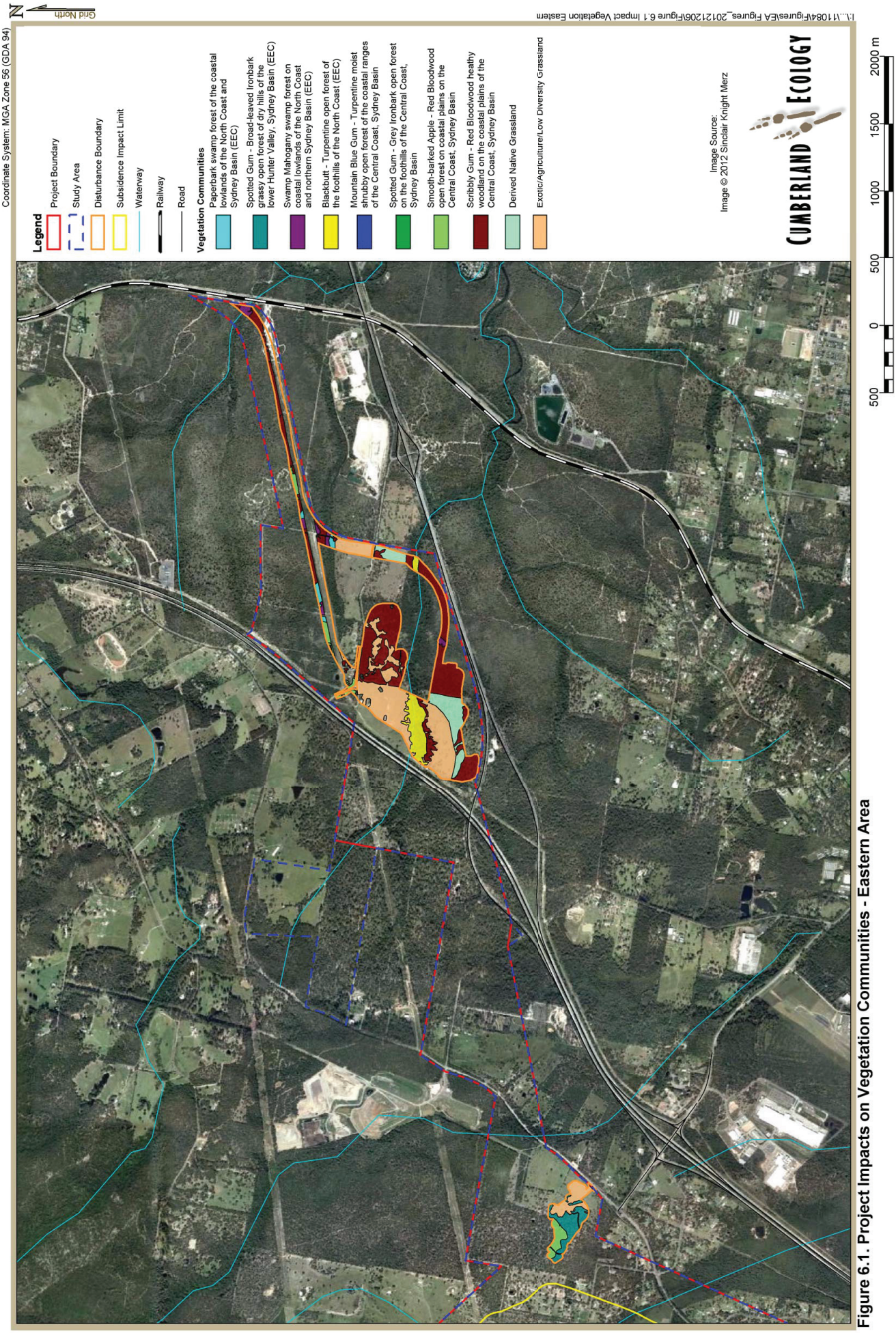

Figure 6.1. Project Impacts on Vegetation Communities - Eastern Area

Figure 6.2. Project Impacts on Vegetation Communities - Western Area

6.2 Impacts of Subsidence

Due to the underground longwall method of mining that is being employed for the Project; there is potential for impacts associated with subsidence to occur. Subsidence occurs where the surface of the land collapses and subsides into the void left after the coal is extracted. This has potential to change conditions on the surface, including changes in elevation, cracking of the soil surface and associated impacts on water flows and hydrology. The limit, magnitude and nature of subsidence movements are dependent on numerous factors, such as mine design, geological conditions, surface topography, and the distance between the mine workings and the ground surface (NSW DPI 2006).

The degree of subsidence impacts on the environment depends strongly on the magnitude/nature of subsidence, and the nature of the environmental system. Mining under watercourses on floodplains, or in other relatively flat-lying areas, may result in localised diversion of water flows and possible increases in the incidence of flooding, erosion and other impacts. Surface water may permeate into the shallow groundwater system through open fractures caused by subsidence. This water will usually return to the surface further downstream, but in some cases may be chemically altered by minerals in the rock strata. During extended periods of dry weather, the loss of surface water from rivers or creeks may become evident with a noticeable but localised reduction in surface flows. Altered flows and stream chemistry may have an impact on the lifecycle of aquatic species and riparian vegetation.

Alteration to habitat following subsidence from longwall mining constitutes a KTP under the TSC Act. The potential impacts arising from subsidence from the Project are considered in detail below.

6.2.1 Surface Cracking

The potential extent of subsidence in the Study Area has been modelled for the Project (Wyong Areas Coal Joint Venture 2012), and this indicates that surface cracking associated with longwall mining for the Project is unlikely to occur. This is partly a result of the depth of the proposed underground panels. Surface cracking is more often observed over shallow mines than deep operations such as that proposed by the Project. The subsidence modelling indicated that there would be some increased permeability in the immediate bedrock beneath the alluvium as a result of subsidence-related cracking, though it is predicted that this would only extend 10-15 m into the bedrock and not connect with the deeper, mining induced fracture systems. Actual surface cracking is also dependent on the thickness and inherent plasticity of the soils that overlie the bedrock. The floodplain of the Dooralong valley typically consists of 30 m of alluvium so the likelihood of surface cracks appearing on the floodplain is negligible.

Cracking caused by subsidence in non alluvial elevated hard rock areas may lead to localised redirection of groundwater flow paths in some areas. The elevated hard rock areas are those that are at higher altitudes in Wyong State Forest. Fissures that transect drainages in these areas may infill from sediment load during periods of surface runoff, or may remain as localised conduits redirecting flows down slope (including underflows).

It is not possible to predict with accuracy the location and hydraulic connectivity of such cracking. Hence it is possible that parts of a low-order ephemeral drainage line in elevated forested areas may exhibit localised reduction of runoff flow which would most likely be returned to the drainage system downstream (Mackie Environmental Research 2013).

6.2.2 Overall Subsidence

Although it is considered that the likelihood of surface cracks appearing is low, some overall subsidence will occur (Wyong Areas Coal Joint Venture 2012). Modelling indicates that the local main drainage feature (Jilliby Jilliby Creek) will also subside by a similar amount as the floodplain. This will maintain the same relative surface flow and seepage patterns as currently occurs because the Creek is the local drainage control point for flow and alluvial seepage. While overall subsidence in the floodplain generally ranges up to 1.4 metres, the amount of differential subsidence however is likely to be extremely low. Based on the maximum subsidence predictions, the difference in subsidence in the floodplain that will occur between the chain pillars and the longwall panels is between 200 and 250 mm over a distance of nearly 200 metres. This relatively even overall subsidence across the floodplain provides only a very, very slight gradient change that will be visually imperceptible and very difficult to measure. This will prevent or minimise any restrictions to movement or access by amphibians to existing preferred habitats.

6.2.3 Change in Water Table Level

The most significant impact on shallow alluvial groundwater resources is considered to be the temporary localised change in water table level (Mackie Environmental Research 2013). In areas with slopes of less than a few degrees subsidence will induce a fall in the alluvial water table elevation as a part of a panel is subsided relative to an adjacent unsubsided area. A maximum subsidence of the order of 1.4 m is predicted in areas associated with Jilliby Jilliby Creek and Dooralong Valley sediments while a maximum subsidence of the order of 2.4 m is predicted in areas of elevated topography which are predominantly areas of State forest (Mackie Environmental Research 2013). In the alluvial groundwater system, the relative change in groundwater levels from unsubsided to subsided areas will establish localised hydraulic gradients towards the subsided area. Groundwater will migrate towards the subsided area thereby lowering the water table in the unsubsided area and raising the water table in the subsided area. However all areas will continue to be recharged from rainfall and from surface drainages and there will be a general increase in groundwater storage and water table elevation within any subsided alluvial lands.

However, the subsided water table will recover, depending on the permeability and storage characteristics of local unconsolidated alluvial sediment, the recharge capacity of local drainages, and the prevailing climate. Impacts in the Study Area of an average 1.3 metres subsidence on alluvium storage have been calculated with an estimated recovery of between 55 and 75% in the water table expected within approximately 6 months in the absence of significant rainfall recharge (Mackie Environmental Research 2013). These are very conservative estimations however, and the subsided water table is likely to rapidly re-establish (at a shallower depth) following rainfall events.

6.2.4 Depletion of Alluvial Groundwater Storage

Other impacts of subsidence include depletion effects in the alluvial groundwater storage system. According to groundwater assessments completed for the Study Area (Mackie Environmental Research 2013) subsidence over underground longwall panels will directly affect the shallow alluvial groundwater systems as a result of temporary and localised change in the groundwater storage component of those systems. This change may occur through filling of temporary shallow cracks in hardrock immediately beneath the alluvium that have been caused by subsidence.

Filling of shallow cracks may lead to very localised short term depletion of alluvial groundwater storage followed by rapid recovery. These adjustments in storage are calculated to be small to negligible and unlikely to have any measurable impacts on the alluvial groundwater system. Connective cracking to deeper strata is not predicted to occur and hence shallow alluvial groundwater resources will not freely drain down to the mined panels.

Modelling indicates that alluvial groundwater storage will actually increase by approximately 2100 ML over the life of the Project, indicating that there will be no long term depletion but rather an enhancement of the alluvial groundwater storage.

6.2.5 Summary

The results of the groundwater assessment indicate that although some initial localised depletion of alluvial groundwater reserves and lowering of water table may occur, these impacts are expected to be minor and temporary, with recovery occurring following hydraulic equilibration and recharge by rainfall. As the depth to groundwater and the quantity of groundwater available to plants is not expected to change in the long term, this means that the communities that have developed as a result of the current drainage patterns are likely to persist in their current form in the Study Area.

6.3 Indirect Impacts

Although the direct impacts of the Project are expected to be relatively minor and restricted to the clearing of a relatively small area of native vegetation for the surface infrastructure, there is some potential for further indirect impacts to occur to the remaining vegetation and nearby environments.

6.3.1 Noise

The Project has the potential to generate noise during construction of surface and underground infrastructure and through routine mining operations. Although the mining operations will be conducted underground, noise can be generated at the surface by traffic, machinery and generators used in the daily operation of the Project. Some fauna species are sensitive to elevated levels of noise in their environment and this has the potential to impact negatively on these species (AMEC Americas Limited 2005).

Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts that include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC Americas Limited, 2005). Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise generated by the Project, has the potential to disrupt the species relying on these calls with deleterious results including reduced reproductive success and mortality (AMEC Americas Limited, 2005).

The noise created by the construction and operation of the Infrastructure areas is likely to affect native species and affect the value of the habitats that remain to some degree. Some species are likely to move in response to noise, and therefore the value of the habitat remaining around the infrastructure areas may decrease. This has the effect of increasing the amount of habitat for native species that will be removed as a result of the Project. However, it is likely that most animal species will habituate to the noise disturbance (AMEC Americas Limited, 2005), and the construction phase of the Project is likely to only cause temporary disturbance to fauna. Furthermore, the impacts from noise emissions are likely to be localised close to the operational area (up to 100m) and are not likely to have a significant, long-term impact on wildlife populations. In the long term, and depending on final post-mining land use, noise levels will return to normal following rehabilitation of the total mined area and cessation of mining.

6.3.2 Light

The Project has the potential to increase the level of artificial light in the natural environment. Increased light levels may adversely impact wildlife by direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in light levels (Saleh 2007, Longcore and Rich 2010)

Research into impacts from altered lighting indicates that it can trigger behavioural and physiological responses that include but are not limited to:

- Changes in foraging behaviour, such as when diurnal species begin foraging during night-time;
- A disruption of seasonal day length cues which trigger critical behaviours (Longcore and Rich 2004, Saleh 2007, Longcore and Rich 2010);
- Disorientation and/or temporary blindness; and
- Interference with predator-prey relationships.

While the construction and operational phases of the Project will have some effect on the surrounding woodland environment, the impacts from light pollution are likely to remain close to the immediate Infrastructure Areas, with only limited glare into the surrounding natural vegetation. It is likely that most fauna species would habituate to the relatively minor

disturbance and light pollution is unlikely to have a significant or long-term impact on any fauna species.

6.3.3 Vehicle Strike

Vehicle strike can pose a significant risk to some wildlife, particularly but not exclusively ground dwelling species (Taylor and Goldingay 2010). The Project will result in the construction of a new entry road and some minor tracks around the Tooheys Road site which means an increased length of road for animals to cross and navigate, as well as an increase in the number of vehicles operating in the Project Boundary. These changes are likely to increase the likelihood of vehicle strikes on native fauna, with an associated increase in mortality.

This is likely to be more significant during the construction phase, when vegetation and habitats are being cleared. This may also occur during the operation of the mine as a result of collision with vehicles entering and leaving the area as well as during the normal daily movements of workers and vehicles throughout the site.

Although some mortality of animals as a result of vehicle strike is likely, it is not expected to be significant. The main access road serving the Tooheys Road surface infrastructure is located in an existing cleared area alongside the F3 Freeway and, accordingly, has a low propensity for traversing fauna. Limiting speeds along internal roads, appropriate signage and careful driving policies will increase the awareness of drivers and decrease the risk of vehicles striking fauna.

6.3.4 Erosion

The Project has the potential to increase the amount of erosion occurring in the Project Boundary through the construction of roads, tracks and surface infrastructure. Soil disturbance will take place for the construction of the surface facilities and during wet periods large volumes of rain can wash away any disturbed earth relatively easily. This has the potential to result in sedimentation and increased turbidity of streams and would impact the aquatic environment. Sheet and rill erosion can occur where large areas are cleared, particularly on hillsides. Where there is no obvious existing channel for the water to follow, it will form rills or flow overland. The risk of this kind of erosion is likely to be exacerbated by vegetation clearing for the Project.

The overall area of land that is being impacted for the Infrastructure Boundary is relatively small (approximately 103 ha) and the underground mining is unlikely to result in substantial erosion. A range of sediment control measures will be implemented including installation of sediment control fences, bunds, covering of soil stockpiles and revegetation of disturbed areas. With the implementation of appropriate sediment and erosion control measures, this is not likely to impact surrounding vegetation or the aquatic environment.

6.3.5 Discharge to Wallarah Creek

The Project has the potential to affect the flow regime and water quality of Wallarah Creek through the discharge of surplus mine water into a tributary of Wallarah Creek. Discharge of treated water will occur at a single location within the Tooheys Road Site, at a predicted flow rate of 3 ML/day (WRM Water & Environment Pty Ltd 2013). As historical records indicate that Wallarah Creek is an ephemeral watercourse, there is potential for treated water discharges to occur at times when there is no natural flow in Wallarah Creek and would impact the environment, the aquatic environment in particular. There is also potential for increased bank erosion, particularly at the point of discharge, and changes to water quality, such as salinity, temperature and pH, from the treated water discharges into the Wallarah Creek tributary.

The overall flow rate of treated water discharge is relatively low and is unlikely to result in substantial erosion of creek banks. Although the treated water discharges could occur at times when there is no natural flow in the creek, the low rate of discharge is unlikely to have a significant impact on overall flow regime and the creek will retain its ephemeral nature (WRM Water & Environment Pty Ltd 2013). The proposed Water Treatment Plant will treat mine waters to a quality which is similar to existing receiving water quality within Wallarah Creek. With the implementation of an appropriate water management strategy, the controlled discharges into Wallarah Creek are not likely to impact surrounding vegetation. As the point of discharge occurs downstream of the proposed offset areas, there is very little potential for discharges to impact on the Offset areas. Impacts of discharge on the aquatic environment are discussed further in the Aquatic Ecology Report (Marine Pollution Research 2013).

6.3.6 Weeds and Feral Animals

Alterations to habitat conditions often favour introduced plant and animal species that can proliferate in disturbed conditions. Such species have potential to impact upon the original local native plant and animal species. Weeds such as thistles and other introduced plants have potential to out-compete regenerating native plant species. Feral animals such as foxes, rabbits and some species of birds can also breed in the more open areas following clearance of forest and woodland. They can impact on native fauna species by preying upon them or by competing with them for food and resources.

Several exotic fauna species have been recorded from the Study Area including the European Red Fox (*Vulpes vulpes*) and the European Rabbit (*Oryctolagus cuniculus*). The fox in particular has long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (SEWPaC 2010). Feral rabbits are known to degrade habitat by heavy grazing, and they compete directly for resources with native herbivores such as kangaroos and wallabies.

As outlined above, there is the potential for these species to negatively impact on the biodiversity values of remaining vegetation. To mitigate these potential impacts, a Biodiversity Management Plan (BMP) will be prepared that will contain mitigation measures to avoid these impacts. These will include monitoring levels of weeds and feral animals, and the implementation of control strategies when appropriate.

With the implementation of appropriate monitoring and control measures, it is not expected that weeds or feral animals will have a large impact on the biodiversity remaining the Study Area.

6.4 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. This section considers the potential impacts of the Project on these areas.

Parts of Jilliby SCA and Wyong SF are located within the Extraction Area in the Study Area, however the areas that will be cleared in the Infrastructure Boundary are not located within these areas. The parts of Jilliby SCA and Wyong SF that are located in the Extraction Area have potential to be impacted by subsidence to a limited degree. This is not expected to impact substantially on the ecological values of these areas as native vegetation and its associated habitat values will remain intact (See Section 6.2). There is some potential for some subsidence cracking to occur in the shallow surface zone, however these will be appropriately mitigated according to a Subsidence Management Plan (SMP) that will be prepared and implemented for the Project.

Large areas of native vegetation occur nearby in land within Ourimbah SF and Olney SF; however it is not expected that the Project will impact on these areas as they are outside the Subsidence Impact Limit and remote from areas of clearing associated with the surface infrastructure.

According to the Guidelines for Developments Adjoining Land and Water Managed by the Department of Environment, Climate Change and Water (DECCW, 2010), Councils and other consent authorities need to consider the following issues when assessing proposals adjoining DECCW (now OEH) land and, in particular, their impacts:

- Erosion and sediment control;
- Stormwater runoff;
- Wastewater;
- Management implications relating to pests, weeds and edge effects;
- Fire and the location of asset protection zones;
- Boundary encroachments and access through DECCW/OEH lands;
- Visual, odour, noise, vibration, air quality and amenity impacts;
- Threats to ecological connectivity and groundwater dependent ecosystems; and
- Cultural heritage.

This is relevant to the Jilliby SCA as this is managed by OEH. The State Forests are managed by the NSW Department of Primary Industries and not OEH.

As the majority of the Project consists of an underground mine, there is limited potential for the above listed impacts to occur on Jilliby SCA. No vegetation will be cleared from within Jilliby SCA, thereby avoiding most of these impacts, and it is considered that the conservation and recreation values of Jilliby SCA will remain.

Appropriate mitigation measures will be implemented to ensure that the above listed issues do not impact on Jilliby SCA or the other State Forests and these are detailed in **Chapter 8**. This includes appropriate sediment control measures to minimise impacts from erosion, sedimentation and stormwater runoff, as outlined in **Section 6.3.4**.

A BMP will be prepared for the Project (see Section 8.5) that will contain details of measures to manage the risk of weeds, pests and edge effects.

6.5 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 (SSF);
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (RFEF);
- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion (LHSGIF);
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (LR); and
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (FW).

The Project will remove small areas of EEC vegetation for the surface infrastructure and has the potential to impact on remaining vegetation through subsidence as a result of underground mining. Impacts to these communities are considered individually in more detail in subsequent subsections.

i. Swamp Sclerophyll Forest

The EEC Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSF) 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

This swamp community has an open to dense tree layer of eucalypts and paperbarks and the most widespread and abundant dominant trees include *Eucalyptus robusta* (Swamp Mahogany) and *Melaleuca quinquenervia* (Paperbark). Other trees may be scattered throughout at low abundance or may be locally common, including *Callistemon salignus* (Sweet Willow Bottlebrush), *Casuarina glauca* (Swamp Oak) and *Eucalyptus resinifera* subsp. *hemilampra* (Red Mahogany) (NSW Scientific Committee 2004g).

Approximately 64 ha of this community is present in the Project Boundary, of which a total of approximately 2.9 ha will be directly removed. A further 26.7 ha may be indirectly impacted on by subsidence. This community is more susceptible to subsidence impacts as there is the potential to alter the local hydrology and affect the water that is necessary for this community's survival.

An Assessment of Significance has been prepared to assess the potential impact of the Project on this community and is presented in **Appendix H**. This assessment indicates that no significant impact to this community is predicted to occur as a result of the Project.

ii. River Flat Eucalypt Forest

The EEC River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (RFEF) 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.

RFEF is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, of which the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (Forest Red Gum)*, E. amplifolia* (Cabbage Gum), *Angophora floribunda* (Rough-barked Apple) and *A. subvelutina* (Broad-leaved Apple). A layer of small trees may be present, including *Melaleuca decora, M. styphelioides* (Prickly-leaved Teatree), *Backhousia myrtifolia* (Grey Myrtle), *Melia azaderach* (White Cedar), *Casuarina cunninghamiana* (River Oak) and *C. glauca* (Swamp Oak). Scattered shrubs include *Bursaria spinosa*, *Solanum prinophyllum, Rubus parvifolius, Breynia oblongifolia, Ozothamnus diosmifolius, Hymenanthera dentata, Acacia floribunda* and *Phyllanthus gunnii (*NSW Scientific Committee 2004f*)*.

Approximately 48.3 ha of this community is present in the Project Boundary, of which a total of approximately 5.9 ha will be directly removed. A further 25.5 ha, of which 2.4 ha lies outside the Project Boundary, may be indirectly impacted on by subsidence. This community is more susceptible to subsidence impacts as they have the potential to alter the local hydrology and affect the water that is necessary for this community's survival.

An Assessment of Significance has been prepared to assess the potential impact of the Project on this community and is presented in **Appendix H**. This assessment indicates that no significant impact to this community is predicted to occur as a result of the Project.

iii. Lower Hunter Spotted Gum - Ironbark Forest

Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion (LHSGIF) is represented in the Study Area by one community; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin. This community is dominated by *Corymbia maculata* (Spotted Gum) and *Eucalyptus fibrosa* (Broad-leaved Ironbark), while *E. punctata* (Grey Gum) and *E. crebra* (Grey Ironbark) occur occasionally. A number of other eucalypt species occur at low frequency, but may be locally common in the community. One of these species, *E. canaliculata*, intergrades extensively in the area with *E. punctata*.

The understorey is marked by the tall shrub, *Acacia parvipinnula*, and by the prickly shrubs, *Daviesia ulicifolia, Bursaria spinosa, Melaleuca nodosa* and *Lissanthe strigosa*. Other shrubs include *Persoonia linearis, Maytenus silvestris* and *Breynia oblongifolia*. The ground layer is diverse; frequent species include *Cheilanthes sieberi, Cymbopogon refractus, Dianella revoluta, Entolasia stricta, Glycine clandestina, Lepidosperma laterale, Lomandra multiflora, Microlaena stipoides, Pomax umbellata, Pratia purpurascens, Themeda australis* and *Phyllanthus hirtellus (*NSW Scientific Committee 2005a*)*.

Approximately 285.5 ha of this community is present in the Project Boundary, of which a total of approximately 4.5 ha will be directly removed. A further 174.7ha of which 15.9 ha lies outside the Project Boundary, may be indirectly impacted on by subsidence.

An Assessment of Significance has been prepared to assess the potential impact of the Project on this community and is presented in **Appendix H**. This assessment indicates that no significant impact to this community is predicted to occur as a result of the Project.

iv. Lowland Rainforest

Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (LRF) is represented in the Study Area by one community; Coachwood – Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin. This community is a subtropical rainforest and contains some related, structurally complex forms of dry rainforest. Lowland Rainforest has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes, results in an irregular canopy appearance. The trees are taxonomically diverse at the genus and family levels, and some may have buttressed roots.

A range of plant growth forms are present in Lowland Rainforest, including palms, vines and vascular epiphytes. In disturbed stands of this community the canopy cover may be broken, or the canopy may be smothered by exotic vines (NSW Scientific Commitee 2006).

Approximately 525.8 ha of this community is present in the Project Boundary. This community will not be directly removed but 582.3 ha, of which 63.7 ha lies outside the Project Boundary, may be indirectly impacted on by subsidence.

An Assessment of Significance has been prepared to assess the potential impact of the Project on this community and is presented in **Appendix H**. This assessment indicates that no significant impact to this community is predicted to occur as a result of the Project.

v. Freshwater Wetland

Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (FW) is in the Study Area by one community; *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin. This community typically occurs on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains, although there may be minor saline influence in some wetlands. The structure of the community may vary from sedgelands and reedlands to herbfields, and woody species of plants are generally scarce. Typically these wetlands form mosaics with other floodplain communities, and often they include or are associated with ephemeral or semi-permanent standing water (e.g. Goodrick 1970). The composition of Freshwater Wetlands on Coastal Floodplains is primarily determined by the frequency, duration and depth of waterlogging and may be influenced by the level of nutrients and salinity in the water and substrate (NSW Scientific Committee 2004b).

Approximately 1.2 ha of this community is present in the Project Boundary. This community will not be directly removed but may be indirectly impacted on by subsidence.

An Assessment of Significance has been prepared to assess the potential impact of the Project on this community and is presented in **Appendix H**. This assessment indicates that no significant impact to this community is predicted to occur as a result of the Project.

6.6 Impacts to GDEs

As described in **Chapter 5**, the occurrence of GDEs in the Study Area is likely to be represented by six communities that are at least seasonally waterlogged and are at least partially dependent on groundwater. These are:

- Blackbutt – Turpentine open forest of the hills of the North Coast;
- Coachwood – Crabapple warm temperate rainforest of the north coast and Northern Sydney Basin;

- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin;
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin;
- Swamp Mahogany 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.

Of these communities, the riparian Blackbutt – Turpentine forest and Coachwood – Crabapple rainforest are likely to be dependent on groundwater only during periods of drought, whereas the wetland and swamp communities are likely to have a higher dependence on groundwater.

There are two main potential impacts that may occur to GDEs in the Study Area:

- Direct clearance as a result of clearance for the surface infrastructure; and
- Subsidence affecting the hydrological regime.

Both potential impacts are discussed below in more detail.

6.6.1 Impacts to GDEs from Clearing of Vegetation

Approximately 8.8 ha of potential GDE vegetation will be removed by the Project, comprising 1.1 ha of Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin, 1.8 ha of Swamp Mahogany forest on coastal lowlands of the north coast and northern Sydney Basin and 5.9 ha of Blackbutt – Turpentine open forest of the hills of the North Coast. These areas are a very small proportion of the extent of these communities in the Study Area and the locality. All three of these communities are listed as EECs under the TSC Act. Assessments of significance have been conducted for these communities and are presented in **Appendix H**. These assessments indicate that due to the small area of each community that will be impacted and the large areas that remain in the Study Area and locality, no significant impact is predicted to occur. That notwithstanding a BOS has been developed for the Project which will result in the protection of further occurrences of these GDEs within the Study Area and is detailed in section **8.4.1**. These offset areas will be conserved in perpetuity and the Project, therefore, is unlikely to place these GDE communities at risk of extinction.

6.6.2 Impacts to GDEs from Subsidence

There is also potential for indirect impacts to occur to approximately 610.2 ha of GDEs within the SIL, 63.7 ha of which occurs outside the Project Boundary, as a result of subsidence.

This includes 582.3 ha of Coachwood – Crabapple rainforest, 1.2 ha of *Phagmites australis* and *Typha orientalis* wetland, 0.7 ha of Swamp Mahogany forest and 26.0 ha of Woollybutt – Paperbark sedge forest. Of these communities, Coachwood – Crabapple rainforest is found predominantly in hilly terrain while the other communities are found in more low-lying areas of the Dooralong valley floodplain.

As discussed in Section 5.3, GDEs are highly dependent on particular hydrologic regimes, and subsidence has the potential to impact on the hydrology of the Study Area and thereby impact these communities. The potential impacts on GDEs from subsidence include:

- Surface cracking; and
- Changes in surface water drainage and groundwater storage.

As indicated in Section 6.2, the extent of potential subsidence occurring as a result of the Project has been estimated and modelled. The modelling indicates that the surface cracking is expected to be minor due to the significant depth of mining and the presence of thick alluvial deposits above bedrock in the floodplain areas. Actual surface cracking is also dependent on the thickness and inherent plasticity of the soils that overlie the bedrock. The floodplain of the Dooralong Valley, where the GDEs occur, typically consists of 30 m of alluvium so the likelihood of surface cracks appearing on the floodplain is negligible. Any surface cracking is expected to be minor, isolated and represent a very small percentage of the Extraction Area. Accordingly, surface cracking is not predicted to have a significant impact on GDEs within the SIL and wider Study Area.

The most significant impact of subsidence is considered to be the temporary change in alluvial water table levels. However, Groundwater flow modelling of the displacements associated with subsidence indicates that the relatively low permeability of alluvial materials within the SIL results in minimal impact on the water table. In unsubsided areas, the water table may fall by up to 1.3 m but will experience a 55% to 75% recovery within 6 months, depending on the rainfall as evidenced by historical water table monitoring (Mackie 2012). These results indicate that alluvial groundwater levels will continue at current depth ranges where it will remain accessible for vegetation that is currently dependent on it. Futhermore, long term impacts from drawdown of the water table due to depressurisation are predicted to occur only near the entry to the underground drift.

In elevated terrain and forested areas where the majority of the GDEs occur, the water table is generally predicted to be deep. Therefore, the GDEs in the SIL are likely to have a high dependence on the soil moisture within the unsaturated zone and rely on groundwater for only a small percentage of their requirements. The unsaturated zone is sustained by rainfall and runoff groundwater which is not expected to change post-subsidence. Therefore, despite some temporary reduction, the water levels required for the maintenance of GDEs will persist in the long term. As the GDEs within the SIL are likely to depend predominantly on water from the saturated zone, no adverse impacts on GDEs are predicted during the six month period of reduced groundwater. Furthermore as GDEs are absent from the area around the entry to the underground drift, no long term impacts from drawdown are predicted to occur on GDEs.

Accordingly, subsidence is not expected to have a significant impact on GDEs in the Study Area.

6.7 Impacts to Threatened Flora Species

Several threatened flora species have been recorded from the Study Area including the following species:

- *Acacia bynoeana* (Bynoe's Wattle), listed as Vulnerable under the EPBC Act and Endangered under the TSC Act;
- *Angophora inopina* (Charmhaven Apple), listed as Vulnerable under both the EPBC Act and the TSC Act;
- *Cryptostylis hunteriana* (Leafless Tongue Orchid) listed as Vulnerable under both the EPBC Act and the TSC Act;
- *Grevillea parviflora subsp. parviflora* (Small-flower Grevillea) listed as Vulnerable under both the EPBC Act and the TSC Act;
- *Melaleuca biconvexa* (Biconvex Paperbark) listed as Vulnerable under both the EPBC Act and the TSC Act; and
- *Tetratheca juncea* (Black-eyed Susan) listed as Vulnerable under both the EPBC Act and the TSC Act;

These are considered below in subsequent subsections.

6.7.1 Acacia bynoeana

Acacia bynoeana is listed as Endangered under the TSC Act and as Vulnerable under the EPBC Act. This species was included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC. *Acacia bynoeana* was recorded at two locations, in Scribbly Gum Red Bloodwood woodland and in Smooth-barked Apple – Red Bloodwood forest, at the Tooheys Road Site. Several individuals have been recorded near the Study Area, on the eastern side of the F3 freeway (OzArk 2012). There are 26 records of this species in the locality (OEH 2012a).

The Project will result in the removal of 1 known specimen of this species, and approximately 42.9 ha of potential habitat. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction.

A BOS has been developed for the Project which will result in the further protection of approximately 169.4 ha of potential habitat for this species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially

subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for this species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to *Acacia bynoeana*.

6.7.2 Angophora inopina

Angophora inopina is listed as Vulnerable under the TSC Act and the EPBC Act. Potential impacts to this species area considered a controlled action as per the Supplementary DGRs for the Project, provided by SEWPaC.

Large numbers of this small tree occur within the Tooheys Road Site, predominantly in Scribbly Gum Red Bloodwood woodland with some scattered individuals in cleared areas, Swamp Mahogany forest, or Paperbark Swamp forest. Density estimates for *Angophora inopina* within the Impact areas of Tooheys Road was calculated at approximately 14 individuals per hectare whereas that for the Offset areas was calculated at approximately 22 individuals per hectare. Further individuals have been recorded in adjacent private properties outside the Project Boundary in previous studies (OzArk 2012). There are 105 records of this species in the locality (OEH 2012a).

The Project will result in the removal of approximately 80 specimens of this species, and approximately 47.7ha of potential habitat. Further individuals have been recorded in other parts of the Study Area and will be retained. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction.

A BOS has been developed for the Project which will result in the further protection of 135.4 ha of potential habitat for this species as described in **Section 8.4**. Comparisons of density estimates between impact and offset areas have determined that *Angophora inopina* occurs in higher densities within the offset areas (see **Section 5.5.1 – ii**). The offset ratio for the potential habitat for this species is 2.8:1. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for this species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to *Angophora inopina*.

6.7.3 Cryptostylis hunteriana

Cryptostylis hunteriana is listed as Vulnerable under the TSC Act and the EPBC Act. This species was included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC. A single *Cryptostylis hunteriana* individual was recorded within the Project Boundary, north of the Tooheys Road Site in Scribbly Gum Red Bloodwood woodland. There are 2 records of this species within the locality (OEH 2012a).

The Project will not result in the removal of any known specimens of this species, but will remove approximately 48.7 ha of potential habitat. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction.

A BOS has been developed for the Project which will result in the further protection of approximately 186.3 ha of potential habitat for this species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for this species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to *Cryptostylis hunteriana*.

6.7.4 Grevillea parviflora subsp. parviflora

Grevillea parviflora subsp. *parviflora* is listed as Vulnerable under the TSC Act and the EPBC Act. This species was included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC. *Grevillea parviflora* subsp. *parviflora* was recorded at six locations within the Hue Hue road offset site in Spotted Gum – Broadleaved Ironbark. Some patches of this species are also present outside Project Boundary, east of the F3 Freeway (OzArk 2012). There are 119 records of this species in the locality (OEH 2012a).

The Project will not result in the removal of any known specimens of this species, but will remove approximately 44.6 ha of potential habitat. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction.

A BOS has been developed for the Project which will result in the further protection of approximately 175.9 ha of potential habitat for this species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for this species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to *Grevillea parviflora subsp. parviflora*.

6.7.5 Melaleuca biconvexa

Melaleuca biconvexa is listed as Vulnerable under the TSC Act and the EPBC Act. This species was included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC. Several stands of *Melaleuca biconvexa* were recorded within the Project Boundary, east of Buttonderry impact site in Blackbutt – Turpentine forest. Stands were largely confined to within 4 m of creeklines and wet depressions except between the eastern side of the creek and Hue Hue Road where the species was found in areas damp from

surface runoff. The species showed variable abundance within the area of occupancy, ranging from scattered stems to dense thickets. Overall cover abundance was medium and included mature, young and immature stems as well as saplings. Previous studies have also recorded *Melaleuca biconvexa* individuals in lands the Extraction Area (ERM 2003) although these were not recorded within accessible areas surveyed. There are 279 records of this species in the locality (OEH 2012a).

The Project will not result in the removal of any known specimens of this species, but will remove approximately 9.5 ha of potential habitat, consisting of swamp forests at the Tooheys Road site. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction.

As this species depends on swampy communities, there is potential for subsidence to impact on these vegetation types through cracking and diversion of water. Groundwater and subsidence modelling has been undertaken for the Project which indicate that the impacts of subsidence are expected to be relatively minor. Groundwater levels are expected to remain within the reach of the roots of *Melaleuca biconvexa* and this species and the communities in which it occurs is expected to remain viable.

A BOS has been developed for the Project which will result in the further protection of 27.3 ha of potential habitat for this species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for this species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to *Melaleuca biconvexa*.

6.7.6 Tetratheca juncea

Tetratheca juncea is listed as Vulnerable under the TSC Act and the EPBC Act. Potential impacts to this species are considered a controlled action as per the Supplementary DGRs for the Project, provided by SEWPaC.

Numerous patches and diffuse occurrences of this species were recorded within the Tooheys Road Site and Hue Hue Road offset site, predominantly in Scribbly Gum Red Bloodwood woodland and Smooth-barked Apple – Red Bloodwood forest but with some occurrences in Swamp Mahogany Forest and Blackbutt – Turpentine forest. There are 121 records of this species in the locality (OEH 2012a).

The Project will result in the removal of known specimens of this species from approximately 28 locations, and approximately 50.5 ha of potential habitat. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbahh SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small

area of potential habitat is unlikely to place this species at risk of extinction. The majority of the habitat for this species in the Study Area will remain, and this species habitat is unlikely to be affected by potential minor subsidence occurring as a result of the Project. This is a relatively widespread species, and it occurs in several protected areas.

A BOS has been developed for the Project which will result in the further protection of approximately 192.8 ha of potential habitat for this species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for this species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to *Tetratheca juncea*.

6.7.7 Impacts to Threatened Flora with Potential to Occur

In addition to the threatened flora species recorded from the Study Area, several threatened flora species have been recorded from the locality and are considered to have potential to occur. These include the following species:

- *Asterolasia elegans*, listed as Endangered under the EPBC Act;
- *Caladenia tessellata* (Thick Lip Spider Orchid), listed as Vulnerable under the EPBC Act and Endangered under the TSC Act;
- *Callistemon linearifolius* (Netted Bottle Brush), listed as Vulnerable under the TSC Act;
- *Eucalyptus camfieldii* (Camfield's Stringybark), listed as Vulnerable under the EPBC Act and the TSC Act;
- *Genoplesium insignis* (Variable Midge Orchid), listed as Endangered under the TSC Act;
- *Maundia triglochinoides*, listed as Vulnerable under the TSC Act;
- *Rhizanthella slateri* (Eastern Underground Orchid), listed as Endangered under the EPBC Act;
- *Rutidosis heterogama* (Heath Wrinklewort) Listed as Vulnerable under the EPBC Act and the TSC Act;
- *Syzygium paniculatum* (Magenta Lilly Pilly), listed as Vulnerable under the EPBC Act and the TSC Act;
- *Thelymitra sp. adorata* (Wyong Sun Orchid), listed as Critically Endangered under the TSC Act; and

- *Eucalyptus parramattensis subsp. parramattensis* (*Eucalyptus parramattensis C. Hall. subsp. parramattensis* in Wyong and Lake Macquarie local government areas), listed as an Endangered population under the TSC Act.

The potential impacts to these species are similar to those that will occur to flora species known to be present, which is the removal of potential habitat. Although it is unlikely that the Project Boundary will represent habitat for all these species, due to their different habitat requirements, for the sake of this impact assessment it is presumed that all the native vegetation in the Disturbance Boundary provides potential habitat for all of these species. This means that a total of 60.5 ha of potential habitat will be removed by the Project under the theoretical worst case assessment scenario. Specifics of impacted areas for MNES species are detailed in **Chapter 7**.

Large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction.

A BOS has been developed for the Project which will result in the further protection of approximately 208.0 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for these species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.2**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to these flora species.

Table 6.2 Threatened Flora Impact Areas

Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Potential habitat within SIL (ha)
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	169.4	1200.2
Angophora inopina	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood forest, Paperbark Swamp forest	47.7	135.4	98.8

Table 6.2 Threatened Flora Impact Areas

Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Potential habitat within SIL (ha)
Cryptostylis hunteriana	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, Blackbutt - Turpentine open forest	48.7	186.3	1200.2
Grevillea parviflora subsp parviflora	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest	44.6	175.9	1200.9
Melaleuca biconvexa	Blackbutt – Turpentine forest, Spotted Gum - Grey Ironbark open forest, Swamp Mahogany swamp forest, Woollybutt - Paperbark sedge forest, Paperbark Swamp forest, Phragmites australis and Typha orientalis coastal freshwater wetlands	9.5	27.3	955.2
Tetratheca juncea	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, Blackbutt – Turpentine forest	50.5	192.8	1200.9

Table 6.2 Threatened Flora Impact Areas

Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Potential habitat within SIL (ha)
Potentially occurring flora species (*Asterolasia elegans, Caladenia tessellata, Callistemon linearifolius, 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	208.0	2879.1

6.8 Impacts to Threatened Fauna Species

Numerous threatened fauna species have been recorded within the Study Area, as well as several migratory species listed under the EPBC Act. The potential impacts of the Project on these species are mostly related to the potential disturbance and removal of habitat. Approximately 89 ha of vegetation, including exotic grasslands, will be removed for the surface operations, and approximately 4011 ha of native and exotic vegetation, including areas outside the Project Boundary, have potential to be indirectly impacted through subsidence. The species most at risk of subsidence impacts are those that depend on waterways and riparian vegetation that has potential to be affected by changes in hydrology caused by subsidence and cracking.

As habitat removal is the main predicted impact of the Project, this section groups the species with potential to be affected according to their habitat requirements and biology and discusses the potential impacts of the Project on each group.

6.8.1 Amphibians

Several threatened amphibians have been recorded from the Study Area during recent OzArk surveys as well as past surveys by ERM and BHP. These include the following species:

- Wallum Froglet (*Crinia tinnula*) listed as Vulnerable under the TSC Act;
- Giant Barred Frog (*Mixophyes iteratus*) listed as Endangered under the EPBC Act and TSC Act;
- Green and Golden Bell Frog (*Litoria aurea*), listed as Vulnerable under the EPBC Act and Endangered under the TSC Act;
- Green-thighed Frog (*Litoria brevipalmata*) listed as Vulnerable under the TSC Act;

Although not recorded from the Study Area, the following threatened amphibians are considered to have potential to occur:

- Giant Burrowing Frog (*Heleioporus australiacus*), listed as Vulnerable under the EPBC Act and as Vulnerable under the TSC Act;
- Littlejohn's Tree Frog (*Litoria littlejohni*), listed as Vulnerable under the EPBC Act and Vulnerable under the TSC Act; and
- Stuttering Frog (*Mixophyes balbus*), listed as Vulnerable under the EPBC Act, and Endangered under the TSC Act.

Of these species, Littlejohn's Tree Frog and the Stuttering Frog were included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC. Potential impacts to the Giant Barred Frog (*Mixophyes iteratus*) are considered a controlled action as per the Supplementary DGRs for the Project, provided by SEWPaC.

These species occupy a range of habitats, although they mostly occur in moist environments ranging from forests and woodlands and shelter under leaf litter where it is moist. Their life-cycle usually requires proximity to streams or pools in order for the tadpoles to complete their lifecycle. Several vegetation communities in the Study Area are likely to provide habitat for these amphibians, particularly those in close proximity to streams or swampy areas including Paperbark Swamp Forest and Swamp Mahogany Forest. Large areas of suitable habitat for these species occurs in the locality in protected areas, and all of these amphibian species have been recorded numerous times in the locality, in particular in large stands of native vegetation in the nearby reserves of Jilliby SCA, Munmorah SCA, Olney SF, and Ourimbah SF.

The Project will result in the removal of 10.4 ha of habitat for these species, comprising Paperbark Swamp Forest, Swamp Mahogany Forest, Blackbutt - Turpentine and Mountain Blue Gum – Turpentine forest. The wetland communities and waterways that are important for these species have potential to be indirectly impacted by subsidence and subsequent alteration of hydrological regimes. Approximately 1624.9 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). Although some drawdown of alluvial groundwater is likely to occur, the majority of it is expected to be temporary. Although an average of approximately 1.3 m drawdown has been modeled, up to 75% recovery is expected. This means that the alluvial water table will remain accessible to vegetation roots and the communities that depend on groundwater will persist. Similarly, no impacts are predicted to occur to the waterways in the Study Area as a result of subsidence, and these aquatic habitats that are critical for amphibians will remain.

Large areas of known and potential habitat will remain in the locality for these threatened amphibians, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction.

A BOS has been developed for the Project which will result in the further protection of 27.3 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to these threatened amphibians.

6.8.2 Large Forest Owls

Four large forest owls have either been recorded from the Study Area or have potential to occur; the Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Barking Owl (Ninox connivens) and Sooty Owl (*Tyto tenebricosa*), all of which are listed as Vulnerable under the TSC Act.

Although they have slightly different habitat requirements, these owls are all large raptors that nest in large tree hollows and forage over wide areas for prey. They occur in a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. All of these have been recorded numerous times in the locality, in particular in large stands of native vegetation in the nearby conservation reserves of Jilliby SCA, Munmorah SCA, Olney SF, and Ourimbah SF.

The Project will result in the removal of 44.5 ha of habitat for these species, mostly comprising, Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark and Spotted Gum – Grey Ironbark.

Approximately 2240.9 ha of potential habitats have the potential to be impacted by subsidence, however the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 169 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in Appendix H. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Powerful Owl, Masked Owl, Barking Owl or Sooty Owl.

6.8.3 Arboreal Mammals

Several arboreal mammals have been recorded from the Study Area; the Eastern Pygmy Possum (*Cercartetus nanus*), the Squirrel Glider (*Petaurus norfolcensis*) and the Yellow-bellied Glider (*Petaurus australis*), all of which are listed as Vulnerable under the TSC Act.

Large areas of suitable habitat are present in the Study Area for these species, including rainforests, sclerophyll forests, and woodlands, and these species are known to utilise these habitats. All of these have been recorded numerous times in the locality; there are 147 records of Squirrel Gliders within the Wyong LGA, and 270 records of the Yellow-bellied Glider, many of which are in large stands of native vegetation in the Jilliby SCA, Munmorah SCA, Olney SF, and Ourimbah SF. This shows that these species are relatively abundant in the locality and are well represented in conservation reserves. There are fewer records of the Eastern Pygmy Possum; 16 records of the species within the Wyong LGA (OEH 2012a), with one occurring in Munmorah SCA and the others within Olney SF.

The Project will result in the removal of approximately 46.6 ha of habitat for these species, mostly comprising Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum Turpentine forest, Scribbly Gum – Red Bloodwood woodland and Blackbutt – Turpentine forest). Approximately 2142.8 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 112.3 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Eastern Pygmy Possum, the Squirrel Glider or the Yellow-bellied Glider.

6.8.4 Microchiropteran Bats

Several threatened microchiropteran bats have been recorded from the Study Area or have potential to occur, all of which are listed as Vulnerable under the TSC Act. This includes the following species:

- East-coast Freetail Bat (*Mormopterus norfolkensis*);
- Eastern Bentwing Bat (*Miniopterus orianae oceanensis*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Golden-tipped Bat (*Kerivoula papuensis*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Little Bentwing Bat (*Miniopterus australis*);
- Southern Myotis (*Myotis macropus*); and
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

Of these, the Large-eared Pied Bat is also listed as Endangered under the EPBC Act and was included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC. The majority of these species are known to roost in tree hollows, however the Eastern Bentwing Bat and the Large-eared Pied Bat depends on caves to breed and roost.

These species are primarily insectivorous and forage in and over the canopy for insect prey. They forage in a wide range of habitats, including moist eucalypt forest, rainforest, wet and dry sclerophyll forests, and dense coastal forests. The exception is the Southern Myotis that forages over streams and pools catching insects, prawns and small fish by raking their feet across the water surface.

Large areas of suitable habitat are present in the Study Area for these species, including rainforests, sclerophyll forests, and woodlands, and these species are known to utilise these habitats.

All of these species have been recorded numerous times in the locality, and large areas of habitat occur in large stands of native vegetation in the Jilliby SCA, Munmorah SCA, Olney SF and Ourimbah SF. This shows that these species are relatively abundant in the locality and are well represented in conservation reserves.

The Project will result in the removal of approximately 50.4 ha of habitat for these species, mostly comprising Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark forest, Scribbly Gum – Red Bloodwood woodland, Blackbutt – Turpentine Forest and Mountain Blue Gum Turpentine forest. This habitat provides foraging and roosting habitat for most of these species except the Southern Myotis that forages over water, and the Eastern Bentwing Bat that roosts in caves. Approximately 2240.9 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). Despite the removal of habitat, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the Extraction Area is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 186.3 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to these microbats.

6.8.5 Wetland Birds

Four threatened wetland birds have been recorded within the Study Area (ERM 1999; BHP 2002, 2003); the Black Bittern (*Ixobrychus flavicollis*), the Black-necked Stork (*Ephippiorhynchus asiaticus*), the Black-tailed Godwit (*Limosa limosa)* and the White-fronted Chat (*Epthianura albifrons)* while a further two species the Australasian Bittern (*Botaurus poiciloptilus*) and Australian Painted Snipe (*Rostratula australis*) have the potential to occur. The Black Bittern, Black-tailed Godwit and White-fronted Chat are listed as Vulnerable while the Black-necked Stork, Australasian Bittern and Australian Painted Snipe are listed as Endangered under the TSC Act. The Black-tailed Godwit and Australian Painted Snipe are also listed as Migratory under the EPBC Act. The Australian Painted Snipe is also listed as Vulnerable under the EPBC Act.

These species inhabit permanent wetlands and surrounding vegetation, including swamps, floodplains, watercourses and billabongs. All species have been recorded in several locations in the locality. Areas of suitable habitat in the Study Area for these species include swamp sclerophyll forest and other vegetation that forms near water and in low-lying parts of the landscape.

The Project will result in the removal of 2.9 ha of habitat at the Tooheys Road site for these species, mostly comprising of Swamp Mahogany and Paperbark swamp forests. Despite this removal of habitat, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. Approximately 28 ha of these wetland communities and waterways that are important for these species have potential to be impacted by subsidence and subsequent alteration of hydrological regimes. . However, the impacts of subsidence are considered likely to be relatively minor (see Sections 6.2 and 6.6). Although some drawdown of alluvial groundwater will occur, it is expected to be a temporary and localised effect. Although an average of approximately 1.3 m drawdown of alluvial groundwater has been modeled, up to 75% recovery is expected. This means that the water table will remain accessible to vegetation roots and the communities that depend on groundwater will persist.

A BOS has been developed for the Project which will result in the further protection of 10.4 ha of potential habitat for these species. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to these waterbirds.

6.8.6 Migratory Parrots

Two migratory/nomadic parrots have been either recorded in the Study Area or have potential to occur; the Little Lorikeet (*Glossopsitta pusilla*) and the Swift Parrot (*Lathamus discolor).* The Little Lorikeet occurs mostly in dry, open eucalypt forests and woodlands but also moves into riparian habitats to forage. The species is partly nomadic (Higgins 1999), with movements occurring primarily in response to food availability. The Swift Parrot is a migratory species that migrates to the Australian south-east mainland between March and October and is found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.

Both of these species range widely in search of food, and forage in eucalypt forests and woodlands. The Project will result in the removal of approximately 51.6 ha of habitat for these species, mostly comprising Smooth-barked Apple - Red Bloodwood forest and Scribbly Gum - Red Bloodwood woodland. Approximately 1200.9 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 196.7 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Little Lorikeet and Swift Parrot.

6.8.7 Cockatoos

Two threatened species of cockatoo have been recorded or have the potential to occur in the Study Area; the Glossy Black Cockatoo (*Calyptorhynchus lathami*) and the Gang-gang Cockatoo (*Callocephalon fimbriatum*); both listed as Vulnerable under the TSC Act.

Glossy Black Cockatoo is found along the NSW coast and tablelands in eucalypt open forest and woodland with hollow-bearing trees and stands of she-oak species (Birds Australia 2011). The species feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species) (OEH 2012t).

The Gang-gang Cockatoo is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests but can migrate to lower altitudes to drier more open eucalypt forests and woodlands in winter (OEH 2012q).

The Project will result in the removal of 38.3 ha of habitat for these species, mostly comprising Spotted Gum – Broad Leaved Ironbark Forest and Scribbly Gum - Red Bloodwood woodland. Approximately 174.7 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for these species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 95.4 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Glossy Black Cockatoo or the Gang-gang Cockatoo.

6.8.8 Regent Honeyeater

Regent Honeyeater (*Anthochaera phrygia*) is listed as Endangered under the EPBC Act and as Critically Endangered under the TSC Act.

This species inhabits temperate woodland and dry open forest; Box-Ironbark woodland and riparian forests of River Sheoak. It sometimes occurs in coastal forest, especially in stands dominated by Swamp Mahogany, Spotted Gum, and Southern Mahogany (SEWPaC 2012a).

The Project will result in the removal of approximately 44.2 ha of habitat for this species, mostly comprising Scribbly Gum - Red Bloodwood woodland. Approximately 1025.5 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that this species depends on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected to remain.

A BOS has been developed for the Project which will result in the further protection of approximately 130.9 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Regent Honeyeater.

6.8.9 Grey-headed Flying-Fox

Grey-headed Flying-Fox (*Pteropus poliocephalus*) is listed as Vulnerable under the EPBC Act and as Vulnerable under the TSC Act. This species was included in Appendix A of the Supplementary DGRs for the Project, provided by SEWPaC.

This species occurs in a variety of habitats, ranging from subtropical and temperate rainforests to tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. They have roosting camps, often in gullies with dense vegetation and nearby water, which are generally located within 20 km of a regular food source. Individual camps may have tens of thousands of animals and are used for mating, giving birth and rearing young (OEH 2012y).

The Grey-headed Flying-Fox has the potential to use the majority of the Study Area for foraging purposes as this is a wide-ranging species that can access resources from a wide area. It is unlikely to utilise the Study Area for breeding however as no known camps are present.

The Project will result in the removal of approximately 48.4 ha of foraging habitat for this species, mostly comprising Spotted Gum – Grey Ironbark forest or Mountain Blue Gum - Turpentine. Approximately 2,725.8 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the Extraction Area is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 118.8 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Grey-headed Flying Fox.

6.8.10 Little Eagle

The Little Eagle (*Hieraaetus morphnoides*) is listed as Vulnerable under the TSC Act. The species is most commonly found in open eucalypt forest and woodland, She-oak or acacia woodlands and riparian woodlands with abundant prey availability (NSW Scientific Committee 2010).

The Project will result in the removal of approximately 43.4 ha of habitat for this species, mostly comprising Scribbly Gum - Red Bloodwood woodland and Blackbutt – Turpentine forest. Approximately 98.1 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 130.9 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Little Eagle.

6.8.11 Varied Sittella

The Varied Sittella (*Daphoenositta chrysopter*) is listed as Vulnerable under the TSC Act. It inhabits eucalypt forests and woodlands. It prefers rough-barked tree species and mature smooth-barked gums with dead branches where it feeds on arthropods (OEH 2012').

The Project will result in the removal of approximately 37.6 ha of habitat for this species, mostly comprising Smooth-barked Apple - Red Bloodwood forest and Scribbly Gum - Red Bloodwood woodland. Approximately 98.1 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 114 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Varied Sittella.

6.8.12 Bush Stone-curlew

The Bush Stone-curlew (*Burhinus grallarius*) inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber (OEH 2012i).

The Project will result in the removal of approximately 37.6 ha of habitat for this species, mostly comprising Scribbly Gum - Red Bloodwood woodland. Approximately 98.1 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 114.0 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**.

This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Bush Stone-curlew.

6.8.13 Koala

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the EPBC Act and the TSC Act. Koalas inhabit eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species (OEH 2012|). It has not been recorded from the Study Area, however suitable feed trees are present and it has potential to occur.

The Project will result in the removal of approximately 51.5 ha of potential habitat for this species, mostly comprising Scribbly Gum - Red Bloodwood woodland. Approximately 2240.9 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected remain.

A BOS has been developed for the Project which will result in the further protection of approximately 190.2 ha of potential habitat for these species as described in **Section 8.4**. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Koala.

6.8.14 Spotted-tailed Quoll

The Spotted-tailed Quoll (*Dasyurus maculatus*) occurs in a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (OEH 2012‹).

The Project will result in the removal of approximately 48.4 ha of habitat for this species, mostly comprising Scribbly Gum - Red Bloodwood woodland and Spotted Gum – Broadleaved Ironbark. Approximately 2725.8 ha of potential habitats have the potential to be impacted by subsidence. However the impacts of subsidence are considered likely to be relatively minor (see **Sections 6.2 and 6.6**). That notwithstanding, large areas of known and potential habitat will remain in the locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of a small area of potential habitat is unlikely to place these species at risk of extinction. The habitats that these species depend on are unlikely to be impacted by subsidence, and the habitat in the SIL is expected to remain.

A BOS has been developed for the Project which will result in the further protection of approximately 118.8 ha of potential habitat for these species. A comparison of habitat areas for this species which are to be cleared, offset and potentially subject to subsidence is provided in **Table 6.3**. An Assessment of Significance has been prepared for these species and is presented in **Appendix H**. This assessment indicates that with the implementation of the proposed impact mitigation and compensation measures, the Project will not result in a significant impact to the Spotted-tailed Quoll.

Table 6.3 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Potential habitat within SIL (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, Spotted Gum - Broad-leaved Ironbark forest, Swamp Mahogany Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands,	10.4	27.3	1624.9
Forest Owls (Powerful Owl, Masked Owl, Barking Owl, Sooty Owl)	Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark, Spotted Gum – Grey Ironbark, Mountain Blue Gum - Turpentine	44.5	169.4	2240.9
Arboreal mammals (Eastern Pygmy Possum, Squirrel Glider, Yellow-bellied Glider)	Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum - Turpentine forest, Scribbly Gum – Red Bloodwood woodland, Blackbutt – Turpentine forest	46.6	112.3	2142.8

Table 6.3 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Potential habitat within SIL (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)	Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark forest, Scribbly Gum – Red Bloodwood woodland, Blackbutt – Turpentine Forest and Mountain Blue Gum Turpentine forest, Smooth-barked Apple – Red Bloodwood forest,	50.4	186.3	2240.9
Wetland birds (Black Bittern, Black-necked Stork, Black-tailed Godwit, White-fronted Chat, Australasian Bittern)	Paperbark Swamp Forest, Swamp Mahogany Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands	2.9	10.4	27.9
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	196.7	1200.9
Cockatoos (Glossy Black Cockatoo, Gang-gang Cockatoo)	Spotted Gum – Broad Leaved Ironbark Forest, Scribbly Gum - Red Bloodwood woodland	38.3	95.4	174.7
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,	44.2	130.9	1025.5

Table 6.3 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat in impact area (ha)	Habitat within offset area (ha)	Potential habitat within SIL (ha)
Grey-headed Flying Fox	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum - Red Bloodwood woodland; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany forest	48.4	118.8	2725.8
Little Eagle	Scribbly Gum - Red Bloodwood woodland, Blackbutt – Turpentine forest, Smooth-barked Apple - Red Bloodwood forest,	43.4	130.9	98.1
Varied Sittella	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood woodland	37.6	114.0	98.1
Bush Stone-curlew	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood woodland	37.6	114.0	98.1
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	51.5	190.2	2240.9
Spotted tailed Quoll	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum - Red Bloodwood woodland; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany swamp forest	48.4	118.8	2725.8

6.9 Impacts from Key Threatening Processes

6.9.1 Clearing of native vegetation

As discussed in **Section 6.1**, the largest direct impact of the Project is the removal of native vegetation. Approximately 89 ha of vegetation (including approximately 13.2 ha of EEC) comprising remnant and regenerating forest and woodland and large areas of open grassland with scattered trees will be removed over the life of the Project. These vegetation communities provide habitat for a range of flora and fauna, including species listed as threatened or migratory under the EPBC Act and/or TSC Act.

The direct removal of vegetation communities is likely to result in the following impacts to remaining habitat by:

- 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 (**Section 6.1.1**);
- Exacerbating fragmentation and isolation of already patchy woodland areas. (**Section 6.1.2**);
- Reducing connectivity by removing areas of woodland and forest that would serve as "habitat corridors" for mobile fauna;
- Reducing nutrient and water cycling through the system;
- Loss of soil to wind or water erosion as a result of the lack of groundcover shelter;
- Removing important pollinators such as birds, bats and insects critical for the pollination of native plants; and
- Increasing edge effects, particularly along linear patches (**Section 6.1.3**).

Offset strategies have been developed to address and counter such predicted impacts. These are discussed in **Chapter 8**. Offsets include the purchase and ongoing management of like-for-like vegetation communities and habitats for threatened species. Additionally, targeted revegetation of Scribbly Gum Woodland will occur, which will increase habitat for the threatened species *Angophora inopina*.

6.9.2 Alteration of habitat following subsidence due to longwall mining

As discussed in **Section 6.2**, the impacts of subsidence are predicted to be negligible. The potential extent of subsidence in the Study Area has been modelled for the Project (Wyong Areas Coal Joint Venture 2012), and this indicates that surface cracking associated with longwall mining for the Project is unlikely to occur, however some overall subsidence will occur.

The subsidence that does occur is not considered likely to alter aquatic habitat substantially, as modelling indicates that the local main drainage feature (Jilliby Jilliby Creek) will subside by a similar amount as surrounding the floodplain, thus maintaining the same relative surface flow and seepage patterns as currently occur.

The most significant impact on shallow alluvial groundwater resources is considered to be the temporary localised change in water table level (Mackie Environmental Research 2013). In areas with slopes of less than a few degrees, subsidence will induce a fall in the alluvial water table elevation as a part of a panel is subsided relative to an adjacent unsubsided area.

Impacts to terrestrial flora and fauna as a result of subsidence are considered to be negligible. Surface impacts are not predicted to impact on vegetation communities present on the site, nor fauna species utilising the vegetation.

6.9.3 Alteration of natural flow regimes or rivers and streams and their floodplains and wetlands

As stated in **Section 6.2.2**, overall subsidence in the floodplain generally ranges up to 1.4 m, the amount of differential subsidence however is likely to be extremely low. Based on the maximum subsidence predictions, the difference in subsidence in the floodplain that will occur between the chain pillars and the longwall panels is between 200 and 250 mm over a distance of nearly 200 m. It is considered unlikely that subsidence will measurably alter the natural flow regime of local waterways.

The Project has the potential to affect the flow regime and water quality of Wallarah Creek through the discharge of surplus mine water into a tributary of Wallarah Creek. As discussed in **Section 6.3.5**, the overall flow rate of treated water discharge is relatively low and is unlikely to result in substantial erosion of creek banks. Although the treated water discharges could occur at times when there is no natural flow in the creek, the low rate of discharge is unlikely to have a significant impact on overall flow regime and the creek will retain its ephemeral nature (WRM Water & Environment Pty Ltd 2013). A proposed Water Treatment Plant will treat mine waters to a quality which is similar to existing receiving water quality within Wallarah Creek.

6.9.4 Infection of frogs by amphibian chytrid fungus causing the disease chytridiomyosis

As Chytrid fungus is known to exist within the Hunter-Central Rivers CMA, it is therefore likely that frog populations within the boundaries of the Project are currently infected with Chytrid fungus. The Project is not considered likely to cause or exacerbate the infection of frogs within the locality of the Project as negligible impacts are predicted to surface water flows. As the extent of these impacts is predicted to be limited, it is not likely that frog populations will be placed under additional stress due to variation in surface water levels or flows.

Though the impacts are considered to be minimal, Chytrid control protocols will be implemented for any works in areas of frog habitat. This will alleviate the risk of infecting any uninfected populations, should they exist within the Project Boundary. Protocols will include the disinfection of boots, equipment and vehicles prior to entry and exit from an area deemed suitable frog habitat.

6.9.5 Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae

The Project is not considered likely to cause the introduction or establishment of Exotic Rust Fungi of the order Pucciniales. Rust fungi of the order Pucciniales (known commonly as Myrtle Rust) are known to occur within the Central Coast region (Carnegie et al. 2010). Spores can be dispersed (NSW Industry & Investment 2010) by wind, water-splash, on plant material including seed, on people and their clothing and equipment, and by insects including Honey Bees (*Apis mellifera*) which work the spore masses (Carnegie et al, 2010). As such, it is likely that the remnant vegetation within the Project boundary has some level of infection. The Project is not considered likely to infect or exacerbate existing infections, as limited clearing (areas where likelihood of infection is highest) is proposed.

Though the Project is not considered likely to cause new infections or exacerbate the occurrence of extant infections, protocols for management of the pathogens will be put in place to further mitigate the risk of infection. Protocols will include the disinfection of equipment and clothing prior to entry into areas identified as at-risk of infection.

6.9.6 Anthropogenic climate change

The proposal is considered likely to exacerbate the impacts of anthropogenic climate change to both locally occurring and globally occurring species. At all stages of the Project's operations, fossil fuels will be relied upon to provide power for construction and production facilities. Additionally, the product of the mine, coal, will be burnt releasing CO2 into the atmosphere, thus exacerbating anthropogenic climate change. Emissions associated with this project are defined as follows:

- Scope 1 – Direct Greenhouse Gas Emissions;
- Scope 2 – Energy Product Use Indirect Greenhouse Gas Emissions; and
- Scope 3 – Other Indirect Greenhouse Gas Emissions.

Based on the calculations of Pae Holmes (2012), **Table 6.4** details levels of Greenhouse Gas emissions predicted.

Table 6.4 Emissions Predictions

Source	Tonnes of CO2 Emitted over life of Project
Diesel Fuel	93, 071
Electricity Production	1,776,328
Fugitive Methane*	6,700,294
Coal Transportation	222,758
Energy from Product Coal	360,338,101
Total Emissions from Project	369,130,552

*Calculated as a CO^2 equivalent

Though the Project is predicted to have a low level of Scope 1 emissions – those directly associated with the production of coal, the resultant emissions from the use of the product coal are significant. An average of 9.71 Mega tonnes of CO2 will be released per annum as a result of the Project, totalling 369.1 Mega tonnes by the end of the Project. Though this level of emission is not considered significant in terms of Australia's total emissions (PAE Holmes, 2012), the cumulative impact of these emissions, when combined with emissions from other coal mines in Australia, is considered likely to exacerbate the impact of anthropogenic climate change.

6.10 Impacts to land within the Wetlands Management Zone (Wyong LEP - Zone 7(g))

The Project, being a State Significant Development (Part 4, Division 4.1 of EP&A Act), is exempt from certain conditions required by Wyong Shire Council. Nevertheless, an assesment of wetland areas classified as Zone 7(g) Wetlands under the Wyong LEP has been conducted.

These wetland areas are present along the southern edge of the power easement present within the Tooheys Road site. The wetland communities within this area include:

- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC); and
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC).

Less than one hectare of each community will be cleared from the 7 (g) zone as the majority of both these communities within the 7 (g) zone lie within the proposed Tooheys Road Southern Offset (**See Figs 6.1 and Fig 8.1**). Assessments of direct and indirect impacts to these two vegetation communities are detailed in **Sections 6.5i and 6.6.1.**

Threatened flora and fauna species that are known or have potential to occur within the 7(g) wetland area include but are not limited to:

- *Angophora inopina* (Vulnerable – TSC Act, EPBC Act);
- *Melaleuca biconvexa* (Vulnerable – TSC Act, EPBC Act);
- *Tetratheca juncea* (Vulnerable – TSC Act, EPBC Act);
- *Maundia triglochinoides* (Vulnerable – TSC Act);
- Wallum Froglet (Vulnerable – TSC Act)
- Green and Golden Bell Frog (Vulnerable – TSC Act);
- Green-thighed Frog (Vulnerable – TSC Act);
- Masked Owl (Vulnerable – TSC Act);
- Varied Sittella (Vulnerable – TSC Act);
- Squirrel Glider (Vulnerable – TSC Act);
- Yellow-bellied Glider (Vulnerable – TSC Act)
- Grey-headed Flying Fox (Vulnerable – TSC Act, EPBC Act); and
- Microchiropteran Bats, in particular the Southern Myotis (Vulnerable – TSC Act).

Descriptions of these species are provided in **Sections 5.7.1** and **5.8** while impact assessments are provided in **Sections 6.7** and **6.8**. Mitigation, management and offset stategies, in accordance with OEH regulations, for vegetation communties and threatened species, which include those within the 7 (g) zone, are detailed in **Sections 8.2, 8.3** and **8.4.** The detailed assessments of vegetation communities and native flora and fauna have determined that the Project will not have any significant impacts within the areas zoned as 7(g) wetlands.

6.11 Impacts to Interim Conservation Areas for Wyong Shire

Areas identified as potential conservation lands under the Wyong LEP fall within the Project Boundary and require a Conservation Assessment in accordance with Council's DCP Chapter 13 – Interim conservation Areas. The Project is a State Significant Development (Part 4, Division 4.1 of EP&A Act), and is therefore exempt from certain conditions required by Wyong Shire Council. Nonetheless, assessments required under DCP Chapter 13 have been incorporated into studies conducted. A description of the Project and proposed development has been provided in **Chapter 1** of this EIA while descriptions of the site and locality are provided in **Sections 3.4 – 3.8**. Detailed descriptions of vegetation, flora and fauna present within the Study Area are provided in **Sections 5.2 – 5.7** with corresponding impact assessments in **Chapter 6**. Several mitigation, monitoring and offseting stategies have been proposed for this Project and detailed assessments of vegetation communities and native flora and fauna have determined that the Project will not have any significant

impacts on areas currently identified as potential conservation lands under DCP 13 – Interim Conservation Areas.

6.12 Cumulative impacts from Mining Projects

The Hunter-Central Rivers CMA region has experienced extensive vegetation clearance and continues to be subject to significant landscape modification as a result of past and present land practices. Broad-scale clearance has occurred in the region to make way for urban development, various agricultural practices including grazing and cropping, forestry and mining. The Project will add to ecological impacts that continue to be experienced on a regional scale by removing up to 89.1 ha of vegetation, of which 60.5 ha is remnant forest, open woodland and derived native grassland.

Multiple underground coal mining projects have long been established in the region. The scope and proximity of these mines which are a significant distance from the Project are listed in **Table 6.5** below.

Table 6.5 Mining projects in the region

Name	Status	Proximity to the Project
Mandalong Colliery	Underground longwall mining operation with approval to operate	Approximately 15 km north
Cooranbong Colliery	Underground longwall mining operation (Merged with Mandalong Collier)	Approximately 25 km north
Newstan Colliery	Longwall and continuous miner underground mining operation with approval to operate	Approximately 50 km north
Chain Valley Colliery	Bord and pillar underground mining operations with approval to operate until 2016	Approximately 11 km north-east
Moonee Colliery	Closed	Approximately 20 km north-east
Wallarah Colliery	Closed	Approximately 20 km north-east
Endeavour Colliery	Closed	Approximately 10 km north-east
Myuna Colliery	Continuous miner and Bord and Pillar underground mine operation with approval to operate until 2032	Approximately 30 km north
Awaba Colliery	Bord and Pillar extraction underground mine approved to operate until 2015	Approximately 35 km north
Munmorah Coal Mine	Closed	Approximately 10 km north-east
Wyee Colliery (Mannering)	Bord and Pillar underground operation with approval to operate until 2018	Approximately 10 km north-east

Table 6.5 Mining projects in the region

Name	Status	Proximity to the Project
Boral Montoro	Clay quarry with approval for extraction until 2023	Approximately 1.5 km east

Each mine requires associated surface infrastructure and has an existing surface disturbance footprint. These mines are also serviced by transport routes (road and rail) and related operational facilities. Mining operations in the region largely operate underground and when considered together in a regional context, have cleared only relatively minor areas of vegetation and habitat. There is potential for impacts from subsidence from these undergrond projects but these have been deemed to be minor with ongoing monitoring to detect any unpredicted impacts. Risks of impacts associated with these projects have been addressed in accordance with regulations relevant to them. These projects have also developed relevant biodiversity conservation and management approaches and large areas of conservation lands remain intact above underground mining areas, such as Munmorah SCA.

When considered together with the Project, a high proportion of the surrounding locality has been and will continue to be subject to underground mining with limited surface disturbance areas. In the region, the most significant surface disturbance and vegetation clearing will occur for proposed residential, industrial and infrastructure land uses within the next two to three decades. If no mitigation or compensatory measures are provided, cumulative impacts on flora and fauna will result as habitats are further reduced and fragmented, potentially resulting in fewer occurrences of remnant vegetation and adversely modifying the biodiversity values of the region.

Although severe clearing in the region has occurred in the past for agriculture, residential and industrial land uses, many contemporary mining projects are capable of positively addressing current and future threatened species and ecological community impacts via offsetting. In light of both these impacts and opportunities, current assessments and offsetting projects now place a high focus on replacing and supplementing ecological communities by rehabilitating mined areas and returning them to forest and woodland.

The offsets provided by the Project will protect existing forest and woodland communities and restore vegetation in areas previously cleared for farming and grazing. The offsetting arrangements will result in an increase in total woodland vegetation in the locality that will be held under conservation tenures. The Project's offsets will also provide significant benefits in terms of wildlife corridor protection that are consistent with the broad conservation planning objectives in local and regional planning strategies.

Chapter **7**

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.

The Project involves the development and operation of an underground coal mine, extracting up to 5.0 million tonnes (Mt) pa of thermal coal by longwall methods, and associated infrastructure and facilities generally including:

- Coal handling and storage facilities;
- Rail loop and loading infrastructure;
- An underground drift entry;
- Ventilation shafts;
- Gas and water management facilities; and
- Offices and employee amenities.

The projected life of the Project is 42 years. As State planning approval has been sought for a period of 28 years within the Project Boundary the current EPBC Referral and Development Consent Application for the Project relates to the first 28 years only. Details on the Project Background and descriptions of the controlled action are provided within the main volume of the EIS.

The proponent has a maintained a good record of environmental performance. WACJV has not been subject to any proceedings under a Commonwealth or State law for the protection of the environment or the conservation and sustainable use of natural resources.

In order to facilitate responsible environmental management, WACJV conducts operations in accordance with the WACJV Environmental Policy. Since 1996, WACJV has undertaken environmental monitoring for the purposes of collecting baseline data for the Project. All exploration activities have been undertaken in accordance with the conditions of WACJV's ELs and Authorisations.

This chapter of the EIA provides an assessment of the impacts of the Project on MNES, specifically those recorded from the Study Area, and those considered to have the potential to occur. Consideration has been given to the species listed in the SEWPaC submission to the DGRs as well as additional MNES with potential to occur which are listed below:

- *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);
- *Rhiznathella slateri* (Eastern Underground Orchid);
- *Rutidosis heterogama* (Heath Wrinklewort)
- *Syzygium paniculatum (Magenta Lilly-pilly);*
- Giant Barred Frog (*Mixophyes iteratus*);
- Green and Golden Bell Frog (*Litoria aurea*);
- Giant Burrowing Frog (*Heleoporus australiacus*);
- Litttejohn's Tree Frog (*Litoria littlejohni*);
- Stuttering Frog (*Mixophyes balbus*);
- Regent Honeyeater (*Anthochaera phygia*);
- Australasian Bittern (*Botaurus poiciloptilus*);
- Australian Pained Snipe (*Rostratula australis*);
- Swift Parrot (*Lathamus discolor*);
- Grey-headed Flying Fox (*Pteropus poliocephalus*);
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*);

- Koala (*Phascolarctos cinereus*); and
- Large-eared Pied Bat (*Chalinolobus dwyeri*).

A discussion of the potential impacts of the Project on these species is presented below, as well as Assessments of Significance according to the EPBC Act significant impact criteria. These have been provided by SEWPaC to assist in determining whether a Project will have a significant impact on MNES.

According to the Significant Impact Guidelines (DEWHA 2009), the concept of an 'important population' is central to assessing the potential for an action to have a significant impact on a Vulnerable species. According to the guidelines…*'an important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are*:

- *key source populations either for breeding or dispersal*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species range.*

An assessment of whether each of the species listed as Vulnerable constitutes an "important population" is provided for each species below, followed by an Assessment of Significance. Assessments of Significance have been conducted for all species listed as Endangered. For the purposes of these threatened species assessments, vegetation communities that the species are known to be associated with are utilised to describe suitable habitat for each individual species, as vegetation communities are generally associated with the geological and hydrological features that constitute habitat for the threatened species. Summary tables of habitat to be cleared, potentially impacted by subsidence and protected for flora and fauna species are provided in **Sections 7.13** and **7.28** respectively.

Overall, assessments on MNES have determined that there are no significant impacts on any MNES. Residual impacts are generally confined to the removal of native vegetation which as been assesed for each individual MNES. While impacts from subsidence and edge effects have been modelled and assessed, due to the nature of these impacts, there is potential for futher unknown and unpredictable impacts to occur from edge effects and subsidence. The impacts will not directly affect any MNES and ongoing monitoring programs will be periodically updated to account for any unknown or unpredictable impacts that may occur over the life of the Project.The following sections provide detailed impact assessments of the MNES listed above.

7.1 Angophora inopina

Angophora inopina is listed as Vulnerable under the EPBC Act. *Angophora inopina* is found in open dry sclerophyll woodland of *Eucalyptus haemastoma* and *Corymbia gummifera* with a dense shrub understorey. The woodland occurs on deep white sandy soils over sandstone, often with some gravelly laterite (NSW Scientific Committee 1998a). As discussed in Bell (2004), the species is typically associated with Clifton sub-group geology, principally Munmorah Conglomerates, and approximately 1500 ha of habitat for the species has been mapped on the Central Coast. Habitat for the species ranges in quality from large stands within intact reserves, to isolated populations in a highly fragmented landscape caused by development (Bell, 2004). Bell also notes that vegetation communities in which the species is noted to occur include the NPWS vegetation mapping units Coastal Plains Smooth-barked Apple Woodland (map unit 30) and Riparian Melaleuca Swamp Woodland (map unit 42). Though the species was found in these communities, it is noted that it was only considered a diagnostic species of Coastal Plains Scribbly Gum Woodland (map unit 31) (NSW NPWS 2000b).

Within the Project Boundary, four vegetation communities occur which correspond to the communities listed in Bell (Bell 2004) as suitable habitat for the species. These include Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin, 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 Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin. A total of 47.7 ha of these communities exist within the disturbance footprint. An additional 135.4 ha of these communities occur within the proposed offset. Map unit 31 occupies 4250 ha within the region (NSW NPWS 2000b). Combined with the other two minor communities, a conservative estimate of approximately 40120 ha of potential *Angophora inopina* habitat remains in the region, with 1655 ha of these protected within formal conservation reserves within the lower Hunter Valley and Central Coast (NSW NPWS 2000b).

Large numbers of this small tree occur within the Tooheys Road Site, predominantly in Scribbly Gum Red Bloodwood woodland with some scattered individuals in cleared areas, Swamp Mahogany forest or Paperbark Swamp forest. Further individuals have been recorded in adjacent private properties outside the Project Boundary in previous studies (OzArk 2012). There are 105 records of this species in the locality (OEH 2013).

The condition of habitat for the species within the Project Boundary is considered to be moderate to good as per Biobanking guidelines. However overall quality is generally low, as the areas of the Project containing these species have been cleared and fragmented by past land uses. The quality of habitat within the locality is considered to be higher, with 1,655 ha of suitable habitat occurring within reserved vegetation. Connectivity of existing habitat within the Project Boundary is currently low. The vegetation communities within which the species exist have undergone past clearing which has led to fragmentation of the population.

The Project is not predicted to significantly impact on the viability of the local population in the long-term or put the species at risk of extinction.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The population of *Angophora inopina* that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. This species is known to occur in the locality and due to the widespread habitat that is available in protected areas and State Forests; it is considered to be locally abundant. As such the individuals that occur in the Study Area are not likely to be a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the widespread occurrence of this species in the Study Area and in the surrounding locality, it is unlikely that the plants in the Study Area are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Angophora inopina*. It has a patchy distribution, ranging from of Lake Macquarie to north of the Hunter River. The largest and most intact stands occur in the Wyong and Lake Macquarie LGAs, where approximately 1,250 ha of occupied habitat have been mapped.

For the reasons outlined above, the population of *Angophora inopina* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As the population of *Angophora inopina* within the Study Area is not considered to be an important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will reduce the area of occupancy of this species, however as the population of *Angophora inopina* within the Study Area is not considered to be an important population of the species, the Project will not reduce the area of occupancy of an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment an existing population into two or more populations. Furthermore, the population of *Angophora inopina* within the Study Area is not considered to be an important population of the species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Angophora inopina*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

disrupt the breeding cycle of an important population

As the population of *Angophora inopina* within the Study Area is not considered to be an important population of the species, the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Angophora inopina is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, offset areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Angophora inopina*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Angophora inopina* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Angophora inopina*. Large areas of similar habitat occur in the locality that will remain, and this species will remain viable in these areas. Furthermore, degraded vegetation in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Angophora inopina*.

7.2 Tetratheca juncea

Tetratheca juncea (Black-eyed Susan) is listed as Vulnerable under the EPBC Act. The species is usually occurs on ridges but is also found on upper slopes, midslopes and occasionally in gullies (NSW NPWS 2000a). It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover (OEH 2012e). It is found in sandy, occasionally moist heath and in dry sclerophyll vegetation communities, in sandy skeletal soil on sandstone, sandy-loam soils and clayey soil from conglomerates.

Numerous patches and diffuse occurrences of this species were recorded within the Tooheys Road Site and Hue Hue Road offset area, predominantly in Scribbly Gum - Red Bloodwood woodland and Smooth-barked Apple – Red Bloodwood forest but with some occurrences in Swamp Mahogany Forest and Blackbutt – Turpentine forest. There are 116 records of this species in the locality (OEH 2013). The species is typically found in vegetation communities that correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar) (OEH, 2012).

The species occur predominantly within the following vegetation communities (SEWPaC. 2011):

- Coastal plains smooth-barked apple woodland;
- Coastal plains scribbly gum woodland; and
- Coastal foothills spotted gum-ironbark forest.

The species is also associated with the following vegetation communities (SEWPaC, 2011):

- Alluvial tall moist forest;
- Heath;
- Lower Hunter spotted gum-ironbark forest;
- Wyong paperbark swamp forest;
- Coastal sheltered apple-peppermint forest;
- Coastal sand wallum woodland-heath;
- Swamp mahogany-paperbark forest;
- Riparian melaleuca swamp woodland;

- Coastal clay heath;
- Coastal wet sand cyperoid heath;
- Coastal wet gully forest;
- Coastal sand apple-blackbutt forest; and
- Hunter Valley moist forest.

Corresponding vegetation communities that occur within the Study Area include:

- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; and
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin.

Habitats in which the species occur listed as "rare habitats" by SEWPaC (2011) found on site include:

- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin;
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC); and
- Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin (EEC).

The NSW NPWS considers that *Tetratheca juncea* is adequately conserved in the south-eastern portion of its range with approximately 1300 plant clumps known from Awabakal Nature Reserve, Glenrock State Recreation Area, Lake Macquarie Recreation Area, and Munmorah State Recreation Area (Payne 2000).

The Project will result in the removal of known specimens of this species from approximately 28 locations, and approximately 50.5 ha of potential habitat. That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction. The majority of the habitat for this species in the Study Area will remain, and this species habitat is unlikely to be affected by potential minor subsidence occurring as a result of the Project. This is a relatively widespread species, and it occurs in several protected areas.

Assessment of "Important Population" status

NSW NPWS Environmental Impact Assessment Guidelines state that populations of over 100 individuals should be considered significant across the species' range (NPWS, 2000). The commonwealth referral guidelines state the following in relation to the determination of "Important Population" status of the species:

"*A black-eyed susan population is regarded as an important population if it meets any of the following:*

- *has greater than 1000 plant clumps;*
- *an area of habitat has an average estimated plant clump density of 20 clumps/hectare or greater;*
- *occurs in rare habitat;*
- *occurs in an area of "important habitat" as defined in Maps 4a 4 and 4b and has greater than 500 plant clumps;*
- *occurs at or near the distributional limits of black-eyed susan (Maps 1 to 3);*
- *occurs in close proximity to a protected area (e.g. National Park) where black-eyed susan is known to occur. Close proximity refers to:*
    - *within 500 m if connected by a suitable habitat corridor such as native vegetation*
    - *within 100 m over disturbed habitat or non-native vegetation.*"

As individuals of the species occur in vegetation communities described as "Rare Habitat", the population of the species within the study area must be considered as a an Important Population. A total of three clumps of this species exist within designated "Rare Habitat". A further 78 exist in vegetation in which the species is typically found. A total of 36 clumps exist within the impact area and75 clumps exist within the proposed Offset Area.

Key source population either for breeding or dispersal

The population of *Tetratheca juncea* that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. NSW NPWS Environmental Impact Assessment Guidelines state that populations of over 100 individuals should be considered significant across the species' range (NPWS, 2000). This species is abundant in the Study Area and numerous specimens are located outside the Disturbance Boundary and in the Offset Areas. It is known to occur in many places in the locality and large areas of suitable habitat are available in nearby protected areas and State Forests.

Populations that are necessary for maintaining genetic diversity

Tetratheca juncea is known from many records in the Study Area and the surrounding locality, and therefore it is unlikely that the plants in the Study Area are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Tetratheca juncea*. It is known to occur from Wyong north to Bulahdelah, and inland 50 km east-west to the edge of the Sugarloaf Range.

For the reasons outlined above, the population of *Tetratheca juncea* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As the population of *Tetratheca juncea* within the Study Area is not considered to be an important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves and State Forests that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will reduce the area of occupancy of this species, however as the population of *Tetratheca juncea* within the Study Area is not considered to be an important population of the species, the Project will not reduce the area of occupancy of an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment an existing population into two or more populations. Furthermore, the population of *Tetratheca juncea* within the Study Area is not considered to be an important population of the species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Tetratheca juncea*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

disrupt the breeding cycle of an important population

As the population of *Tetratheca juncea* within the Study Area is not considered to be an important population of the species, the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Tetratheca juncea is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Tetratheca juncea*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Tetratheca juncea* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Tetratheca juncea*. Large areas of similar habitat occur in the locality that will remain, and this species will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Tetratheca juncea*.

7.3 Acacia bynoeana

Acacia bynoeana is listed as Vulnerable under the EPBC Act. It occurs mainly in heath and dry sclerophyll forest, typically in sand and sandy clay substrates, often with ironstone gravels, which are usually very infertile and well-drained. The species seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds (from grading) and in recently burnt open patches.

Associated overstorey species often include; *Corymbia gummifera*, *Eucalyptus haemastoma*, *E. gummifera*, *E. parramattensis*, *E. sclerophylla*, *Banksia serrata* and *Angophora bakeri* (NSW NPWS 1999).

Acacia bynoeana was recorded at two locations, in vegetation communities comprising overstorey species in which the species is typically associated. Vegetation communities the species was found in were Scribbly Gum – Red Bloodwood woodland and in Smooth-barked Apple – Red Bloodwood forest, at the Tooheys Road Site (Ozark 2012). Several individuals have been recorded near the Study Area, on the eastern side of the F3 Freeway (OzArk 2012). There are 26 records of this species in the locality (OEH 2013). The species is known to occur in association with the following vegetation types occurring within the Study Area (OEH, 2013):

- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Approximately 42.9 ha of these vegetation communities will be impacted by the Project. Approximately 169.4 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 91,391.47 ha of these vegetation communities occur across the Lower Hunter and Central Coast.

That notwithstanding, large areas of known and potential habitat will remain in the Study Area and locality, including protected areas such as Jilliby SCA, Wyong SF and Ourimbah SF. These areas will continue to provide habitat for this species and the removal of several individuals and a small area of potential habitat is unlikely to place this species at risk of extinction.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The population of *Acacia bynoeana* that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. This species is known to occur in the locality and large areas of suitable habitat are available in protected areas and State Forests.

Populations that are necessary for maintaining genetic diversity

Acacia bynoeana is known from the Study Area and the surrounding locality, and therefore it is unlikely that the plants in the Study Area are genetically distinct. As such, it is not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Acacia bynoeana*. It is known from around Morisset, in the Hunter District, south to Berrima and Mittagong in the Southern Highlands, with the main occurrence being in the Blue Mountains.

For the reasons outlined above, the population of *Acacia bynoeana* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As the population of *Acacia bynoeana* within the Study Area is not considered to be an important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will reduce the area of occupancy of this species, however as the population of *Acacia bynoeana* within the Study Area is not considered to be an important population of the species, the Project will not reduce the area of occupancy of an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment an existing population into two or more populations. Furthermore, the population of *Acacia bynoeana* within the Study Area is not considered to be an important population of the species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Acacia bynoeana*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

disrupt the breeding cycle of an important population

As the population of *Acacia bynoeana* within the Study Area is not considered to be an important population of the species, the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Acacia bynoeana is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Acacia bynoeana*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Acacia bynoeana* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Acacia bynoeana*. Large areas of similar habitat occur in the locality that will remain, and this species will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Acacia bynoeana*.

7.4 Cryptostylis hunteriana

Cryptostylis hunteriana (Leafless Tongue Orchid) is listed as Vulnerable under the EPBC Act. It inhabits a range of habitats, mostly coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest in soils that include moist sands or moist to dry clay loam (Jones 2006, OEH 2012~).

A single *Cryptostylis hunteriana* individual was recorded within the Project Boundary, north of the Tooheys Road Site in Scribbly Gum - Red Bloodwood woodland (OzArk 2012). There are two records of this species within the locality (OEH 2013).

The species is known to occur in association with the following vegetation types occurring within the Study Area (OEH, 2013):

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Approximately 48.7 ha of these vegetation communities will be impacted by the proposal. Approximately 186.3 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 91,391.5 ha of these vegetation communities occur across the Lower Hunter and Central Coast.

The individual detected does not occur within the impact area. The individual occurs in the proposed offset area, thus is not considered at risk from the proposal.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The population of *Cryptostylis hunteriana* that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. This species is known to occur in the locality and large areas of suitable habitat are available in protected areas and State Forests.

Populations that are necessary for maintaining genetic diversity

Cryptostylis hunteriana is known from the Study Area and the surrounding locality, and therefore it is unlikely that the plants in the Study Area are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Cryptostylis hunteriana*. It is known to occur from Victoria to Queensland.

For the reasons outlined above, the population of *Cryptostylis hunteriana* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As the known population of *Cryptostylis hunteriana* within the Study Area is not proposed to be directly impacted and because it is not considered to be an important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will reduce the area of occupancy of this species, however as the population of *Cryptostylis hunteriana* within the Study Area is not considered to be an important population of the species, the Project will not reduce the area of occupancy of an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment an existing population into two or more populations. Furthermore, the population of *Cryptostylis hunteriana* within the Study Area is not considered to be an important population of the species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Cryptostylis hunteriana*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

disrupt the breeding cycle of an important population

As the population of *Cryptostylis hunteriana* within the Study Area is not considered to be an important population of the species, the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Cryptostylis hunteriana is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Cryptostylis hunteriana*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Cryptostylis hunteriana* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Cryptostylis hunteriana*. Large areas of similar habitat occur in the locality that will remain, and this species will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Cryptostylis hunteriana*.

7.5 Grevillea parviflora subsp. parviflora

Grevillea parviflora subsp*. parviflora* (Small-flower Grevillea) is listed as Vulnerable under the EPBC Act. It occurs in heathy associations or shrubby woodland, in sandy or light clay soils, usually over thin shales often with lateritic ironstone gravels which are often infertile and poorly drained. Most populations are found in open, slightly disturbed sites, particularly close to roads and tracks (OEH 2012^).

Six plants were recorded in total, all of which fall outside of the proposed disturbance boundary and within the proposed offset area. This is considered to constitute a small population, as populations of less than 20 individuals are classified as small populations within the approved conservation advice (SEWPaC, 2008). There are 119 records of this species in the locality (OEH 2012a).

The species is known to occur in association with the following vegetation type occurring within the Study Area (OEH, 2013):

- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin.

Approximately 44.6 ha of these vegetation communities will be impacted by the proposal. Approximately 175.9 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 100,599.0 ha of these vegetation communities occur across the Lower Hunter and Central Coast.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The population of *Grevillea parviflora* subsp*. parviflora* that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. The population is classified as a small population, being less than 20 plants (SEWPaC, 2008).This species is known to occur in the locality and large areas of suitable habitat are available in protected areas and State Forests.

Populations that are necessary for maintaining genetic diversity

Grevillea parviflora subsp*. parviflora* is known from the Study Area and the surrounding locality, and therefore it is unlikely that the plants in the Study Area are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Grevillea parviflora* subsp*. parviflora*. It is known to occur from Victoria to Queensland.

For the reasons outlined above, the population of *Grevillea parviflora* subsp*. parviflora* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As the population of *Grevillea parviflora* subsp*. parviflora* within the Study Area is not considered to be an important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will reduce the area of occupancy of this species, however as the population of *Grevillea parviflora* subsp*. parviflora* within the Study Area is not considered to be an important population of the species, the Project will not reduce the area of occupancy of an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment an existing population into two or more populations. Furthermore, the population of *Grevillea parviflora* subsp*. parviflora* within the Study Area is not considered to be an important population of the species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Grevillea parviflora* subsp*. parviflora*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

disrupt the breeding cycle of an important population

As the population of *Grevillea parviflora* subsp*. parviflora* within the Study Area is not considered to be an important population of the species, the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Grevillea parviflora subsp*. parviflora* is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Grevillea parviflora* subsp*. parviflora*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Grevillea parviflora* subsp*. parviflora* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Grevillea parviflora* subsp*. parviflora*. Large areas of similar habitat occur in the locality that will remain, and this species will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Grevillea parviflora* subsp*. parviflora*.

7.6 Melaleuca biconvexa

Melaleuca biconvexa (Biconvex Paperbark) is listed as Vulnerable under the EPBC Act. The species grows in damp places, often near streams and rivers or low-lying areas on alluvial soils of low slopes or sheltered aspects. Dense, narrow stands, often in association with other *Melaleuca* species, can occur adjacent to watercourses (NSW Scientific Committee 1998b, OEH 2012d).

Several stands of *Melaleuca biconvexa* were recorded within the Project Boundary, east of the Buttonderry impact Site in Blackbutt – Turpentine forest. Stands were largely confined to within 4 m of creeklines and wet depressions except between the eastern side of the creek and Hue Hue Road where the species was found in areas damp from surface runoff. The species showed variable abundance within the area of occupancy, ranging from scattered stems to dense thickets. Overall cover abundance was medium and included mature, young and immature stems as well as saplings.

Previous studies have also recorded *Melaleuca biconvexa* individuals in the Extraction Area (ERM 2003). There are 279 records of this species in the locality (OEH 2013).

The species is also known to occur in association with the following vegetation type occurring within the Study Area (OEH, 2013):

- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin (EEC);
- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin;
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin;
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC); and
- Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin (EEC).

Approximately 9.5 ha of these vegetation communities will be impacted by the Project. Approximately 27.3 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 60,400.4 ha of these vegetation communities occur across the Lower Hunter and Central Coast.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The population of *Melaleuca biconvexa* that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. This species is known to occur in the locality and large areas of suitable habitat are available in protected areas and State Forests.

Populations that are necessary for maintaining genetic diversity

Melaleuca biconvexa is known from the Study Area and the surrounding locality, and therefore it is unlikely that the plants in the Study Area are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Melaleuca biconvexa*. It is known to occur from Jervis Bay in the south to the Lake Macquarie area to the north.

For the reasons outlined above, the population of *Melaleuca biconvexa* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As the population of *Melaleuca biconvexa* within the Study Area is not considered to be an important population of the species and because no direct disturbance to known locations of this species will occur, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will reduce the area of occupancy of this species, however as the population of *Melaleuca biconvexa* within the Study Area is not considered to be an important population of the species, the Project will not reduce the area of occupancy of an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment an existing population into two or more populations. Furthermore, the population of *Grevillea parviflora* subsp*. parviflora* within the Study Area is not considered to be an important population of the species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Melaleuca biconvexa*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

disrupt the breeding cycle of an important population

As the population of *Melaleuca biconvexa* within the Study Area is not considered to be an important population of the species, the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Melaleuca biconvexa is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Melaleuca biconvexa*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Melaleuca biconvexa*. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Melaleuca biconvexa*. Large areas of similar habitat occur in the locality that will remain, and this species will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Melaleuca biconvexa*.

7.7 Asterolasia elegans

Asterolasia elegans is listed as Endangered under the EPBC Act. The species grows as a tall, slender shrub, up to 3 m high. The narrow leaves are lanceolate or elliptical, with dark green upper surfaces and white to rusty stellate hairs. Flowers are terminal, occur in clusters and are white in colour (OEH 2011b).

This species grows in wet sclerophyll forest on moist hillsides and is known from only seven populations, north of Sydney. The species grows on Hawkesbury Sandstone or Gymea erosional landscapes, commonly among rocky outcrops and boulders. The species is found on the mid to lower slopes of rolling to very steep terrain. The species occurs in wet sheltered sclerophyll forests. One population occurs at the base of large rock shelves (OEH, 2011).

This species has not been recorded within the Study Area and there are no records in the locality or wider Wyong LGA. However it was recorded on the EPBC Protected Matters Search Tool and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

The species is known to occur within the Hawkesbury- Nepean Catchment (OEH, 2012). The Study Area does not fall within this catchment; however vegetation communities listed as being associated with this species do occur within the Study Area. No vegetation communities are found on site which directly correspond to those listed as suitable habitat for the species, however three communities fall within the same Biometric vegetation class. Communities corresponding to those listed as habitat for the species found within the Study Area include:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Approximately 50.41 ha of these vegetation communities will be impacted by the proposal. Approximately 186.25 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 151,940 ha of these vegetation communities occur across the Lower Hunter and Central Coast.

No individuals of this species have been detected within the impact areas. It is considered likely that should the species occur within the Study Area, it would occur in the western portion, which is unlikely to be significantly impacted by subsidence. Specifically, 1,040.70 ha of Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin occur within the subsidence impact area, and will be retained within Jilliby State Conservation Area. No significant impact is considered likely to occur to this species.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As there is no known population of *Asterolasia elegans* within the Study Area it is not proposed to be directly impacted. As there is no known population of this species within the Study Area, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of this species, as no population of *Asterolasia elegans* is considered likely to occur within the Study Area. As a result, the Study Area is not considered to be an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment any potentially existing population into two or more populations. Furthermore, a population of *Asterolasia elegans* is considered unlikely to occur within the Study Area, and the area is not considered to constitute important habitat for this species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Asterolasia elegans*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable if present in these areas.

disrupt the breeding cycle of an important population

As a population of *Asterolasia elegans* is considered unlikely to occur within the Study Area, the Study Area is not considered to be an important population of the species, and the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Asterolasia elegans is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas.

Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Asterolasia elegans*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Asterolasia elegans* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Asterolasia elegans*. Large areas of similar habitat occur in the locality that will remain, and this species, if present, will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Asterolasia elegans*.

7.8 Caladenia tessellata

Caladenia tessellata is listed as Vulnerable under the EPBC Act. It is a perennial orchid that sprouts annually from an underground tuber. This species generally flowers from September – November and has a single, hairy 30 cm tall flowering stem (SEWPaC 2012e). The flower is characterised by five long spreading cream coloured petals with reddish stripes and a broad down-curled labellum with darker stripes (OEH 2012□).

The Thick-lipped Spider-orchid is endemic to mainland south-east Australia. It is distributed from the central coast of NSW to the Westernport region of southern Victoria. This includes the South East Coastal Plain, South East Corner, and Sydney Basin bioregions. The species usually occurs on or near the coast, but in southern NSW it extends well inland to Braidwood. Within NSW, the orchid is known to occur within the Hawkesbury-Nepean, Hunter-Central Rivers, Southern Rivers and Sydney Metro Catchment Management Regions (SEWPaC 2012e).

The species has not been recorded in the locality. However there are six records for this species in the Wyong LGA (OEH 2012a) and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Within the Hunter-Central Rivers CMA, this species is known or predicted to occur in association with the following vegetation types, which occur within the Study Area (OEH, 2013):

- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Approximately 5.28 ha of these vegetation communities will be cleared by the proposal. Approximately 55.36 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 82,504.4 ha of these vegetation communities occur across the Lower Hunter and Central Coast.

No individuals of this species have been detected within the impact areas. It is considered likely that should the species occur within the Study Area, it would occur in the western portion, which is unlikely to be significantly impacted by subsidence or within the proposed Offset Area. Specifically, 1,017 ha of Spotted Gum- Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin and Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin occurs within the subsidence impact area, of which over 900 ha of Spotted Gum - Grey Ironbark open forest will be retained within Jilliby SCA and Wyong SF. No significant impact is considered likely to occur to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

No known population of *Caladenia tessellata* occurs in the Study Area although this species is known to occur in the Wyong LGA. Thus, there is no key source population for breeding or dispersal within the Study Area.

Populations that are necessary for maintaining genetic diversity

Caladenia tessellata is known from the surrounding locality, and therefore any potential population within the Study Area is unlikely to be genetically distinct. It is therefore not considered that any potential population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Caladenia tessellata*. It is known to occur further north along the Central coast of NSW down to Victoria.

For the reasons outlined above, any potential population of *Caladenia tessellata* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As no known population of *Caladenia tessellata* occurs within the Study Area, this species is not proposed to be directly impacted. As there are no important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of this species, as no population of *Caladenia tessellata* is considered likely to occur within the Study Area. As a result, the Study Area is not considered to be an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment any potentially existing population into two or more populations. Furthermore, a population of *Caladenia tessellata* is considered unlikely to occur within the Study Area, and the area is not considered to constitute important habitat for this species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Caladenia tessellata*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable if present in these areas.

disrupt the breeding cycle of an important population

As a population of *Caladenia tessellata* is considered unlikely to occur within the Study Area, the Study Area is not considered to be an important population of the species, and the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Caladenia tessellata is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Caladenia tessellata*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Caladenia tessellata* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Caladenia tessellata*. Large areas of similar habitat occur in the locality that will remain, and this species, if present, will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Caladenia tessellata.*

7.9 Eucalyptus camfieldii

Eucalyptus camfieldii is listed as Vulnerable under the EPBC Act. It is a mallee shrub/small tree ranging from 4 – 9 m in height. The bark is greyish-brown, rough, fibrous and stringy. The flowers are white while the fruit is flattened and globe-shaped. This species occurs mostly in exposed areas of on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heaths or low open woodland (OEH 2012k).

This species occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (OEH 2012k). It grows in shallow sandy soils overlying Hawkesbury sandstone or Coastal heath, on exposed sandy ridges (SEWPaC 2012h).

Camfield's Stringybark was originally known from as far south as Bulli Pass (near Wollongong) and as far north as Gosford (SEWPaC 2012h). In NSW, this species is known to occur within the Hawkesbury-Nepean, Hunter-Central Rivers, Southern Rivers and Sydney Metro Catchment Management Regions and has a restricted distribution in a narrow band extending from Raymond Terrace in the north to Waterfall in the south (OEH 2012k).

The species has not been recorded in the Study Area. However there are records for this species in the locality and wider Wyong LGA (OEH 2012a) and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Within the Hunter-Central Rivers CMA, this species is known or predicted to occur in association with the following vegetation type, which occurs within the Study Area (OEH, 2013):

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

Approximately 33.8 ha of this vegetation community will be cleared by the Project. Approximately 40 ha of this vegetation community is to be included in the proposed offset. Additionally, this vegetation community occurs in the broader locality and across the range of the species. A total of 6,000 ha of this vegetation community occurs across the Lower Hunter and Central Coast.

No individuals of this species have been detected within the impact areas. It is considered likely that should the species occur within the Study Area, it would occur within the Infrastructure areas and Offset Areas at Tooheys Road. No significant impact is considered likely to occur to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

No known population of *Eucalyptus camfieldii* occurs in the Study Area although this species is known to occur in the Wyong LGA. Thus, there is no key source population for breeding or dispersal within the Study Area.

Populations that are necessary for maintaining genetic diversity

Eucalyptus camfieldii is known from the surrounding locality, and therefore any potential population within the Study Area is unlikely to be genetically distinct. It is therefore not considered that any potential population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Eucalyptus camfieldii*. It is known to occur further north in the Raymond Terrace area of NSW down to Wattamola.

For the reasons outlined above, any potential population of *Eucalyptus camfieldii* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As no known population of *Eucalyptus camfieldii* occurs within the Study Area, this species is not proposed to be directly impacted. As there are no important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of this species, as no population of *Eucalyptus camfieldii* is considered likely to occur within the Study Area. As a result, the Study Area is not considered to be an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment any potentially existing population into two or more populations. Furthermore, a population of *Eucalyptus camfieldii* is considered unlikely to occur within the Study Area, and the area is not considered to constitute important habitat for this species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Eucalyptus camfieldii*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable if present in these areas.

disrupt the breeding cycle of an important population

As a population of *Eucalyptus camfieldii* is considered unlikely to occur within the Study Area, the Study Area is not considered to be an important population of the species, and the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Eucalyptus camfieldii is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Eucalyptus camfieldii*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Eucalyptus camfieldii* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* or Exotic Rust Fungi of the order Pucciniales into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Eucalyptus camfieldii.* Large areas of similar habitat occur in the locality that will remain, and this species, if present, will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Eucalyptus camfieldii*.

7.10 Rhizanthella slateri

The Eastern Underground Orchid (*Rhizanthella slateri*) is listed as Endangered under the EPBC Act. The species is described as a 'terrestrial saprophytic' (grows on and derives its nourishment from dead or decaying organic matter) herb with a fleshy underground stem of 15 cm long and 15 mm diameter. The stem is whitish, often branching, with prominent, fleshy, overlapping bracts. Flowering heads mature below the soil surface and may extend up to 2 cm above the ground. The stems grow from a horizontal rhizome which has no roots, only hairs (SEWPaC, 2013).

The Eastern Underground Orchid is restricted to NSW. It is currently known only from 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. The population in the Great Lakes area occurs at the known northern limit of the species' range and is disjunct from other known populations of the species.

The Eastern Underground Orchid is difficult to detect. It is usually located when the soil is disturbed, and there may well be more locations of the species within its known range (SEWPaC, 2013).

The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available (DECC 2005b; c). As such, the following vegetation communities within the Study Area are considered to comprise suitable habitat for the species:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin (EEC)
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Approximately 50.41 ha of these vegetation communities will be impacted by the Project. Approximately 186.61 ha of these vegetation communities are to be included in the proposed offset. In addition to this 2,601 ha of Eucalypt dominated woodland and forest will be retained within the Jilliby State Conservation Area, within the subsidence area.

Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 151,940.2 ha of these vegetation communities occur across the Lower Hunter and Central Coast

The EPBC SPRAT Profile (SEWPaC, 2013) for the species states that:

"*Ancillary benefits of protecting known populations of the Eastern Underground Orchid include protection of the largest known population of Cryptostylis hunteriana (another saprophytic orchid), a threatened species under State and Commonwealth legislation, known to occur in the same area as the Eastern Underground Orchid on Bulahdelah Mountain (NSW Roads and Traffic Authority 2005), and protection of one of only three known populations of Corybas dowlingii, a relatively new and little known species of terrestrial orchid that was only described in September 2004 (Jones 2004b), also known to occur in the same area as the Eastern Underground Orchid on Bulahdelah Mountain (NSW Roads and Traffic Authority 2005).*"

Rhizanthella slateri has not been detected within the Study Area. However the Study Area is contains one individual of *Cryptostylis hunteriana.* Approximately 42.86 ha of vegetation communities comprising habitat for these species will be impacted by the Project. Approximately 169.40 ha of these vegetation communities are to be included in the proposed offset. Additonal suitable habitat will be retained within the Jilliby State Conservation Area. No significant impact is considered likely to occur to *Rhizanthella slateri*.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As there is no known population of *Rhizanthella slateri* within the Study Area, it is not proposed to be directly impacted. As there is no known population of this species within the Study Area, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of this species, as no population of *Rhizanthella slateri* is considered likely to occur within the Study Area. As a result, the Study Area is not considered to be an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment any potentially existing population into two or more populations. Furthermore, a population of *Rhizanthella slateri* is considered unlikely to occur within the Study Area, and the area is not considered to constitute important habitat for this species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Rhizanthella slateri*. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable if present in these areas.

disrupt the breeding cycle of an important population

As a population of *Rhizanthella slateri* is considered unlikely to occur within the Study Area, the Study Area is not considered to be an important population of the species, and the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality which will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Rhizanthella slateri is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Rhizanthella slateri*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Rhizanthella slateri* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Rhizanthella slateri*. Large areas of similar habitat occur in the locality that will remain, and this species, if present, will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Rhizanthella slateri*.

7.11 Rutidosis heterogama

Rutidosis heterogama is listed as Vulnerable under the EPBC Act. It is a perennial herb with decumbent to erect stems, 30 cm high, growing from a woody base. The leaves are narrow and stalkless with curved edges and a rough texture. This species mainly flowers in autumn (March – April) but occasionally from November – January. The flower heads are tiny and yellow. The species mostly inhabits heath, and is often found along disturbed roadsides (OEH 2012{).

There are 66 records for this species in the locality and a total of 183 records in the Wyong LGA in two disjunct locations, Munmorah State Conservation Area (SCA) and around the Woongarrah area, south east of the Study Area (OEH 2012a). The species was previously recorded in the vicinity of the Study Area but was not recorded during OzArk surveys (OzArk 2012). However it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Within the Hunter-Central Rivers CMA, this species is known or predicted to occur in association with the following vegetation types, which occur within the Study Area (OEH, 2013):

- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Approximately 42.86 ha of these vegetation communities will be cleared by the Project. Approximately 169.40 ha of these vegetation communities are to be included in the proposed offset. Additionally, these vegetation communities occur in the broader locality and across the range of the species. A total of 91,391.47 ha of this vegetation community occurs across the Lower Hunter and Central Coast.

No individuals of this species have been detected within the impact areas. It is considered likely that should the species occur within the Study Area, it would occur within the Infrastructure areas and offset areas at Tooheys Road. No significant impact is considered likely to occur to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

No known population of *Rutidosis heterogama* occurs in the Study Area although this species is known to occur in the Wyong LGA. Thus, there is no key source population for breeding or dispersal within the Study Area.

Populations that are necessary for maintaining genetic diversity

Rutidosis heterogama is known from the surrounding locality, and therefore any potential population within the Study Area is unlikely to be genetically distinct. It is therefore not considered that any potential population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Rutidosis heterogama*. It is known to occur further south in Woy Woy and extend further north up to Cessnock.

For the reasons outlined above, any potential population of *Rutidosis heterogama* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As no known population of *Rutidosis heterogama* occurs within the Study Area, this species is not proposed to be directly impacted. As there are no important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of this species, as no population of *Rutidosis heterogama* is considered likely to occur within the Study Area. As a result, the Study Area is not considered to be an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment any potentially existing population into two or more populations.

Furthermore, a population of *Rutidosis heterogama* is considered unlikely to occur within the Study Area, and the area is not considered to constitute important habitat for this species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Rutidosis heterogama.* Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable if present in these areas.

disrupt the breeding cycle of an important population

As a population of *Rutidosis heterogama* is considered unlikely to occur within the Study Area, the Study Area is not considered to be an important population of the species, and the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Rutidosis heterogama is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Rutidosis heterogama*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Rutidosis heterogama* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* or Exotic Rust Fungi of the order Pucciniales into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Rutidosis heterogama.* Large areas of similar habitat occur in the locality that will remain, and this species, if present, will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Rutidosis heterogama*.

7.12 Syzygium paniculatum

Syzygium paniculatum is listed as Vulnerable under the EPBC Act. This rainforest species can form a tree to 15 m tall, but is generally 3–8 m high and shrubby in form. The stem is without conspicuous buttresses. The bark is flaky to almost tessellated, with the outer blaze cream, pale brown or pink, and fibrous in texture. Leaves are lanceolate to obovate, 4.5–10 cm long and are generally dark green and glabrous (smooth) on the upper surface and paler underneath (OEH 2012*f*).

This species is found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (SEWPaC 2012t). Rainforests are often remnant stands of littoral or gallery rainforest.

The Magenta Lilly-Pilly is endemic to NSW and has been recorded in widely scattered small populations along the NSW coast from Booti Booti in the north to Conjola State Forest in the south (SEWPaC 2012s). In NSW, this species is known to occur within the Hawkesbury-Nepean, Hunter-Central Rivers, Southern Rivers and Sydney Metro Catchment Management Regions along a narrow linear coastal strip (OEH 2012k).

The species has not been recorded in the Study Area. However, there are records for this species in the locality and wider Wyong LGA (OEH 2012a) and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Within the Hunter-Central Rivers CMA, this species is known or predicted to occur in association with the following vegetation type, which occurs within the Study Area (OEH, 2013):

- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin.

This vegetation community will not be cleared for the Project.

No individuals of this species have been detected within the impact areas. It is considered unlikely that should the species occur within the Study Area, it would occur within the Infrastructure areas and offset areas at Tooheys Road. No significant impact is considered likely to occur to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

No known population of *Syzygium paniculatum* occurs in the Study Area although this species is known to occur in the locality and Wyong LGA. Thus, there is no key source population for breeding or dispersal within the Study Area.

Populations that are necessary for maintaining genetic diversity

Syzygium paniculatum is known from the surrounding locality, and therefore any potential population within the Study Area is unlikely to be genetically distinct. It is therefore not considered that any potential population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of *Syzygium paniculatum*. It is known to occur further north in Booti Booti National Park down to Jervis Bay.

For the reasons outlined above, any potential population of *Syzygium paniculatum* that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

As no known population of *Syzygium paniculatum* occurs within the Study Area, this species is not proposed to be directly impacted. As there are no important population of the species, the Project will not lead to a long term decrease in the size of an important population. Large areas of similar habitat will remain outside the Study Area in conservation reserves that will remain and will continue to provide habitat for this species.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of this species, as no population of *Syzygium paniculatum* is considered likely to occur within the Study Area. As a result, the Study Area is not considered to be an important population.

fragment an existing important population into two or more populations

The Study Area is surrounded by similar vegetation to that which will be impacted. However, vegetation will remain connected and habitat linkages will remain. Accordingly, the Project will not fragment any potentially existing population into two or more populations. Furthermore, a population of *Syzygium paniculatum* is considered unlikely to occur within the Study Area, and the area is not considered to constitute important habitat for this species.

adversely affect habitat critical to the survival of a species

The habitat to be removed in the Study Area is not considered to be critical to the survival of *Syzygium paniculatum.* Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable if present in these areas.

disrupt the breeding cycle of an important population

As a population of *Syzygium paniculatum* is considered unlikely to occur within the Study Area, the Study Area is not considered to be an important population of the species, and the Project will not disrupt the breeding cycle of an important population. Large areas of similar habitat, including suitable breeding habitat will remain in the locality that will continue to provide habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Syzygium paniculatum is unlikely to decline as a result of habitat removed for the Project. Large areas of similar habitat occur in conservation reserves in the locality that will remain, and this species will remain viable in these areas. Furthermore, Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

It is considered unlikely that the Project will result in an invasive species becoming established in habitat for *Syzygium paniculatum*. Significant numbers of exotic plants already occur in the Study Area and these will be controlled as part of the Project. It is unlikely that any other invasive plant or animal will become established as a result of the Project.

introduce disease that may cause the species to decline, or

It is considered unlikely that the Project will introduce a disease that may cause *Syzygium paniculatum* to decline. Appropriate avoidance measures will be implemented to avoid transferring the soil borne pathogenic fungus *Phytopthera cinnamomi* or Exotic Rust Fungi of the order Pucciniales into the Study Area.

interfere substantially with the recovery of the species.

The Project will not interfere with the recovery of *Syzygium paniculatum.* Large areas of similar habitat occur in the locality that will remain, and this species, if present, will remain viable in these areas. Furthermore, degraded land in the Offset Areas will be rehabilitated to contain woodland habitats that will provide suitable habitat for this species in the long term.

Conclusion

The Project is considered unlikely to result in a significant impact to *Syzygium paniculatum*.

7.13 Threatened Flora Impact Areas

Table 7.1 below details the areas of habitat to be cleared, habitat present within offsets and potential habitat within the SIL for all EPBC listed flora species known or considered likely to occur within the Study Area.

Table 7.1 Threatened Flora Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
Acacia bynoeana	Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest	42.9	169.4	1200.2
Angophora inopina	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest	47.7	135.4	98.8
Cryptostylis hunteriana	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest, Blackbutt - Turpentine open forest	48.7	186.3	1200.2
Grevillea parviflora subsp parviflora	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest, Woollybutt - Paperbark sedge forest	44.6	175.9	1200.9
Melaleuca biconvexa	Blackbutt – Turpentine forest, Spotted Gum - Grey Ironbark open forest, Swamp Mahogany	9.5	27.3	955.2

Table 7.1 Threatened Flora Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	swamp forest, Woollybutt - Paperbark sedge forest, Phragmites australis and Typha orientalis coastal freshwater wetlands			
Tetratheca juncea	Scribbly Gum - Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood , Spotted Gum - Broad-leaved Ironbark grassy open forest, , Spotted Gum - Grey Ironbark open forest, Woollybutt - Paperbark sedge forest Swamp Mahogany Forest , Blackbutt – Turpentine forest	50.5	192.8	1200.9
Asterolasia elegans	Scribbly Gum - Red Bloodwood heathy,Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest, Mountain Blue Gum - Turpentine moist shrubby open forest, Blackbutt - Turpentine open forest	50.41	186.25	2059.35
Caladenia tessellata	Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest	5.28	55.36	1017.12
Eucalyptus camfieldii,	Scribbly Gum - Red Bloodwood heathy	33.81	40.04	0.0
Rhinzanthella slateri	Rough-barked Apple - red gum grassy woodland, Scribbly Gum - Red Bloodwood heathy woodland, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open	50.41	186.61	2601.00

Table 7.1 Threatened Flora Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	forest, Spotted Gum - Grey Ironbark open forest, Sydney Basin Blackbutt - Turpentine open forest, Coachwood - Crabapple warm temperate rainforest , Mountain Blue Gum - Turpentine moist shrubby open forest			
Syzygium paniculatum,	Coachwood – Crabapple rainforest	0.0	0.0	518.58

7.14 Giant Barred Frog

The Giant Barred Frog (*Mixophyes iteratus*), is listed as Endangered under the EPBC Act. The species is distributed from Belli Creek near Eumundi, south-east Queensland, south to Warrimoo, mid-eastern NSW. The Giant Barred Frog is currently known from mid to low altitudes below 610 m. Five populations of the species are known from the Watagan Mountains area (SEWPaC, 2013), which includes the large, mainly natural region west of the Study Area.

The species occurs in uplands and lowlands in rainforest and wet sclerophyll forest, including farmland. Populations have been found in disturbed areas with vegetated riparian strips on cattle farms and in regenerated logged areas. Many sites where the Southern Barred Frog is known to occur are the lower reaches of streams which have been affected by major disturbances such as clearing, timber harvesting and urban development in their headwaters..

This species is found amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest (OEH 2012s). This species is a stream-breeding species with eggs deposited out of the water, under overhanging banks or on steep banks of large pools (SEWPaC 2012n).

The species is known to occur in association with the following vegetation types (OEH, 2012):

- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC);

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin; and
- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of aquatic vegetation supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain water bodies suitable for breeding;
- Shelter – Riparian vegetation occurs within the Study Area, in addition to shelter habitat in the form of logs, bark and ground debris; and
- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

Approximately 9.32 ha of these vegetation communities will be impacted by the Project. Approximately 23.4 ha of these vegetation communities are to be included in the proposed offset. In addition to this 209.04 ha of these vegetation communities will be retained within the Jilliby SCA, within the subsidence area. Additionally, these vegetation communities occur in the broader locality and across the range of the species.

A total of 31,992.8 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 110,425.6 ha of these vegetation communities are mapped as occurring within the Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) Area (LHCCREMS, 2003).

Giant Barred Frogs were recorded at four locations within the Extraction Area in Mountain Blue Gum – Turpentine Forest. Previous studies have also recorded Giant Barred frogs within the Extraction Area (ERM 2003). There are 10 records of the species within the locality (OEH 2012a), with most occurring within Jilliby SCA.

Significant Impact Criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The Giant Barred Frog has been recorded within the Study Area and suitable habitat occurs. The Project will remove a small area of potential habitat for this species, however this species is not likely to be dependent on the habitat.

The majority of the potential habitat within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of a population of the Giant Barred Frog is considered likely to occur.

Reduce the area of occupancy of the species

The Project will remove small areas of potential habitat for the Giant Barred Frog; however these areas are located in the middle of large areas of habitat that will remain. This species is likely to continue to use the Study Area as before and the loss of small, degraded areas of habitat is not expected to reduce the overall area of occupancy of this species in the Study Area and the locality.

Fragment an existing population into two or more populations

It is unlikely that the Project will fragment an existing population into two or more populations. The areas of habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Giant Barred Frog occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas. The small areas of potential habitat that will be removed for the Surface Infrastructure are relatively degraded and are not critical to the survival of the Giant Barred Frog. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Giant Barred Frog.

Disrupt the breeding cycle of a population

The Project will not remove any breeding habitat for this species. It is known to breed in streams, and no streams will be removed in the Infrastructure Boundary. There is potential for subsidence to impact on streams in the Study Area, including Jilliby Jilliby Creek, however appropriate mitigation measures will be implemented to ensure that the basic hydrological, geomorphic and ecological features of the creeks will be minimally affected. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of habitat for the Giant Barred Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Giant Barred Frog.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Giant Barred Frog to decline. Chytrid fungus is a known threatening process for native frogs, however it is unlikely that the Project will result in the introduction of this disease. Appropriate hygiene protocols will be implemented when work is undertaken in wet and swampy areas that may harbour populations of frog infected with this fungus.

Interfere with the recovery of the species

A small area of habitat for the Giant Barred Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Giant Barred Frog as a result of the Project.

7.15 Green and Golden Bell Frog

The Green and Golden Bell Frog (*Litoria aurea*) is listed as Vulnerable under the EPBC Act. The Green and Golden Bell Frog occurs mainly along coastal lowland areas of eastern NSW and Victoria. The species was previously known from elsewhere in the Southern Tablelands, but is now considered to have disappeared from the ACT (SEWPaC 2013) and central slopes around Bathurst (NSW DEC 2005e).

The Green and Golden Bell Frog was formerly common throughout its range. Since about 1960, severe declines in the distribution and abundance of the species have been observed, particularly in NSW and the ACT. In NSW, the species disappeared completely from all highland areas above 250 m (except for one population near Captains Flat). Coastal populations have reduced in number and are becoming more isolated from other populations (SEWPaC 2013).

In NSW, the Green and Golden Bell Frog has been found in a wide range of water bodies except fast flowing streams. It inhabits many disturbed sites, including abandoned mines and quarries.

Breeding habitat includes water bodies that are still, shallow, ephemeral, unpolluted (but the frog can be found in polluted habitats), unshaded, with aquatic plants and free of Mosquito Fish (*Gambusia holbrooki*) and other predatory fish, with terrestrial habitats that consisted of grassy areas and vegetation no higher than woodlands, and a range of diurnal shelter sites . Breeding occurred in a significantly higher proportion of sites with ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds, and where predatory fish were absent.

The species would likely use the forested vegetation communities within the Study Area as shelter habitat, and the riparian and aquatic areas as breeding habitat. The species is associated with the following vegetation communities occurring within the Study Area:

- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC);
- Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin (EEC);
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin;
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC); and
- Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin (EEC).

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of aquatic vegetation supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain water bodies suitable for breeding;
- Shelter – Forested areas of the Study Area adjacent to water bodies contain suitable shelter habitat in the form of logs, bark and ground debris; and
- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

There are 10 records for the Green and Golden Bell Frog in the Wyong LGA, with most occurring on the eastern side of the F3 freeway. Previous studies have recorded this species within the Extraction Area (BHP 2002, 2003) and database recordhave located this species within the Hue Hue Road area (OEH 2012a).

Approximately 8.14 ha of vegetation communities comprising habitat for this species will be impacted by the Project. Approximately 65.78 ha of these vegetation communities are to be included in the proposed offset. In addition to this, approximately 1,019.04 ha of these communities will be retained within the remainder of the project, including in Jilliby SCA.

A total of 29,444.6 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 95,650.13 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered at risk as a result of the Project.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The Green and Golden Bell Frogs that were recorded in the Study Area are not considered to be part of a key source population for breeding or dispersal. This species is widespread throughout the region and there are widespread areas of suitable habitat that is available in nearby protected areas and State Forests. As such the individuals that occur in the Study Area are not likely to be part of a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the wide distribution of this species in the locality and the state, it is unlikely that the Green and Golden Bell Frogs in the Study Area are genetically distinct. It is therefore not considered that they belong to a population that is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Green and Golden Bell Frog. It occurs along the entire coast of NSW and northern Victoria and the Study Area is in the middle of its range.

For the reasons outlined above, the individuals of the Green and Golden Bell Frog that occurs in the Study Area are not part of a population that is considered to be important for the long term survival and recovery of this species and are not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The population of the Green and Golden Bell Frog that utilises the Study Area is not considered to be an important population.

The wetland habitat for this species that occurs within the Study Area will not be removed and is expected to remain. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of the Green and Golden Bell Frog is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will not remove wetland habitat for the Green and Golden Bell Frog. Suitable wetland habitat will remain in the Study Area and the Project is not expected to reduce the potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of the Green and Golden Bell Frog into two or more populations. No known habitat will be removed, and connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Green and Golden Bell Frog occurs in the Study Area it is not considered critical to the survival of this species. Large areas of similar habitat occur in the locality, much of which is present in protected areas, and large areas will remain in the Study Area.

Disrupt the breeding cycle of an important population

The Project is not considered likely that the Project will disrupt the breeding cycle of a population of the Green and Golden Bell Frog. No known habitat will be removed and the individuals that have been recorded are expected to continue to breed. Furthermore, the population in the Study Area is not considered to be an important population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No known habitat for the Green and Golden Bell Frog will be removed as part of the Project. Large areas of similar habitat will remain in the Study Area and the locality that may be used by this species. Therefore the Project is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. The introduced Mosquito Fish (*Gambusia holbrooki*) are known to be a threat to this species, however it is unlikely that the Project will result in the introduction of this species into the Study Area.

With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Green and Golden Bell Frog.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Green and Golden Bell Frog to decline. Chytrid fungus is a known threatening process for native frogs; however it is unlikely that the Project will result in the introduction of this disease. Appropriate hygiene protocols will be implemented when work is undertaken in wet and swampy areas that may harbour populations of frog infected with this fungus.

Interfere substantially with the recovery of the species

No known habitat for the Green and Golden Bell Frog will be removed as part of the Project. Large areas of similar habitat will remain in the Study Area and locality that may be used by this species. No breeding habitat of this species will be removed and the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Green and Golden Bell Frog as a result of the Project.

7.16 Giant Burrowing Frog

The Giant Burrowing Frog is listed as Vulnerable under the EPBC Act. It is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based (OEH 2012t).

The species is confined to the eastern slopes of the Great Dividing Range and coastal regions from near Mt Coridudgy and Kings Cross in Wollemi National Park, New South Wales, to Walhalla in the central highlands of eastern Victoria. The species has been found from near sea level up to 1000 m, from the coast to almost 100 km inland along the escarpment of the Great Dividing Range (SEWPAC 2013).

Across its range, the Giant Burrowing Frog appears to be dependent on areas with native vegetation as no Giant Burrowing Frogs have been recorded from cleared lands.

In the Watagan Mountain area, central coast of New South Wales, the species is associated with sandy soil on sandstone ridges that support heath vegetation. It occurs in semi-permanent to ephemeral sand or rock based streams, and infrequently in semi-permanent to permanent constructed dams with a sandy silt or clay base. It is also found in ephemeral to permanent artificial drainage ditches and culverts on roadsides (with a rock or sand/clay base). Giant Burrowing Frogs are not restricted to watercourses. Most radio-tracking locations in Yambulla and Olney State Forests were on the mid and upper slopes, more than 50 m from a stream, and up to 500 m from water.

The species is known to be associated with the following vegetation communities found on site:

- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin (EEC);
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; and
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of terrestrial vegetation supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain water bodies suitable for breeding;
- Shelter – Forested areas of the Study Area within proximity of water bodies contain suitable soils for the creation of burrows, int addition to shelter habitat in the form of logs, bark and ground debris; and
- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

There are 47 records in the Wyong LGA, with most occurring within Ourimbah SF (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area. Approximately 37.58 ha of vegetation communities comprising habitat for this species will be impacted by the Project. Approximately 114.04 ha of these vegetation communities are to be included in the proposed offset. In addition to this, approximately 99.31 ha of these communities will be retained within the remainder of the project, including in Jilliby SCA.

A total of 4,360 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 88,870.1 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered at risk as a result of the Project.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

No known population of Giant Burrowing Frog occurs in the Study Area although this species is known to occur in the Wyong LGA. Thus, there is no key source population for breeding or dispersal within the Study Area.

Populations that are necessary for maintaining genetic diversity

The Giant Burrowing Frog is known from the surrounding locality and therefore any potential population within the Study Area is unlikely to be genetically distinct. It is therefore not considered that any potential population occurring in the Study Area is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Giant Burrowing Frog. It occurs further north in Wollemi National Park and the range extends south into Victoria.

For the reasons outlined above, the any potential individuals of the Giant Burrowing Frog that occur in the Study Area are not part of a population that is considered to be important for the long term survival and recovery of this species and are not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The Giant Burrowing Frog has not been recorded within the Study Area and although this species has potential to occur, it is unlikely that an important population occurs. The Project will remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the native vegetation within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of the Giant Burrowing Frog is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will remove small areas of potential habitat for the Giant Burrowing Frog; however these areas are located in the middle of large areas of habitat that will remain. This species is likely to retain the potential to use the Study Area and the loss of small areas of potential habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of the Giant Burrowing Frog into two or more populations. The species is not known to inhabitat the Study Area, and the areas of potential habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Giant Burrowing Frog occurs in the Study Area it is not known to occur and this habitat is therefore not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas. The small areas of habitat that will be removed for the Surface Infrastructure are relatively degraded and are not critical to the survival of the Giant Burrowing Frog. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Giant Burrowing Frog.

Disrupt the breeding cycle of an important population

The Project will not remove any known breeding habitat for the Giant Burrowing Frog and it is not considered likely that the Project will disrupt the breeding cycle of a population of this species. There is potential for subsidence to impact on streams in the Study Area, including Jilliby Creek, however appropriate mitigation measures will be implemented to ensure that the basic hydrological, geomorphic and ecological features of the creeks will be minimally affected.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for the Giant Burrowing Frog will be directly disturbed as part of the development of the Project's surface facilities at the Tooheys Raod site. However, large areas of similar habitat will remain in the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Giant Burrowing Frog.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Giant Burrowing Frog to decline. Chytrid fungus is a known threatening process for native frogs, however it is unlikely that the Project will result in the introduction of this disease.

Appropriate hygiene protocols will be implemented when work is undertaken in wet and swampy areas that may harbour populations of frog infected with this fungus.

Interfere substantially with the recovery of the species

A small area of potential habitat for the Giant Burrowing Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Giant Burrowing Frog as a result of the Project.

7.17 Litttejohn's Tree Frog

Litttejohn's Tree Frog (*Litoria littlejohni*) is listed as Vulnerable under the EPBC Act. Littlejohn's Tree Frog is confined to eastern New South Wales and north-east Victoria. The Frog occurs in scattered locations between the Watagan Mountains, New South Wales, to Buchan in Victoria.

This species is found in heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground (OEH 2012,). Breeding habitat has been variously reported as rocky streams and semi-permanent dams, still water in dams, ditches, isolated pools and flooded hollows, dams, creeks and lagoons, semi-permanent or permanent dams, ponds and creeks and temporary pools when sufficient run-off water was available. White and Ehmann give a more broad breeding habitat description of temporary pools in forested areas, deep permanent pools of slow creeks (in hanging swamps) or slow, rock-lined rivers, and in fire dams within undisturbed natural vegetation (SEWPaC 2013).

The species is known to be associated with the following vegetation communities occurring within the Study Area:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of aquatic and terrestrial vegetation supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain water bodies suitable for breeding;
- Shelter – Riparian vegetation occurs within the Study Area, in addition to shelter habitat in the form of logs, bark and ground debris; and

- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

There are 15 records in the Wyong LGA, with most occurring within Jilliby SCA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area. Approximately 11.14 ha of these vegetation communities will be impacted by the Project. Approximately 72.21 ha of these vegetation communities are to be included in the proposed offset. In addition to this 1,017.12 ha of these vegetation communities will be retained within the Jilliby SCA, within the subsidence area. Additionally, these vegetation communities occur in the broader locality and across the range of the species.

A total of 28,107.8 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 82,504.46 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered to be at risk as a result of the Project.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

No known population of Littlejohn's Tree Frog occurs in the Study Area although this species is known to occur in the Wyong LGA. Thus, there is no key source population for breeding or dispersal within the Study Area.

Populations that are necessary for maintaining genetic diversity

The Littlejohn's Tree Frog is known from the surrounding areas and therefore any potential population within the Study Area is unlikely to be genetically distinct. It is therefore not considered that any potential population occurring in the Study Area is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Littlejohn's Tree Frog. It occurs further north in the Watagans National Park and the range extends south into Victoria.

For the reasons outlined above, the any potential individuals of the Littlejohn's Tree Frog that occur in the Study Area are not part of a population that is considered to be important for the long term survival and recovery of this species and are not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

Litttejohn's Tree Frog has not been recorded within the Study Area and although this species has potential to occur, it is unlikely that an important population occurs. The Project will remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the land within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of Litttejohn's Tree Frog is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will remove small areas of potential habitat for Litttejohn's Tree Frog; however these areas are located in the middle of large areas of habitat that will remain. This species is likely to retain the potential to use the Study Area and the loss of small areas of potential habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of Litttejohn's Tree Frog into two or more populations. The species is not known to inhabit the Study Area, and the areas of potential habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for Litttejohn's Tree Frog occurs in the Study Area it is not known to occur and this habitat is therefore not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas. The small areas of habitat that will be removed for the Surface Infrastructure are relatively degraded and are not critical to the survival of Litttejohn's Tree Frog. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for Litttejohn's Tree Frog.

Disrupt the breeding cycle of an important population

The Project will not remove any known breeding habitat for Litttejohn's Tree Frog and it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

There is potential for subsidence to impact on streams in the Study Area, including Jilliby Creek, however appropriate mitigation measures will be implemented to ensure that the basic hydrological, geomorphic and ecological features of the creeks will be minimally affected.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for Litttejohn's Tree Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for Litttejohn's Tree Frog.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause Litttejohn's Tree Frog to decline. Chytrid fungus is a known threatening process for native frogs, however it is unlikely that the Project will result in the introduction of this disease. Appropriate hygiene protocols will be implemented when work is undertaken in wet and swampy areas that may harbour populations of frog infected with this fungus.

Interfere substantially with the recovery of the species

A small area of potential habitat for Litttejohn's Tree Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to Litttejohn's Tree Frog as a result of the Project.

7.18 Stuttering Frog

The Stuttering Frog (*Mixophyes balbus*) is listed as Vulnerable under the EPBC Act. This species is found in rainforest and wet, tall open forest in foothills and escarpments on the eastern side of the Great Dividing Range. In non-breeding periods adults live in deep leaf litter and thick understorey vegetation on the forest floor (OEH 2012□).

The Stuttering Frog occurs in eastern-flowing streams of the Great Dividing Range, between the Cann River catchment in East Gippsland, Victoria, and the Clarence River catchment in north-eastern NSW, in the NSW North Coast, New England Tableland, Sydney Basin, South Eastern Highlands and South East Corner IBRA Bioregions.

The species is found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range (OEH, 2012). Adult frogs are highly cryptic, mostly remaining buried in leaf litter or loose soil during drier periods, but actively move about above ground at night after heavy rainfall (Mahony 1993). Foraging habitat for the species occurs within 500m of breeding habitat (OEH, 2012). The Stuttering Frog is an obligate stream breeder. Breeding occurs from early spring to mid autumn, usually after heavy rainstorms. Eggs are deposited in very shallow, slow-flowing riffle sections of the main channel of streams, in shallow nests dug into gravel or leaf litter substrates, or pasted directly onto bedrock (SEWPaC 2013).

The species is associated with the following vegetation communities and habitat types found within the Study Area:

- Water bodies, rivers, lakes, streams (not wetlands);
- Blackbutt - Turpentine open forest of the foothills of the North Coast; and
- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of aquatic and terrestrial vegetation supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain first order streams suitable for breeding;
- Shelter – Riparian vegetation occurs within the Study Area, in addition to shelter habitat in the form of logs, bark and ground debris; and
- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

There are 107 records for this species in the Wyong LGA, distributed between Jilliby SCA, Olney SF and in the vicinity of Ourimbah SF (OEH 2012a). Previous studies have recorded this species within the Extraction Area (BHP 2002, ERM 2003). Approximately 5.86 ha of these vegetation communities will be impacted by the Project. Approximately 16.86 ha of these vegetation communities are to be included in the proposed offset. In addition to this 518.58 ha of these vegetation communities will be retained within the Jilliby SCA, within the subsidence area. Additionally, these vegetation communities occur in the broader locality and across the range of the species.

A total of 5,188.5 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 9, 357.54 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

As this species is listed as Vulnerable, an assessment of whether the population in the Study Area constitutes an important population is first presented, followed by an assessment of the potential impact to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The population of Stuttering Frog that occurs in the Study Area is not considered to be a key source population for breeding or dispersal. This species is known to occur in the locality and there are widespread areas of suitable habitat that is available in protected areas and State Forests. As such the individuals that occur in the Study Area are not likely to be a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the widespread occurrence of this species in the Study Area and in the surrounding locality, it is unlikely that the frogs in the Study Area are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Stuttering Frog. It occurs from southern Queensland to Victoria along the eastern seaboard and the Study Area is in the middle of its range.

For the reasons outlined above, the population of the Stuttering Frog that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The population of the Stuttering Frog in the Study Area is not considered to be an important population. The Project will remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the habitat for this species that occurs within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of Stuttering Frog is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will remove small areas of potential habitat for the Stuttering Frog; however these areas are located in the middle of large areas of habitat that will remain. Suitable habitat will remain in the Study Area and the loss of small areas of habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of the Stuttering Frog into two or more populations. The areas of potential habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Stuttering Frog occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas, and large areas will remain in the Study Area. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Stuttering Frog.

Disrupt the breeding cycle of an important population

The Project is not considered likely that the Project will disrupt the breeding cycle of a population of the Stuttering Frog. There is potential for subsidence to impact on breeding habitat in streams in the Study Area, including Jilliby Creek, however appropriate mitigation measures will be implemented to ensure that the basic hydrological, geomorphic and ecological features of the creeks will be minimally affected.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for the Stuttering Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Stuttering Frog.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Stuttering Frog to decline. Chytrid fungus is a known threatening process for native frogs; however it is unlikely that the Project will result in the introduction of this disease. Appropriate hygiene protocols will be implemented when work is undertaken in wet and swampy areas that may harbour populations of frog infected with this fungus.

Interfere substantially with the recovery of the species

A small area of potential habitat for the Stuttering Frog will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Stuttering Frog as a result of the Project

7.19 Regent Honeyeater

The Regent Honeyeater is listed as Endangered under the EPBC Act. The Regent Honeyeater is known to occur in coastal forest, especially in stands dominated by Swamp Mahogany, Spotted Gum, and Southern Mahogany (SEWPaC 2012a). These habitats are present in the Study Area, and although it has not been recorded, it is considered to have potential to occur.

In 2011, the Regent Honeyeater's population was estimated with medium reliability at 350–400 mature birds . Previous estimates include 500–1,500, 800–2,000 and 1,500 (SEWPaC 2012q).

The Regent Honeyeater is endemic to south-east Australia, where it is widespread but with an extremely patchy distribution (Garnett et al. 2011). Its range extends from south-east Queensland to central Victoria (Menkhorst et al. 1999a). Most sightings originate from a few sites in north-east Victoria, along the western slopes of the Great Dividing Range in NSW and the Central Coast in NSW (Birdlife International 2012). In 2011, key breeding areas for the Regent Honeyeater were identified by Garnett et al. 2011:

- The Chiltern section of Chiltern-Mt Pilot National Park (NP), north-east Victoria
- Capertee Valley, central east NSW; and
- Bundarra-Barraba region, northern NSW.

Other breeding areas included;

- Wangaratta-Mansfield region, Victoria;
- Warrumbungle NP, Pilliga forests and Mudgee-Wollar region, central north NSW;
- Hunter Valley and Clarence Valley, east NSW; and
- south-east Queensland.

In some years, breeding also occurs in areas surrounding these key sites,,for example in the Bathurst-Mudgee-Wollar-Upper Hunter Valley region around the Capertee Valley, and in the Lurg-Killawarra-Albury region around Chiltern. Breeding is recorded with some regularity in the ACT, but this tends to involve individual pairs; and there is evidence to suggest that a small breeding population may occur in the Gore-Karara area in south-east Queensland. There are also some scattered and infrequent records of breeding from elsewhere in the range (Geering 1997, unpub. data; Higgins et al. 2001; Menkhorst et al. 1999a; Oliver et al. 1998).

In 2007, Regent Honeyeaters were recorded breeding in open forest close to Kurri Kurri in the Lower Hunter region. There were also dependent young in the area that had only fledged a few weeks earlier, indicating that breeding had recently occurred in a second location. Nests of the Regent Honeyeater have also been recorded at Quorrobolong, north of the Watagan range in the Lower Hunter region, in lowland forest habitat. Low-lying forests and woodlands of the Hunter Valley are important habitat for the species being used as winter foraging habitat and potential breeding sites. The occurrence of Regent Honeyeaters in the Hunter Valley is often associated with the Box-Ironbark Woodlands of the Upper Hunter, the Spotted Gum-Ironbark Forests of the Lower Hunter and the Swamp Mahogany (Eucalyptus robusta) Forests of the coastal belt (Lindsey 2008 pers comm.).

NSW OEH lists the Regent Honeyeater as being associated with the following vegetation communities found within the study area:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;

- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); and
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Winter flowering eucalypt species occur within the Study Area; and
- Roosting – Trees suitable as nocturnal roosts occur within the Study Area.

No individuals of the species have been detected within the Study Area. Approximately 44.2 ha of vegetation communities comprising habitat for this species will be impacted by the Project. Approximately 130.9 ha of these vegetation communities are to be included in the proposed offset. In addition to this, approximately 1115.22 ha of these communities will be retained within the remainder of the project, including in Jilliby SCA.

A total of 32,242.4 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 91,391.47 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered at risk as a result of the Project.

Significant Impact Criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The Regent Honeyeater has not been recorded within the Study Area, however suitable foraging habitat occurs. This species is not known to breed in the locality however and therefore no breeding habitat is present. The Project will remove a small area of potential foraging habitat for this species; however this habitat is located adjacent to cleared areas and is not of high quality. This species flies large distances in search of food and is not likely to be dependent on the habitat in the areas within the Infrastructure Boundary that will be cleared. The majority of the land within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of a population of the Regent Honeyeater is considered likely to occur.

Reduce the area of occupancy of the species

The Project will remove small areas of potential foraging habitat for the Regent Honeyeater; however these areas are located in the middle of large areas of habitat that will remain. This species is likely to continue to use the Study Area as before and the loss of small, degraded areas of habitat is not expected to reduce the overall area of occupancy of the Regent Honeyeater in the Study Area and the locality.

Fragment an existing population into two or more populations

The Regent Honeyeater is a highly mobile species that forages over large areas, and it is unlikely the Project will not fragment an existing population into two or more populations. The areas of habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable foraging habitat for the Regent Honeyeater occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas. The small areas of habitat that will be removed for the Surface Infrastructure are relatively degraded and are not critical to the survival of the Regent Honeyeater. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Regent Honeyeater.

Disrupt the breeding cycle of a population

The Regent Honeyeater breeds in several key locations, none of which is in the locality of the Study Area. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of foraging habitat for the Regent Honeyeater will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. The Regent Honeyeater is highly mobile and makes use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals.

With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Regent Honeyeater.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Regent Honeyeater to decline.

Interfere with the recovery of the species

A small area of foraging habitat for the Regent Honeyeater will be removed as part of the Project. However, this is not breeding habitat, and large areas of similar habitat will remain in the locality that may be used by this species. The Regent Honeyeater is highly mobile and makes use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Regent Honeyeater as a result of the Project.

7.20 Australasian Bittern

The Australasian Bittern (*Botaurus poiciloptilus*) is listed as Endangered under the EPBC Act. The Australasian Bittern occurs from south-east Queensland to south-east South Australia, Tasmania and in the southwest of Western Australia In eastern Australia, the Bittern occurs in discrete wetlands or wetland clusters in some parts of its range, most notably in the southeast of South Australia and into western Victoria, and in coastal areas in general The global population size of the Australasian Bittern is estimated to be 2,500-3,000 birds. This figure includes an estimated 2000 birds in southeastern Australia (SEWPaC, 2013).

The species occurs mainly in densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands. In Australia, the Australasian Bittern occurs in terrestrial wetlands and, rarely, estuarine habitats. It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over muddy or peaty substrate (OEH 2012b).

The species is known to be associated with the following vegetation type located within the Study Area (OEH, 2013):

- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin (EEC).

The species may also infrequently use the following habitat found within the Study Area:

- Water/Farm Dam.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of aquatic vegetation supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain aquatic vegetation suitable for nesting and breeding; and
- Shelter – Riparian and upright aquatic vegetation occurs within the Study Area.

No primary habitat for this species will be impacted by the Project. 1.21 ha of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands will be retained within the subsidence area. Additionally, 0.58 ha of water/ farm dam will be impacted by the Project. 1.45 ha of this habitat type will be retained within the proposed offset, with a further 23.28 ha remaining within the subsidence area.

A total of 171.4 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002).

This species has been recorded from the Wyong LGA (OEH 2012a) and suitable habitat for this species has been recorded within the Study Area (ERM 2003). Some small areas of wetlands occur in the Study Area, however they do not provide high quality habitat for this species.

The long-term viability of the species is not considered to be at risk as a result of the Project.

Significant Impact Criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The Australasian Bittern has not been recorded within the Study Area, however small areas of suitable wetland habitat occur. The Project will not remove potential habitat for this species, however there is some potential for impacts to GDEs (wetlands) to occur due to subsidence. Large areas of better quality wetland habitat for this species occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of a population of the Australasian Bittern is considered likely to occur.

Reduce the area of occupancy of the species

No areas of potential habitat for the Australasian Bittern will be removed and the Project is not expected to reduce the overall area of occupancy of this species in the Study Area and the locality.

Fragment an existing population into two or more populations

The Australasian Bittern is a mobile species that can fly over disturbed areas, and it is unlikely the Project will not fragment an existing population into two or more populations. No areas of habitat will be removed and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Australasian Bittern occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas. No areas of habitat will be removed and although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Australasian Bittern.

Disrupt the breeding cycle of a population

No areas of habitat that will be removed for the Australasian Bittern breeds and it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No area of habitat for the Australasian Bittern will be removed as part of the Project and it is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Australasian Bittern.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Australasian Bittern to decline.

Interfere with the recovery of the species

No area of habitat for the Australasian Bittern will be removed for the Project and it is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Australasian Bittern as a result of the Project.

7.21 Australian Painted Snipe

The Australian Painted Snipe is listed as Vulnerable under the EPBC Act. The species is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. The total population size of the Australian Painted Snipe is effectively unknown, but tentative estimates range from a few hundred individuals to 5,000 breeding adults (SEWPaC, 2013).

The species generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Also used are inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*). The Australian Painted Snipe occasionally utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber. The Australian Painted Snipe eats vegetation, seeds, insects, worms and molluscs, crustaceans and other invertebrates (SEWPaC, 2013).

Breeding habitat requirements of the Australian Painted Snipe are reported to be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nest records predominantly from or near small islands in freshwater wetlands, with islands being a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (SEWPaC, 2013).

The Australian Painted Snipe has also been recorded nesting in and near swamps, canegrass swamps, flooded areas including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch (*Paspalum*), saltbush (*Halosarcia*) and grass, also in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush. One nest has been found in the centre of a cow-pat in a clump of long grass (SEWPaC, 2013).

The species is known to be associated with the following vegetation community located within the Study Area (OEH, 2013):

- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin (EEC).

The following habitats are also considered suitable for the species:

- Exotic/Agricultural/Low Diversity Grassland; and
- Water/Farm Dam.

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Areas of aquatic vegetation and occasionally inundaded grasslands supporting invertebrates occur within the Study Area;
- Breeding – The Study Area is likely to contain aquatic vegetation suitable for nesting and breeding; and
- Shelter – Riparian and upright aquatic vegetation occurs within the Study Area.

No primary habitat for this species will be impacted by the Project. 1.21 ha of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands will be retained within the subsidence area. Additionally, 28.57 ha of water/ farm dam and exotic/ agricultural land will be impacted by the Project. Of these habitat types, 32.86 ha will be retained within the proposed offset, with a further 1,029.17 ha remaining within the subsidence area.

A total of 171.4 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002).

There are no records of this species in the Wyong LGA. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

The species is not considered to be at risk of extinction as a result of the Project.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

There are no known Australian Painted Snipes in the Study Area, and the individuals that may potentially occur are not considered to be part of a key source population for breeding or dispersal. This species is widely distributed throughout the region and the eastern seaboard of Australia and there are widespread areas of suitable habitat that is available in protected areas and State Forests. As such the individuals that may occur in the Study Area are not likely to be part of a key source population.

Populations that are necessary for maintaining genetic diversity

As the Australian Painted Snipe is widespread throughout the region and the eastern seaboard of Australia, it is unlikely that the Australian Painted Snipes that may occur in the Study Area are genetically distinct. It is therefore not considered that they belong to a population that is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Australian Painted Snipe. It occurs throughout much of Queensland, NSW, Victoria and south-eastern South Australia.

For the reasons outlined above, the individuals of the Australian Painted Snipe that may occur in the Study Area are not likely to be part of a population that is considered to be important for the long term survival and recovery of this species and are not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The Australian Painted Snipe has not been recorded from the Study Area and therefore it is not considered likely to support an important population. The Project may remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the potential habitat for this species that occurs within the Study Area will not be removed and is expected to remain. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of the Australian Painted Snipe is considered likely to occur.

Reduce the area of occupancy of an important population

An important population is unlikely to occur in the Study Area. The Project may remove small areas of potential habitat for the Australian Painted Snipe; however these areas are located in the middle of large areas of habitat that will remain. Suitable habitat will remain in the Study Area and the loss of small areas of potential habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of the Australian Painted Snipe into two or more populations. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Australian Painted Snipe occurs in the Study Area, it has not been recorded and therefore this habitat is not considered critical to the survival of this species. Large areas of similar habitat occur in the locality, much of which is present in protected areas, and large areas will remain in the Study Area. Therefore the Project is unlikely to adversely affect critical habitat for the Australian Painted Snipe.

Disrupt the breeding cycle of an important population

The Project is not considered likely that the Project will disrupt the breeding cycle of a population of the Australian Painted Snipe. No important population is present and no known breeding habitat will be removed.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for the Australian Painted Snipe will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Australian Painted Snipe.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Australian Painted Snipe to decline.

Interfere substantially with the recovery of the species

A small area of potential habitat for the Australian Painted Snipe will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Australian Painted Snipe as a result of the Project

7.22 Swift Parrot

The Swift Parrot is listed as Endangered under the EPBC Act. It is a migratory bird species that migrates to the Australian south-east mainland between March and October and is found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (OEH 2012□).

Favoured feed trees of the species include winter flowering species such as Swamp Mahogany (*Eucalyptus ro*busta), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*). Commonly used lerp infested trees include Inland Grey Box (*E. microcarpa*), Grey Box (*E. moluccana*) and Blackbutt (*E. pilularis*). The species is known to return to some foraging sites on a cyclic basis depending on food availability (OEH, 2012).

Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum (*Eucalyptus globulus*) (OEH, 2012).

Breeding season survey data suggest that the population is at best stable, with an estimated 2000 breeding birds, or 1,000 pairs (Swift Parrot Recovery Team 2001). Two surveys of the breeding population in Tasmania have been conducted. The first during the 1987/88 breeding season, resulting in an estimated 1,320 pairs being located (Brown 1989), and the second during the 1995/96 breeding season, which located an estimated 940 pairs (Swift Parrot Recovery Team 2001). The Swift Parrot occurs as a single population, although it migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (SEWPaC 2013).

Approximately 200 mature birds (10% of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales. This represents the largest concentration of Swift Parrots recorded within Spotted Gum habitats of New South Wales, and the largest record of the species in the state. Records from this region also represent the longest (17 years) and most consistent site fidelity recorded on the Australian mainland. The Lower Hunter Region is thus considered to be one of the most significant Swift Parrot sites in New South Wales.

The Swift Parrot migrates from its Tasmanian breeding grounds to overwinter in the box-ironbark forests and woodlands of Victoria, New South Wales and southern Queensland. The principal wintering grounds are the inland slopes of the Great Dividing Range and along the eastern coastal plains.

Key habitats for the species on the coast and coastal plains of New South Wales include Spotted Gum (*Corymbia maculata*), Swamp Mahogany (*E. robusts*), Red Bloodwood (*Corymbia gummifera*) and Forest Red Gum (*E. tereticornis*) forests (Saunders 2002b; Saunders & Heinsohn 2008). These tree species provide foraging and roosting habitat for the species.

The species is known to be associated with the following vegetation communities occurring within the Study Area (OEH, 2013):

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC);

- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; and
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC).

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Winter flowering eucalypt species occur within the Study Area; and
- Roosting – Trees suitable as nocturnal roosts occur within the Study Area.

Although not recorded from the Study Area, there are over 100 records from the Wyong LGA (OEH 2012a), and this species has potential to occur. Approximately 51.57 ha of vegetation communities comprising habitat for this species will be impacted by the Project. Approximately 196.7 ha of these vegetation communities are to be included in the proposed offset. In addition to this, approximately 1,115.93 ha of these communities will be retained within the remainder of the project, including in Jilliby SCA.

A total of 33,645.4 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 104,537.14 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered at risk as a result of the Project.

Significant Impact Criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The Swift Parrot has not been recorded within the Study Area, however suitable foraging habitat occurs. This species does not breed in the locality however and no breeding habitat is present. The Project will remove a small area of potential foraging habitat for this species; however this habitat is located adjacent to cleared areas and is not of high quality. This species flies very large distances in search of food and is not likely to be dependent on the habitat in the areas within the Infrastructure Boundary that will be cleared.

The majority of the potential foraging habitat within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of a population of the Swift Parrot is considered likely to occur.

Reduce the area of occupancy of the species

The Project will remove small areas of potential foraging habitat for the Swift Parrot; however these areas are located in the middle of large areas of habitat that will remain. This species is likely to continue to use the Study Area as before and the loss of small, degraded areas of habitat is not expected to reduce the overall area of occupancy of Swift Parrot in the Study Area and the locality.

Fragment an existing population into two or more populations

The Swift Parrot is a highly mobile species that forages over large areas, and it is unlikely the Project will not fragment an existing population into two or more populations. The areas of habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable foraging habitat for the Swift Parrot occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas. The small areas of potential foraging habitat that will be removed for the Surface Infrastructure are relatively degraded and are not critical to the survival of the Swift Parrot. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Swift Parrot.

Disrupt the breeding cycle of a population

The Swift Parrot breeds in Tasmania, and no suitable breeding habitat is present in the Study Area for this species. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of foraging habitat for the Swift Parrot will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. The Swift Parrot is highly mobile and makes use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Swift Parrot.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Swift Parrot to decline.

Interfere with the recovery of the species

A small area of foraging habitat for the Swift Parrot will be removed as part of the Project. However, this is not breeding habitat, and large areas of similar habitat will remain in the locality that may be used by this species. The Swift Parrot is highly mobile and makes use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Swift Parrot as a result of the Project.

7.23 Grey-headed Flying Fox

The Grey-headed Flying Fox (*Pteropus poliocephalus*) is listed as Vulnerable under the EPBC Act. The Grey-headed Flying-fox occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria. The species only utilises a small proportion of its range at any one time, as the species moves within its range in response to flowering and fruiting periods of feed tree species. The species is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW (associated with flowering Spotted Gum (*Corymbia maculata*) and on the northwest slopes (generally associated with flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*E. sideroxylon*) (SEWPaC, 2013).

This species occurs in a variety of habitats, ranging from subtropical and temperate rainforests to tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. They have roosting camps, often in gullies with dense vegetation and nearby water, which are generally located within 20 km of a regular food source. Individual camps may have tens of thousands of animals and are used for mating, giving birth and rearing young (OEH 2012y).

The Grey-headed Flying-Fox has a diet of nectar and pollen primarily from the flowers of Eucalypts (genera *Eucalyptus, Corymbia and Angophora*), Melaleucas and Banksias. The species also takes cultivated fruit when available (SEWPaC, 2013).

The species is associates with the following vegetation communities located within the Study Area:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; and
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC).

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Eucalypt dominated forests with varying flowering timings occur within the Study Area; and
- Roost – Riparian vegetation occurs within the Study Area.

Approximately 48.4 ha of these vegetation communities will be impacted by the Project. Approximately 118.8 ha of these vegetation communities are to be included in the proposed offset. In addition to this 2,578.65 ha of these vegetation communities will be retained within the Jilliby SCA, within the subsidence area. Additionally, these vegetation communities occur in the broader locality and across the range of the species.

A total of 61,172.5 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 170,505.4 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS 2003).

Grey-headed Flying Foxes were recorded at 7 locations within the Extraction Area. Previous studies have also recorded this species within the Project Boundary (ERM 2003). There are 66 records of the species within the Wyong LGA (OEH 2012a), with most occurring on the eastern side of the F3 Freeway, mainly around the Tuggerah Lake area and in Munmorah SCA.

As this species is listed as Vulnerable, an assessment of whether the population in the Study Area constitutes an important population is first presented, followed by an assessment of the potential impact to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The Grey-headed Flying Foxes that were recorded in the Study Area is not considered to be part of a key source population for breeding or dispersal. This species is widespread throughout the region and the eastern seaboard of Australia and there are widespread areas of suitable habitat that is available in protected areas and State Forests. As such the individuals that occur in the Study Area are not likely to be part of a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the widespread occurrence of this species in the Study Area and in the surrounding locality, it is unlikely that the Grey-headed Flying Foxes in the Study Area are genetically distinct. It is therefore not considered that they belong to a population that is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Grey-headed Flying Fox. It occurs from northern Queensland to Victoria along the eastern seaboard and the Study Area is in the middle of its range.

For the reasons outlined above, the individuals of the Grey-headed Flying Fox that occurs in the Study Area are not part of a population that is considered to be important for the long term survival and recovery of this species and are not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The population of the Grey-headed Flying Fox that utilises the Study Area is not considered to be an important population. The Project will remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the habitat for this species that occurs within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of the Grey-headed Flying Fox is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will remove small areas of potential habitat for the Grey-headed Flying Fox; however these areas are located in the middle of large areas of habitat that will remain. Suitable habitat will remain in the Study Area and the loss of small areas of habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of the Grey-headed Flying Fox into two or more populations. The Grey-headed Flying Fox is a highly mobile species that accesses resources from a wide area and is able to fly over disturbed areas easily. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Grey-headed Flying Fox occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas, and large areas will remain in the Study Area. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Grey-headed Flying Fox.

Disrupt the breeding cycle of an important population

The Project is not considered likely that the Project will disrupt the breeding cycle of a population of the Grey-headed Flying Fox. This species breeds in known “camps”, none of which occurs in the Study Area.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for the Grey-headed Flying Fox will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species’ habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Grey-headed Flying Fox.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Grey-headed Flying Fox to decline.

Interfere substantially with the recovery of the species

A small area of potential habitat for the Grey-headed Flying Fox will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Grey-headed Flying Fox as a result of the Project.

7.24 Spotted-tailed Quoll

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act. This species is found across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (OEH 2012‹). The Spotted-tailed Quoll is a nocturnal, solitary species with a large home range. Females occupy home ranges up to about 750 ha and males up to 3,500 ha, and they have been known to travel more than 6 km a night, usually traversing their ranges along densely vegetated creek lines. The species hunts medium-sized reptiles and mammals including possums and rabbits, and carrion. Individuals also require an abundance of food, such as birds and small mammals, and large areas of relatively intact vegetation through which to forage (NSW NPWS 1999). This subspecies is moderately arboreal and approximately 11% of travelling is done in trees. The species is associated with the following vegetation communities occurring within the Study Area:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);

- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; and
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC).

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Primary, secondary and supplementary feed species occur within the Study Area;
- Shelter – Hollow logs and small caves are likely present within the Study Area, which are suitable shelter habitat;
- Breeding – Hollow logs and small caves are likely present within the Study Area, which are suitable breeding habitat; and
- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

The Spotted-tailed Quoll has been detected within the Study Area during previous surveys (BHP 2002, BHP 2003). Additionally, there are 42 records in the Wyong LGA, spread across the LGA. Approximately 48.41 ha of vegetation communities comprising habitat for this species will be impacted by the Project. Approximately 118.75 ha of these vegetation communities are to be included in the proposed offset. In addition to this, approximately 2,725 ha of these communities will be retained within the remainder of the project, including in Jilliby SCA.

A total of 60,766.9 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 167,618.9 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered at risk as a result of the Project

Significant Impact Criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The Spotted-tailed Quoll has been recorded within the Study Area and suitable habitat occurs, likely including den habitat. The Project will remove a small area of potential habitat for this species, however this habitat is located adjacent to cleared areas and is not of high quality. This species has large home ranges and is not likely to be dependent on the habitat in the areas within the Infrastructure Boundary that will be cleared.

The majority of the land within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of a population of the Spotted-tailed Quoll is considered likely to occur.

Reduce the area of occupancy of the species

The Project will remove small areas of potential habitat for the Spotted-tailed Quoll; however these areas are located in the middle of large areas of habitat that will remain. This species is likely to continue to use the Study Area as before and the loss of small, degraded areas of habitat is not expected to reduce the overall area of occupancy of this species in the Study Area and the locality.

Fragment an existing population into two or more populations

The Spotted-tailed Quoll is a highly mobile species that forages over large areas, and it is unlikely the Project will not fragment an existing population into two or more populations. The areas of habitat to be removed are relatively small and are located adjacent to cleared areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Spotted-tailed Quoll occurs in the Study Area it is not considered critical to the survival of the Spotted-tailed Quoll. Large areas of habitat occur in the locality, much of which is present in protected areas. The small areas of habitat that will be removed for the Surface Infrastructure are relatively degraded and are not critical to the survival of the Spotted-tailed Quoll. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Spotted-tailed Quoll.

Disrupt the breeding cycle of a population

The small areas of habitat that will be removed for the Surface Infrastructure are relatively degraded and it is unlikely that the Spotted-tailed Quoll breeds there. More remote parts of the Study Area that are in Wyong State Forest are likely to be used for breeding, but these habitats are not expected to be disturbed by the Project. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of habitat for the Spotted-tailed Quoll will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. The Spotted-tailed Quoll is highly mobile and makes use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals.

With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Spotted-tailed Quoll.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Spotted-tailed Quoll to decline.

Interfere with the recovery of the species

A small area of habitat for the Spotted-tailed Quoll will be removed as part of the Project. However, large areas of similar habitat will remain in the locality that may be used by this species. The Spotted-tailed Quoll is highly mobile and makes use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Spotted-tailed Quoll as a result of the Project.

7.25 Koala

The Koala is listed as Vulnerable under the EPBC Act. There are 36 records in the Wyong LGA, spread across the LGA (OEH 2012a). It has not been previously recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Koalas feed almost exclusively on a small number of preferred *Eucalypt* species, with variation within the species' distribution. Koalas also rely on secondary species as shelter trees and as a food source when primary feed trees are not present or productive. Koalas are considered more likely to occur where vegetation structure is intact, and patch sizes are large (DECC (NSW), 2008). The Study Area falls within Koala Management Zone 2 – Central Coast, as defined within the Recovery Plan for the Koala (DECC (NSW) 2008). Appendix 2 of the Recovery Plan defines the following tree species as primary, secondary or supplementary feed species:

Primary food tree species:

Parramatta red gum (*E. parramattensis*), Swamp mahogany (*E. robusta*) Forest red gum (*E. tereticornis*), Tallowwood (*E. microcorys*), Ribbon gum (*E. viminalis*), and Cabbage gum (*E. amplifolia*)

Secondary Food Tree Species:

> Broad-leaved sally (*E. camphora*), Swamp gum (*E. ovata*), Fuzzy box (*E. conica*), Brittle gum (*E. praecox*), Yertchuk (*E. consideniana*), White-topped box (*E. quadrangulata*), Dwyer's red gum (*E. dwyeri*), Red mahogany (*E. resinifera*), Slaty red gum (*E. glaucina*) Rudder's box (*E. rudderi*), Bundy (*E. goniocalyx*), Large-fruited red mahogany (*E. scias*), Craven grey box (*E. largeana*), Grey gum (*E. punctata*), Maiden's gum (*E. maidenii*), Monkey gum (*E. cypellocarpa*), Brittle gum (*E. michaeliana*), Woollybutt (*E. longifolia*), Western grey box (E*. macrocarpa*), Blue box (*E. baueriana*), Grey box (*E. moluccana*), Coast grey box (*E. bosistoana*) and *E. notabilis.*

Stringybarks/supplementary species:

> Blue-leaved stringybark (*E. agglomerate*), *E. oblonga,* Thin-leaved stringybark (*E. eugenioides*), *E. ralla,* White stringybark (*E. globoidea*), *E. tenella* Yellow stringybark (*E. muelleriana*), Privet-leaved stringybark (*E. ligustrina*), Red stringybark (*E. cannonii*), Brown stringybark (*E. capitellata*), *E. prominula,* Heart-leaved stringybark (*E. camfieldii*), Narrow-leaved stringybark (*E. sparsifolia*), *E. bensonii*, *E. imitans* and *E. blaxlandii.*

Two primary feed tree species occur within the Study Area, *Eucalyptus robusta* and *Eucalyptus tereticornis.* Addtionally, to secondary feed tree species occur within the study area, *Eucalyptus resinifera subsp. resinifera* and *Eucalyptus punctata*. Two stingybark supplementary feed species occur within the Study Area, *Eucalyptus globoidea* and *Eucalyptus capitellata.*

The Koala is associated with the following vegetation communities occurring within the Study Area (OEH, 2013):

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC);
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;

- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; and
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC).

The Study Area is considered to contain the following habitat types for the species:

- Foraging – Primary, secondary and supplementary feed species occur within the Study Area;
- Shelter – Trees suitable as shelter habitat occur within the Study Area; and
- Corridor – The vegetation within the Study Area forms a component of a vegetated corridor which may be utilised by the species for dispersal.

The Koala has not been detected within the Study Area, however the species has potential to occur. Approximately 51.5 ha of vegetation communities comprising habitat for this species will be impacted by the Project. Approximately 190.2 ha of these vegetation communities are to be included in the proposed offset. In addition to this, approximately 2,060.07 ha of these communities will be retained within the remainder of the project, including in Jilliby SCA.

A total of 57,085.4 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 165,086 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The long-term viability of the species is not considered at risk as a result of the Project.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

There are no known Koalas in the Study Area, and the individuals that may potentially occur are not considered to be part of a key source population for breeding or dispersal. This species is widespread throughout the region and the eastern seaboard of Australia and there are widespread areas of suitable habitat that is available in protected areas and State Forests. As such the individuals that may occur in the Study Area are not likely to be part of a key source population.

Populations that are necessary for maintaining genetic diversity

As the Koala is widespread throughout the region and the eastern seaboard of Australia, it is unlikely that the Koalas that may occur in the Study Area are genetically distinct. It is therefore not considered that they belong to a population that is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Koala. It occurs from northern Queensland to Victoria along the eastern seaboard and the Study Area is in the middle of its range.

For the reasons outlined above, the individuals of the Koala that may occur in the Study Area are not likely to be part of a population that is considered to be important for the long term survival and recovery of this species and are not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The population of the Koala that utilises the Study Area is not considered to be an important population. The Project will remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the potential habitat for this species that occurs within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of the Koala is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will remove small areas of potential habitat for the Koala; however these areas are located in the middle of large areas of habitat that will remain. Suitable habitat will remain in the Study Area and the loss of small areas of habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

No important population of the Koala is considered to occur in the Study Area. It is unlikely that the Project will fragment an existing population of the Koala into two or more populations. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Koala occurs in the Study Area it is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas, and large areas will remain in the Study Area. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect potential habitat for the Koala.

Disrupt the breeding cycle of an important population

The Project is not considered likely that the Project will disrupt the breeding cycle of an important population of the Koala. No important population is considered to occur, and large areas of potential breeding habitat will remain.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for the Koala will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Koala.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Koala to decline.

Interfere substantially with the recovery of the species

A small area of potential habitat for the Koala will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Koala as a result of the Project.

7.26 Large-eared Pied Bat

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under the EPBC Act.

The species' current distribution is also poorly known. Records exist from Shoalwater Bay, north of Rockhampton, Queensland, through to the vicinity of Ulladulla, NSW in the south. Much of the known distribution is within NSW. Available records suggest that the largest concentrations of populations appear to be in the sandstone escarpments of the Sydney basin and the north-west slopes (Coolah Tops, Mt Kaputar, Warrumbungle National Parks and Pilliga Nature Reserve). Although the species is widely distributed, it is uncommon and patchy within this area. Sightings of note include Tottenham, west of Narromine (NSW), which is the furthest west record; Swansea Open Cut Mine area of the Wallarah Peninsula, north coast NSW; a disused gold mine near Barraba (NSW) that included lactating females and dependent young; and Moreton NP (NSW) at the southern end of the species' range (SEWPaC, 2013).

This species roosts in cave entrances, crevices in cliffs, gullies, and old mine workings in dry open forest and woodland. Maternity roosts are generally found in roof domes in sandstone caves and overhangs (OEH 2012}).

Sandstone cliffs and fertile woodland valley habitat within close proximity of each other is habitat of importance to the Large-eared Pied Bat. Records from south-east Queensland suggest that rainforest and moist eucalypt forest habitats on other geological substrates (rhyolite, trachyte and basalt) at high elevation are of similar importance to the species.

In NSW this species has been recorded from a large range of vegetation types including: dry and wet sclerophyll forest; Cyprus Pine (*Callitris glauca*) dominated forest; tall open eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country. In south-east Queensland the species has primarily been recorded from higher altitude moist tall open forest adjacent to rainforest.

The species is associated with the following vegetation communities located within the Study Area:

- Blackbutt - Turpentine open forest of the foothills of the North Coast;
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);

- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; and
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC).

The Study Area is considered to contain the following habitat type for the species:

- Foraging – Forest vegetation supporting invertebrates occurs within the Study Area.

Approximately 50.4 ha of these vegetation communities will be impacted by the Project. Approximately 186.3 ha of these vegetation communities are to be included in the proposed offset. In addition to this 2,060.07 ha of these vegetation communities will be retained within the Jilliby SCA, within the subsidence area. Additionally, these vegetation communities occur in the broader locality.

A total of 56,831.6 ha of vegetation communities considered to constitute suitable habitat for the species are mapped as occurring within the Wyong LGA (Bell, 2002). A total of 161,147.9 ha of these vegetation communities are mapped as occurring within the LHCCREMS Area (LHCCREMS, 2003).

The communities listed are considered to constitute foraging habitat only. The species is reliant on sandstone cliffs or similar structures as roost habitat, of which none occur within the Study Area. The species is considered likely to utilise cliffs within the broader locality as roost habitat.

There are 4 records in the Wyong LGA, with one occurring near the F3 freeway and others distributed among Olney SF and Jilliby SCA (OEH 2012a). One record of the species exists within 2km of the north of the Study Area. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area and the proximity of the historic records to the Project Boundary.

As this species is listed as Vulnerable, an assessment of whether the population in the Study Area constitutes an important population is first presented, followed by an assessment of the potential impact to this species.

Assessment of "Important Population" status

Key source population either for breeding or dispersal

The Large-eared Pied Bat has not been recorded from the Study Area and therefore it is not considered likely to contain a key source population for breeding or dispersal. This species is known to occur in the locality and there are widespread areas of suitable habitat that is available in protected areas and State Forests. As such the individuals that occur in the Study Area are not likely to be a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the widespread occurrence of this species in the Study Area and in the surrounding locality, it is unlikely that the individuals that may occur in the Study Area are genetically distinct. It is therefore not considered that they are necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Study Area is not located near the limit of the range of the Large-eared Pied Bat. It occurs from central Queensland to southern NSW along the eastern seaboard and the Study Area is in the middle of its range.

For the reasons outlined above, the population of the Large-eared Pied Bat that occurs in the Study Area is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The Large-eared Pied Bat has not been recorded from the Study Area and therefore it is not considered likely to support an important population. The Project will remove a small area of potential habitat for this species; however this species is not likely to be dependent on the habitat. The majority of the potential habitat for this species that occurs within the Study Area will not be removed and is expected to remain despite some minor effects from subsidence. Large areas of similar habitat occur in locality that will not be disturbed by the Project. For these reasons, no long term decrease in the size of an important population of the Large-eared Pied Bat is considered likely to occur.

Reduce the area of occupancy of an important population

The Project will remove small areas of potential habitat for the Large-eared Pied Bat; however these areas are located in the middle of large areas of habitat that will remain. Suitable habitat will remain in the Study Area and the loss of small areas of potential habitat is not expected to reduce the overall potential area of occupancy of this species in the Study Area and the locality.

Fragment an existing important population into two or more populations

It is unlikely that the Project will fragment an existing population of the Large-eared Pied Bat into two or more populations. This species is highly mobile and can fly over disturbed areas. Connectivity will remain between patches of native bushland that will be able to be utilised by this species and no fragmentation is considered likely to occur.

Adversely affect habitat critical to the survival of a species

Although suitable habitat for the Large-eared Pied Bat occurs in the Study Area, it has not been recorded and this habitat is not considered critical to the survival of this species. Large areas of habitat occur in the locality, much of which is present in protected areas, and large areas will remain in the Study Area. Although some subsidence may occur in the Extraction Area, it is unlikely to adversely affect habitat for the Large-eared Pied Bat.

Disrupt the breeding cycle of an important population

The Project is not considered likely that the Project will disrupt the breeding cycle of a population of the Large-eared Pied Bat. No known breeding habitat will be removed, and although some caves may occur in the Extraction Area, they are unlikely to be impacted by subsidence.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

A small area of potential habitat for the Large-eared Pied Bat will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and the locality that may be used by this species. Therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Large-eared Pied Bat.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Large-eared Pied Bat to decline.

Interfere substantially with the recovery of the species

A small area of potential habitat for the Large-eared Pied Bat will be removed as part of the Project. However, large areas of similar habitat will remain in the Study Area and locality that may be used by this species. No breeding habitat of this species will be removed and the removal of a small area of habitat is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Large-eared Pied Bat as a result of the Project.

7.27 Migratory Species

In addition to the threatened species discussed in previous sections, several species listed as Marine and/or Migratory under the EPBC Act have been recorded from or have potential to occur in the Study Area. These include the following:

- 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.

With the exception of the Black-tailed Godwit, these migratory species are not listed as threatened under any Australian legislation. They are all relatively common, abundant and widespread species that are known to have a wide range and distribution. There is no evidence to suggest that the Study Area supports an ecologically significant proportion of the population of these migratory species and no breeding was observed during field surveys. Accordingly, the Study Area is not considered to comprise important habitat for any of these species. Large areas of similar habitat occur elsewhere in the locality that will remain and will continue to provide high quality habitat for these species.

The migratory species recorded or with potential to occur are comprised mostly of wetland-dependent species, aerial insectivores, woodland/forest dependent species and one large raptor.

The habitat requirements and habitat availability in the Study Area for the migratory species recorded and with potential to occur in the Study Area is discussed below, followed by an assessment of significance these species according to the EPBC Act Significant Impact Criteria for listed migratory species. These assessments indicate that no significant impact is likely to occur to any migratory species listed under the EPBC Act.

Wetland-dependent species

The wetland dependent migratory species include the following: Black-tailed Godwit, Cattle Egret; Great Egret; Glossy Ibis; and Latham's Snipe. Suitable habitat for these species in the Study Area includes wetland habitats along Jilliby Creek and the area of freshwater wetland that has been recorded in the central section of the Study Area. These species may also use seasonally inundated areas in the floodplain of Jilliby Creek, and also derived native grasslands when they are waterlogged following rain.

Approximately 15 ha of wetland habitat is present in the Study Area, none of which will be removed by the Project. There is potential for subsidence to impact on wetlands in the Study Area, including Jilliby Creek, however appropriate mitigation measures will be implemented to ensure that the basic hydrological, geomorphic and ecological features of the creeks will be minimally affected.

Aerial insectivores

The Fork-tailed Swift and the White-throated Needletail are aerial birds that forage for insects above the canopy. These adaptable and highly mobile species are known to occur over a wide range of habitats including farm land and forest, and it is likely that the entire Study Area provides suitable habitat for them. Approximately 103 ha of vegetated habitat for these species will be removed.

These species are extremely wide-ranging birds that access resources from across a large area and are unlikely to be dependent on the resources present in the Study Area for their survival. They are known to forage over degraded landscapes and are able to fly over disturbed areas to access food resources.

Forest and woodland dependent species

The Rainbow Bee-eater, Satin Flycatcher, Black-faced Monarch and the Rufous Fantail are forest and woodland dependent species that are likely to forage in and over the wooded areas of the Study Area. Large areas of woodland and forest are present in the Study Area, and approximately 53 ha of native vegetation will be removed by the Project. This vegetation has potential to provide habitat for these forest and woodland dependent species, however it is unlikely to provide important habitat.

Large areas of similar habitat occur in the Study Area and the wider locality that will remain, and the removal of a small area of habitat is unlikely to be detrimental to these species.

White-bellied Sea-eagle

The White-bellied Sea-eagle is a large raptor that primarily feeds over large bodies of water, and nests in close proximity to them. It is often seen flying over terrestrial habitats, but it depends on large open areas of water to forage.

No such waterbodies are present in the Study Area or will be impacted by the Project. There are several large lakes in the locality, including Tuggerah Lakes, and these areas are likely to provide habitat for this species. The individuals recorded from the Study Area are likely to forage and breed near these lakes and are unlikely to utilise habitat in the Study Area.

Significant Impact Criteria

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

> *Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species*

The area of habitat to be modified or removed in the Study Area is not considered to provide important habitat for migratory species. No wetland habitat will be removed and only small areas of woodland habitat will be removed. Large areas of similar habitat occur in the Study Area that will not be disturbed as well as in the locality. No areas of important habitat for migratory species will be removed by the Project.

> *Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or*

As outlined above, the Study Area is not considered to comprise important habitat for migratory species. That notwithstanding, the Project is unlikely to result in an invasive species becoming established. A BMP will be prepared and implemented for the Project that will minimise the risks of invasive species and will include appropriate weed and feral animal control measures.

> *Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

There is no evidence to suggest that the Study Area supports an ecologically significant proportion of the population of any of these migratory species. That notwithstanding, it is not considered likely that the Project will seriously disrupt the lifecycle of any portion of the population of these species.

Conclusion

The Project is considered unlikely to result in a significant impact to any of the listed the migratory species that have been recorded or are considered to have potential to occur in the Study Area.

7.28 Threatened Fauna Impact Areas

Table 7.2 below details the areas of habitat to be cleared, within offsets and within the subsidence area for all EPBC listed species known or considered likely to occur within the Study Area.

Table 7.2 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
Giant Barred Frog	Blackbutt - Turpentine open forest of the foothills of the North Coast; Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin; Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin; 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)	13.8	78.7	209.0
Green and Golden Bell Frog	Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)	8.1	65.8	1019.0
Giant Burrowing Frog	Phragmites australis and Typha	37.6	114.0	99.3

Table 7.2 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	orientalis coastal freshwater wetlands of the Sydney Basin (EEC); Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin			
Littlejohns Tree Frog	Blackbutt - Turpentine open forest of the foothills of the North Coast; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	11.1	72.2	1017.1
Stuttering Frog	Blackbutt - Turpentine open forest of the foothills of the North Coast; Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin	5.9	16.9	518.6
Regent Honeyeater	Blackbutt - Turpentine open forest of the foothills of the North Coast; Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills	48.7	186.3	1115.2

Table 7.2 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin			
Australasian Bittern	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin (EEC); Water/Farm Dam	0.00	0.00	1.2
Australian Painted Snipe	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin (EEC); Exotic/Agricultural/Low Diversity Grassland; Water/Farm Dam	28.6	32.9	1029.2
Swift Parrot	Blackbutt - Turpentine open forest of the foothills of the North Coast; Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC); Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern	51.6	196.7	1115.9

Table 7.2 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	Sydney Basin (EEC)			
Grey-Headed Flying-fox	Blackbutt - Turpentine open forest of the foothills of the North Coast; Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin; Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin; Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)	52.2	192.8	2578.7
Spotted Tailed Quoll	Blackbutt - Turpentine open forest of the foothills of the North Coast; Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin; Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin; Scribbly Gum - Red	48.4	118.8	2480.6

Table 7.2 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)			
Koala	Blackbutt - Turpentine open forest of the foothills of the North Coast; Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin; Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC); Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the	53.3	196.7	2060.1

Table 7.2 Threatened Fauna Impact Areas

Threatened species	Habitat required	Habitat within Impact area (ha)	Habitat within Offset area (ha)	Potential habitat within SIL (ha)
	Central Coast, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)			
Large-eared Pied Bat	Blackbutt - Turpentine open forest of the foothills of the North Coast; Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin; Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin; Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC); Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)	52.2	192.8	2060.1

7.29 Conclusion

The individual Assessments of Significance indicate no significant impacts on any EPBC listed threatened or migratory species. The monitoring and management programs that are proposed for the different stages of the Project as described in **Chapter 8** will be reviewed and updated to accommodate any unknown, unpredictable, indirect or secondary issues that arise from the Project as it progresses. A BOS has been prepared for the Project that protects large areas of suitable habitat for all the EPBC Act listed species recorded from the Study Area or with potential to occur (see **Section 8.4**). The BOS has been prepared in accordance with the Commonwealth offsetting guidelines, and an assessment of compliance is provided in **Table 8.7**.

Chapter 8

Impact Mitigation

The purpose of this chapter is to outline the mitigation measures proposed to ameliorate the impacts of the Project on flora and fauna. As demonstrated in previous chapters, the Project Boundary is biodiverse and provides habitat for a wide range of flora and fauna, including species listed under State and Commonwealth threatened species legislation.

The considerations for reducing the ecological impacts of the Project follow 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.

Furthermore, an ecological monitoring program will be established to monitor the ongoing status and health of flora and fauna communities that will be retained within the Study Area in order to assess the success of the mitigation and compensation measures.

In order to coordinate the implementation of the proposed mitigation measures, a staged Biodiversity Management Plan (BMP) will be prepared, in consulation with OEH and other regulatory authorities, prior to the commencement of construction. The BMP will also provide specifications for the restoration and management of biodiversity offset areas as well as an assessment of the ongoing costs for monitoring and management. The BMP is the key document that will ensure that the conservation objectives of the Project are met and that impacts to biodiversity are adequately managed for the life of the Project. This is explained further in **Section 8.4**.

The structure of this chapter is as follows:

- Measures to Avoid Impacts (Section 8.1);
- Measures to Mitigate Impacts (Section 8.2);

- Monitoring (Section 8.3); and
- Biodiversity Management Plan (Section 8.4).

The BOS as described in **Section 8.4** outlines the measures taken to mitigate for the residual impacts of the Project once the appropriate avoidance and mitigation measures outlined in this chapter have been implemented.

8.1 Measures to Avoid Impacts

Some unavoidable impacts to species habitats will occur due to the construction of surface infrastructure including buildings, coal handling facilities, roads and ventilation shaft. However, environmental impacts have been avoided where possible throughout the Project planning and design phases.

In the first instance, significant modification to the design of the Project was undertaken to improve biodiversity outcomes. The Project mine plan has been devised through the consideration of a number of alternatives which were developed to reduce the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities and species. The detailed configuration of proposed extraction in all areas of the mine plan has been modified to ensure that risks and impacts have been reduced to demonstrably low and manageable levels.

Avoidance measures implemented include excluding an option to locate surface facilities to the west of the freeway. This would have resulted in impacts to vegetation that contained high conservation value identified in the Wyong Conservation Strategy. The construction of the drift connecting the Tooheys Road Site with the underground mine has also avoided the need for a surface overland conveyor and the associated clearance of native vegetation. Where feasible, impacts have been avoided by locating surface infrastructure where facilities already exist and/or in cleared and disturbed areas. For example, the rail spur is proposed to be located in the area of the existing transmission line cleared easement to avoid unnecessary impacts, and dams have been located in land that has already been cleared or disturbed.

Measures have also been undertaken to avoid potential impacts from subsidence which benefit ecology including the following:

- Modification of the original mine plan to avoid mining underneath the Wyong River and avoid mining beneath the vast majority of the Yarramalong Valley and its floodplain;
- Design of the chain pillars to promptly yield following adjacent longwall panel extraction so as to minimise differential vertical subsidence across the surface above adjacent longwall panels and to ensure subsidence management certainty;

- Shortening of some longwall panels immediately north of the main roadways to provide a setback from the Little Jilliby Jilliby Creek near its confluence with Jilliby Jilliby Creek; and
- Alignment of a short longwall panel in the south-east of the mine plan to allow only minor and consistent subsidence underneath Jilliby Creek.

Further avoidance of impacts will be achieved where possible during the detailed design phase of the Project, where practical. Substantive mitigation and compensation measures are proposed to offset the unavoidable impacts of the Project on flora and fauna as described below.

8.2 Measures to Mitigate Impacts

Measures to mitigate some of the direct and indirect impacts of the construction and operation of the Project are summarised below.

8.2.1 General Mitigation Measures

A suite of general environmental control measures will be implemented for the Project which will help to protect the ecology of the site. These general measures are outlined within **Table 8.1**.

Table 8.1 Summary of Proposed General Mitigation Measures for the Project

Mitigation Measures	General Procedures	General Ecological Benefits
Dust minimisation	Watering of unsealed roads during construction; Modifying construction activities (particularly excavation) during windy conditions; Use of water sprays on coal stockpiles; and Wind shielding for conveyors and transfers	Reduces the indirect impacts on vegetation condition and the habitat quality for all native species.
Noise minimisation	Use of low noise rated conveyors and motor drives; Double skin insulated cladding of crushing plant; Selection of mobile plant with secondary noise control kits; Side and roof screens installed on conveyor structures; and	Benefits fauna by reducing the potential for disturbance of animals in habitat patches around the mine.

Table 8.1 Summary of Proposed General Mitigation Measures for the Project

Mitigation Measures	General Procedures	General Ecological Benefits
	Rail spur has been designed to minimise wheel / rail interface noise.	
Management of surface water, erosion and sedimentation	Diversion of clean surface water runoff away from areas disturbed by the Project; Collection of potentially sediment-laden runoff in sediment dams for treatment prior to discharge or reuse; Treatment of mine water using reverse osmosis prior to onsite use or discharge to Wallarah Creek; Collection of contaminated water from industrial areas for treatment in an oil and grease separator; and Design of erosion and sediment control measures in accordance with the relevant design guidelines	Protects the integrity of the landscape.
Visual and lighting management	Landscaping works to reduce visual impact; and External lighting to be designed in accordance with the relevant Australian Standards	Benefits fauna by reducing the potential for disturbance of nocturnal animals via night light emissions around the mine
Due diligence inspections for proposed disturbance areas	Field surveys and ongoing monitoring	Provides data for ongoing adaptive management and protection of adjacent landscape areas if required.

Further details on the various general mitigation measures are provided in the following documents:

- Wallarah 2 Coal Project Air Quality and Greenhouse Gas Impact Assessment (PAEHolmes, 2012);
- Wallarah 2 Coal Project Noise and Vibration Impact Assessment (Atkins Acoustics, 2012);
- Wallarah 2 Coal Project Surface Water Impact Assessment (WRM, 2013); and

- Wallarah 2 Coal Project Visual Impact Assessment (The Design Partnership, 2013).

All proposed mitigation measures are to be undertaken by the proponent unless specified otherwise by regulatory authorities. Details of these mitigation measures will be provided within the relevant management plans which will be prepared in consultation with relevant regulatory authorities (**see Table 8.5**). Additional mitigation measures specific to ecology that will be implemented include; minimising vegetation and habitat loss, vegetation restoration and rehabilitation, and these are discussed in subsequent subheadings below.

8.2.2 Minimising Vegetation and Habitat Loss

During the detailed design stage, opportunities to further minimise vegetation disturbance will be considered. However, disturbance to areas of native vegetation and habitat is likely to be largely unavoidable during the construction process.

In order to minimise clearing impacts and unnecessary disturbance to native vegetation, the following procedures should be implemented:

- The limits of clearing will be delineated during the construction process and marked clearly on plans and on the ground;
- Native vegetation beyond the identified clearing areas should not be disturbed; and
- Ancillary facilities such as stockpile sites, site compounds and construction zones will not be located beyond the limits of clearing.

Where clearing of vegetation and fauna habitats will take place, clearing protocols should be followed, including:

- Preparation of an inventory of trees and hollows to be removed, prior to clearing;
- Checking hollow-bearing trees for the presence of bird nests and arboreal mammals, such as possums, gliders and bats, prior to felling;
- Animals found to be occupying trees should be safely removed before the clearing of trees and relocated into nearby woodlands;
- Nest boxes or salvaged tree hollows should be provided in nearby woodland to compensate for the hollows to be removed due to vegetation clearance, and the numbers should be proportional to the number of hollows removed; and
- Boulders and large logs should be placed in nearby areas of retained vegetation to allow their continued use as fauna habitat.

Specifics of the measures that will be undertaken, how they will be undertaken, as well as timelines for all activities to be conducted will be detailed in the BMP. All procedures will be conducted in accordance with relevant OEH policy guidelines, (e.g. Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004)); with appropriate licences sought where necessary.

8.2.3 Vegetation Restoration and Rehabilitation

In order to maximise the conservation of biodiversity, and mitigate the impacts of the Project, large areas of existing vegetation will be retained in the Study Area and other areas will be restored to build onto existing and future areas of native vegetation, conservation lands and natural corridors (see **Section 8.4**).

For restoration and management of the habitat values of the Project Boundary, the following measures will be implemented:

- Using locally occurring native shrubs, trees and groundcover plants;
- Inclusion of logs, dead trees and stumps in strategic locations to enhance fauna habitat;
- Incorporate existing natural vegetation where possible; and
- Include measures to manage weeds and feral animals.

Details of these mitigation measures will be provided in the BMP which will be prepared in consultation with relevant regulatory authorities.

Final cost estimates for mitigation measures will be provided in the BMP. However a preliminary estimate of $5.9 million over the Project life has been made.

8.3 Monitoring

A monitoring program will be developed to monitor the ongoing status and health of flora and fauna that is to be retained within the Study Area and in offset areas, including both vegetation monitoring and threatened species monitoring. This monitoring will continue over the life of the Project and will provide feedback data to determine the level of success of the mitigation and amelioration measures.

More detailed descriptions for monitoring strategies and the development of reference sites will be incorporated into the BMP, including a framework for reporting on the results of the monitoring.

8.3.1 Vegetation Monitoring

Vegetation monitoring will be undertaken to provide information to quantify the change in biodiversity over time within the Project Boundary, and to determine quantitatively the extent of impacts on native vegetation and threatened species. It is proposed that monitoring sites be established in areas of vegetation both inside and outside of the Disturbance Area and in designated reference areas.

Regenerated areas as described in **Section 8.4** are also proposed to be monitored in the long term to allow changes in species composition and structure over time to be quantified. Information will be used in adaptive management, in order to continually improve the outcomes of the rehabilitation and land management strategy. Appropriate data management procedures will be implemented to ensure that all data is collected using appropriate techniques and suitably analysed to allow meaningful spatial and temporal comparisons to be made. More specific details of the vegetation monitoring strategy will be contained in the BMP.

8.3.2 Threatened Species Monitoring

Monitoring will also be undertaken on selected threatened species of flora and fauna, in order to determine whether populations are being adversely affected by the Project.

Threatened species monitoring will:

- Enable the identification of the impacts of the Project on threatened species;
- Identify changes in population numbers over time;
- Determine the success of impact mitigation and conservation measures; and
- Highlight areas for improvement if these measures are found to be inadequate.

Threatened species monitoring will involve conducting targeted threatened species surveys, in areas of known habitat in order to record the abundance of selected species of threatened flora and fauna. In particular, threatened species monitoring will include annual monitoring of potential impacts of subsidence on the Giant Barred Frog (*Mixophyes iteratus*) and regeneration of *Angophora inopina* within proposed revegetation areas.

8.4 Biodiversity Offset Strategy

This section outlines the measures that will be implemented to compensate for any residual impacts once the avoidance and mitigation measures outlined previously have been implemented. These address the residual impacts of the Project in a strategic and meaningful way that will deliver a real biodiversity outcome, and will ensure that the Project does not result in a net loss of biodiversity values.

Compensation measures for the Project consist mainly of the provision of biodiversity offsets that ensure the best compensatory outcomes are achieved for the predicted ecological impacts of the Project. These measures have been designed to meet State and Commonwealth offsetting requirements and protect and improve biodiversity within the locality with the most efficient utilisation of resources. This involves the protection for conservation of land within the Project Boundary that contains ecological values similar to those being impacted, and the rehabilitation and restoration of degraded areas within the offset lands to improve biodiversity to present levels.

The offsets have been based upon the key principles of offsetting, particularly that:

- Offsets should be targeted to the ecological communities and threatened species that will be impacted by the Project;
- Offsets should be commensurate with the magnitude of the impacts; that is, there should be a net increase in the size and condition of the community types, populations or habitat types that will be impacted by the Project; and
- Offsets should be lasting; that is, there should be a level of legal protection for offset areas.

There are three main areas that are proposed for conservation as biodiversity offsets (**see Figure 8.1**):

- Hue Hue Road Offset area (160.1 ha);
- Tooheys Road Site North Offset area (48.4 ha); and
- Tooheys Road Site Southern Offset area (52.5 ha).

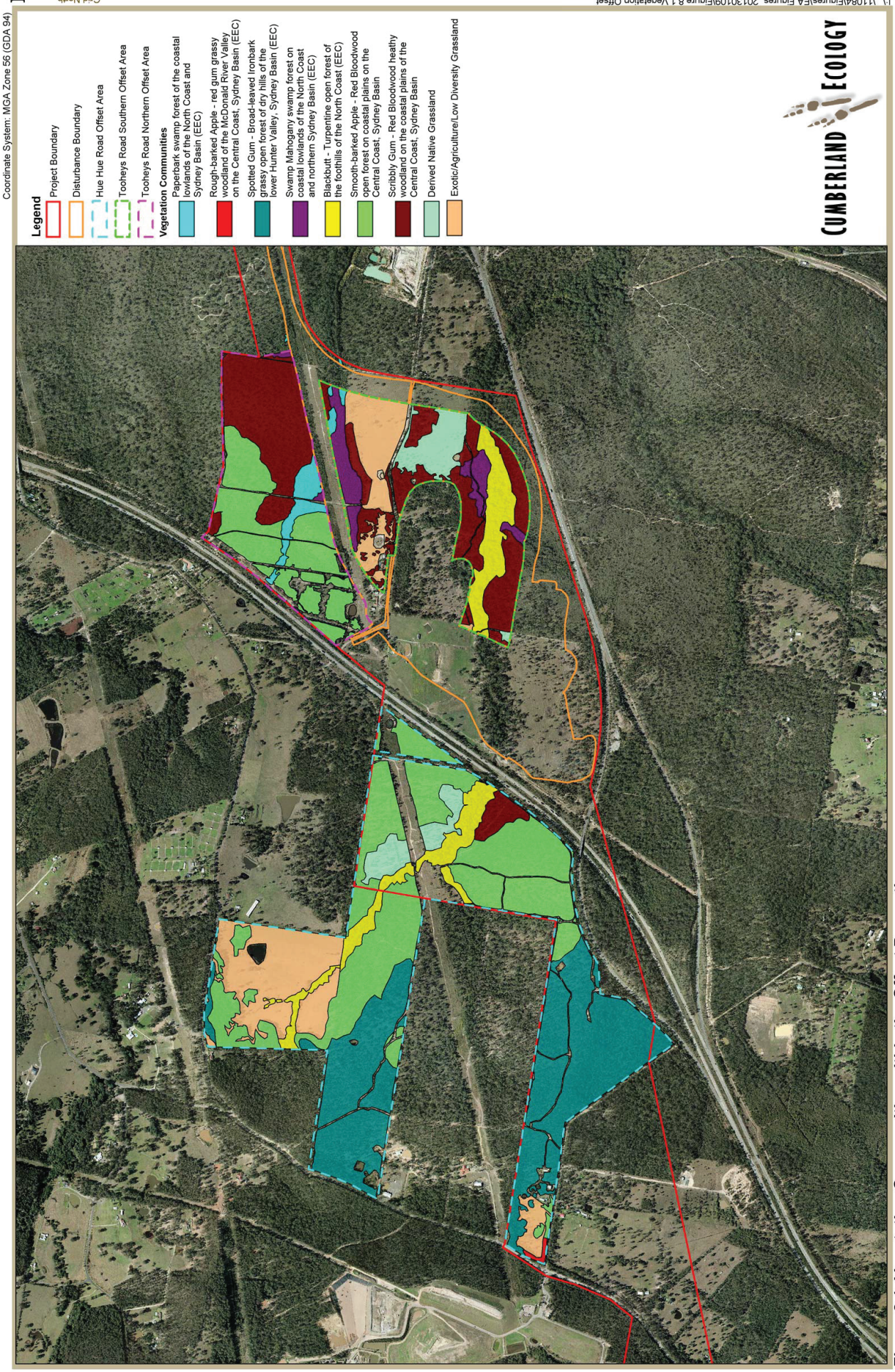

Figure 8.1. Vegetation Communities within the Offset Properties

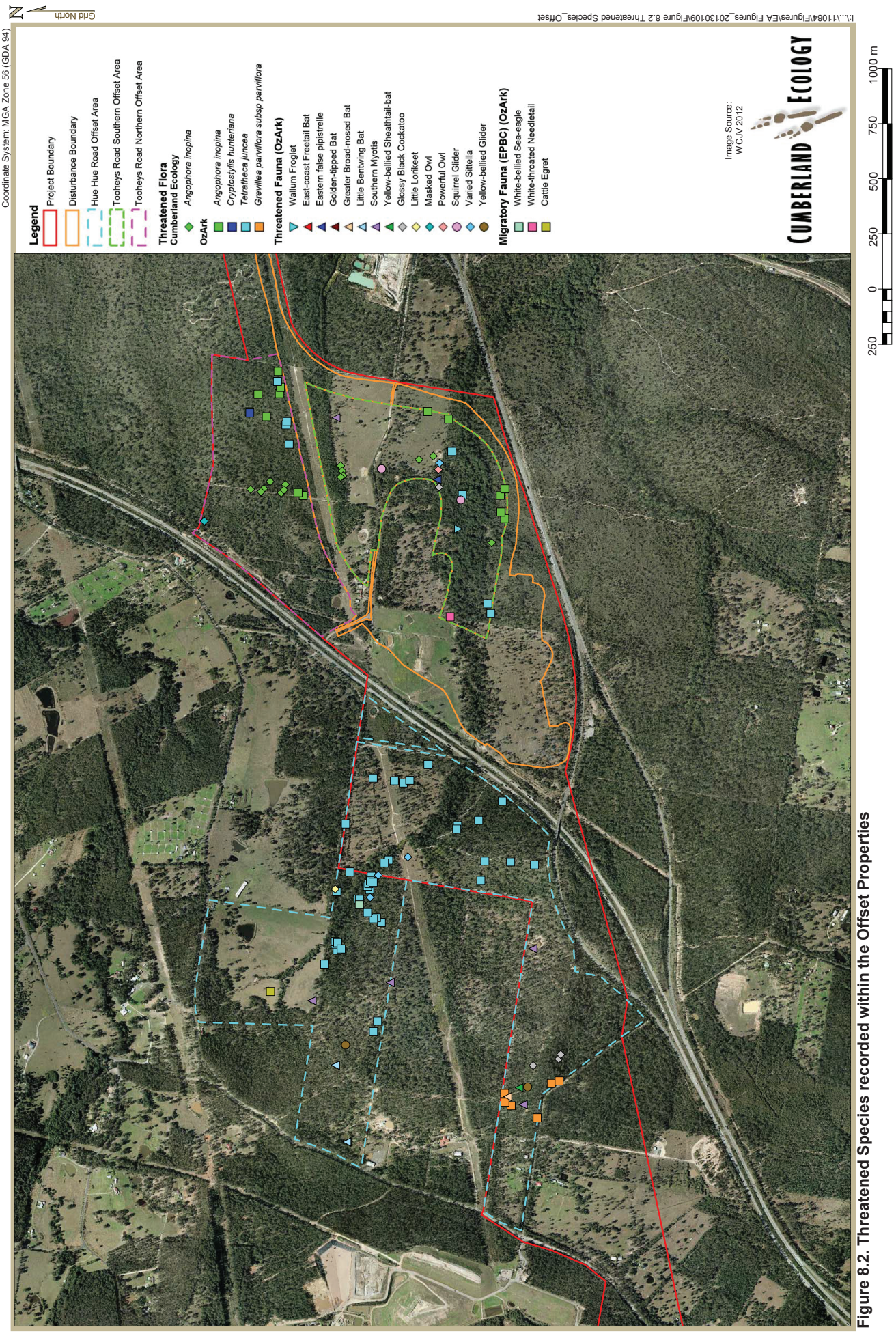

Figure 8.2. Threatened Species recorded within the Offset Properties

8.4.1 Vegetation

The vegetation communities occurring within the Offset Areas, their TSC Act status where applicable and their total area are shown in **Table 8.2**. No EPBC listed communities were recorded within the Study Area. The majority of the vegetation communities occurring within the Offset Areas are identical to those recorded within the Project Boundary, being in such close proximity.

Although woodland vegetation condition within the impact and offset areas can be classified as moderate to good as per the Biobanking methodology, the vegetation communities within the offset areas are considered to be of equal or higher quality than those within the impact areas. The quality of vegetation within the offset areas at Tooheys Road is of equal quality as those in the impact areas. With the exception of the areas along the fringes of exotic grassland, the quality of vegetation within the Hue Hue Road offset is generally of a higher quality than equivalent vegetation types in the Tooheys Road and Buttonderry impact areas as the understorey is less disturbed in general.Descriptions of the communities occurring both within the Project Boundary and the Offset Areas are provided in **Section 5.2**.

Table 8.2 Offset ratios for Vegetation communities to be cleared.

Vegetation Community	Area Disturbed	Area in Offset Areas	Ratio
Blackbutt - Turpentine open forest of the foothills of the North Coast (EEC)	5.9	16.9	2.9:1
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	1.7	0.0	-
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC)	1.1	3.9	3.6:1
Rough-barked Apple - red gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin (EEC)	0.0	0.4	n/a
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	33.8	40.0	1.2:1
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	3.8	74.0	19.6:1
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC)	4.5	55.4	12.4:1
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	0.8	0.0	-

Table 8.2 Offset ratios for Vegetation communities to be cleared.

Vegetation Community	Area Disturbed	Area in Offset Areas	Ratio
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC)	1.8	6.5	3.7:1
Derived Native Grassland	7.3	11.0	1.5:1
Exotic/Agricultural/Low Diversity Grassland	28.0	31.4	-
TOTAL EEC vegetation	13.2	83.0	6.3:1
TOTAL non-EEC native vegetation	47.3	125.0	2.6:1
Total Native vegetation	60.5	208.0	3.4:1

i. Tree Hollows.

Tree hollows are spread across the impact and offset areas. Tree Hollow density surveys determined that the equal to higher quality vegetation within the offset areas has an overall higher density of hollows (**Table 8.3**).

Table 8.3 Tree Hollow densities in impact and offset areas

	Impact density/ha	Offset density/ha
Total # hollows	7.1	15.3
# Large hollows	0.7	1.0
# Medium hollows	3.3	6.4
# Small hollows	2.9	8.2

8.4.2 Habitat for Threatened Species

The majority of the habitats occurring within the Offset Areas are identical to those recorded within the Disturbance Area. Descriptions of the habitats occurring both within the Project Boundary and the Offset Areas are provided in **Section 5.2**.

The habitats available within the Offset Areas provide potential habitat for a suite of threatened species listed under the TSC Act and/or EPBC Act, and key habitat features for these species that are present in the offset areas include the following.

- Swamp areas – habitat for amphibians
- Eucalypt woodlands and forest – habitat for birds, including threatened woodland birds and raptors, arboreal mammals and ground dwelling mammals; and
- Riparian areas – habitat for amphibians, birds, arboreal mammals and ground dwelling mammals.

There is also the potential for other threatened fauna species known from the locality to occur within the properties, including threatened microchiropteran bats and birds. The tree hollows and stags within the property provide potential shelter, roosting and nesting habitat for threatened microchiropteran bats including the Large-eared Pied Bat (*Chalinolobus dwyeri*). Foraging and nesting resources are also available for a range of threatened bird species such as the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*). A summary of the habitat present within the offset areas as well as non - offset habitat that will be retained within the Project Boundary is provided in **Table 8.3** below.

Assessment of the vegetation communities within the offset properties determined the vegetation to be predominantly young regrowth vegetation in good condition. With the implementation of protection measures to remove weed and feral species, it is predicted that condition of vegetation will further improve, thus increasing habitat values for threatened species as well as other non-threatened native flora and fauna.

Table 8.4 Habitat available for threatened species in offset areas and Project Boundary

Threatened species	Habitat required	Habitat to be cleared (ha)	Habitat in offsets (ha)	Potential Habitat retained within non-offset areas of Project Boundary (ha)
FLORA				
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	169.4	1357.2
Angophora inopina	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood forest, Paperbark Swamp forest	47.7	135.4	208.2
Cryptostylis hunteriana	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, Blackbutt - Turpentine open forest	48.7	186.3	1358.1
Grevillea parviflora subsp parviflora	Scribbly Gum - Red Bloodwood woodland, Swamp Mahogany forest, Smooth-barked Apple - Red Bloodwood open forest, Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest	44.6	175.9	1373.1

Table 8.4 Habitat available for threatened species in offset areas and Project Boundary

Threatened species	Habitat required	Habitat to be cleared (ha)	Habitat in offsets (ha)	Potential Habitat retained within non-offset areas of Project Boundary (ha)
Melaleuca biconvexa	Blackbutt – Turpentine forest, Spotted Gum - Grey Ironbark open forest, Swamp Mahogany swamp forest, Woollybutt - Paperbark sedge forest, Paperbark Swamp forest, Phragmites australis and Typha orientalis coastal freshwater wetlands	9.5	27.3	997.8
Tetratheca juncea	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, Blackbutt – Turpentine forest	50.5	192.8	1374.0
Potentially occurring flora species (*Asterolasia elegans*, *Caladenia tessellata, Callistemon linearifolius, Eucalyptus camfieldii, Genoplesium insignis, Maundia triglochinoides, Rhizanthella slateri, Rutidosis heterogama,*	Collectively all vegetation communities occurring in Project Boundary (except Exotic/Agricultural/Low Diversity grasslands)	60.5	208.0	2947.3

Table 8.4 Habitat available for threatened species in offset areas and Project Boundary

Threatened species	Habitat required	Habitat to be cleared (ha)	Habitat in offsets (ha)	Potential Habitat retained within non-offset areas of Project Boundary (ha)
Syzygium paniculatum, *Thelymitra sp. adorata*, *Eucalyptus parramattensis subsp. parramattensis*)				
FAUNA				
Amphibians (Wallum Froglet, Green and Golden Bell Frog, Green-thighed Frog, Giant Burrowing Frog, **Giant Barred Frog, Littlejohn's Tree Frog, Stuttering Frog**)	Blackbutt – Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Paperbark Swamp Forest, Spotted Gum - Broad-leaved Ironbark forest, Swamp Mahogany Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands,	10.4	27.3	1811.0
Forest Owls (Powerful Owl, Masked Owl, Barking Owl, Sooty Owl)	Scribbly Gum – Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood forest, Spotted Gum – Broadleaved Ironbark, Spotted Gum – Grey Ironbark, Mountain Blue Gum - Turpentine	44.5	169.4	2338.7
Arboreal mammals (Eastern Pygmy Possum,	Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum - Turpentine forest, Scribbly Gum – Red Bloodwood	46.6	112.3	2187.5

Table 8.4 Habitat available for threatened species in offset areas and Project Boundary

Threatened species	Habitat required	Habitat to be cleared (ha)	Habitat in offsets (ha)	Potential Habitat retained within non-offset areas of Project Boundary (ha)
Squirrel Glider, Yellow-bellied Glider)	woodland, Blackbutt – Turpentine forest			
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**)	Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark forest, Scribbly Gum – Red Bloodwood woodland, Blackbutt – Turpentine Forest and Mountain Blue Gum Turpentine forest, Smooth-barked Apple – Red Bloodwood forest,	50.4	186.3	2339.6
Wetland birds (Black Bittern, Black-necked Stork, Black-tailed Godwit, White-fronted Chat, **Australasian Bittern**)	Paperbark Swamp Forest, Swamp Mahogany Forest, Phragmites australis and Typha orientalis coastal freshwater wetlands	2.9	10.4	17.2
Migratory Parrots (Little Lorikeet, Swift Parrot)	Blackbutt – Turpentine forest; Paperbark swamp forest; Scribbly Gum - Red Bloodwood; Smooth-barked Apple - Red Bloodwood open forest; Spotted	51.6	196.7	1374.1

Table 8.4 Habitat available for threatened species in offset areas and Project Boundary

Threatened species	Habitat required	Habitat to be cleared (ha)	Habitat in offsets (ha)	Potential Habitat retained within non-offset areas of Project Boundary (ha)
	Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest, Swamp Mahogany swamp forest			
Cockatoos (Glossy Black Cockatoo, Gang-gang Cockatoo)	Spotted Gum – Broad Leaved Ironbark Forest, Scribbly Gum - Red Bloodwood woodland	38.3	95.4	260.3
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,	44.2	130.9	-175.1
Grey-headed Flying Fox	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum - Red Bloodwood woodland; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany forest	48.4	118.8	2729.2
Little Eagle	Scribbly Gum - Red Bloodwood woodland, Blackbutt – Turpentine forest, Smooth-barked Apple - Red Bloodwood forest,	43.4	130.9	187.7

Table 8.4 Habitat available for threatened species in offset areas and Project Boundary

Threatened species	Habitat required	Habitat to be cleared (ha)	Habitat in offsets (ha)	Potential Habitat retained within non-offset areas of Project Boundary (ha)
Varied Sittella	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood woodland	37.6	114.0	186.7
Bush Stone-curlew	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood woodland	37.6	114.0	186.7
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	51.5	190.2	2339.7
Spotted tailed Quoll	Blackbutt - Turpentine forest; Coachwood - Crabapple rainforest; Mountain Blue Gum - Turpentine forest; Scribbly Gum - Red Bloodwood woodland; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest; Swamp Mahogany swamp forest	48.4	118.8	2729.2

Bold – indicates EPBC species listed in the SEWPaC DGRs

8.4.3 Proposed Management of Offset Areas

The management of the Offset Areas will include the conservation and ongoing management of existing vegetation, as well as revegetation and rehabilitation of degraded areas. Details of the management procedures to be implemented within the Offset Areas will be contained within the BMP.

i. Conservation and Ongoing Management of Existing Vegetation

Conservation and ongoing management of existing vegetation will occur within the Offset Areas in order to maintain and improve their ecological value and facilitate regeneration of native vegetation and associated fauna habitat. This will include weed and feral animal management, active replanting and reseeding of vegetation and monitoring.

The Offset Areas contain existing woodland and forest that will form nuclei for ongoing regeneration of trees and shrubs from grassland areas, in particular Scribbly Gum – Red Bloodwood woodland which is habitat for the Vulnerable *Angophora inopina* (see **Section 8.4.3ii** below). Such habitats provide immediate and ongoing habitats for native plants and animals. Existing forest and woodland areas are currently mature, functioning examples of natural ecosystems, but their condition is expected to improve with time as trees mature, tree hollows are generated and as regeneration of understorey takes place when threats are managed.

Areas within the offset properties susceptible to edge effects will be protected by planting of a buffer zone as well as weed and feral animal management. Control action plans will also be developed to account for unexpected impacts from discharges into creeks within the area. Details of these processes will be contained the BMP.

ii. Revegetation

Significant revegetation is proposed to occur within the Offset Areas in order to establish habitat for the suite of threatened species impacted by the Project, in particular the threatened plants *Angophora inopina* and *Tetratheca juncea*. This will occur in approximately 6 ha of naturally regenerating DNG and 10 ha of Low diversity grassland in the Tooheys Road Southern offset (see **Figure 8.1**). A further 21 ha of Exotic/Low diversity grassland available for revegetation is present in the Hue Hue Road Offset Area (**Figure 8.1**). Trees and shrubs will be planted into such areas to form nuclei of regenerating woody habitats that would then be able to progressively grow back into woodland or open forest. It is expected that over time, birds will introduce seed from nearby bushland, thereby increasing plant diversity; however this process will be augmented by selective planting of understorey species over time as the plantings develop in order to maximise the diversity of the restored vegetation.

It is intended that strategic revegetation, combined with the management of weeds and feral animals will accelerate regeneration of degraded areas to forest and woodland areas. In the medium to long term, trees and shrubs are expected to regenerate into such areas if the condition of the land is improved through replanting and weed management (Lindenmayer et al. 2010).

Restoration of forest and woodland to a structural complexity with diverse age classes comparable to the original community structure will take many decades, but it is expected that substantial regeneration will occur within the life of the Project and a mature, functional ecosystem will be established across much of these grassland areas within the life of the Project. As the DNG areas within the Tooheys Road site already show signs of natural regeneration, the prospect of successful regeneration is good. The likelihood of successful regeneration is lower within the more disturbed exotic pastures and more stringent monitoring will be required for successful regeneration within these areas.

As a general indication, a tree density of about 30 to 40 mature trees per hectare is accepted as being ecological optimal for woodland habitat maintenance and minimum woodland patch sizes should be at least 5 ha to be viable (McIntyre *et al.* 2002). Continuous groundcover of tussock grasses, forbs and woody debris are also important in woodland and riparian corridors for soil stabilisation and attenuation of surface water flows. Detailed prescriptions of planting densities will be contained in the BMP.

Local provenance plant species will be utilised when required for revegetation, and additional seed will be collected from native vegetation in the Project Boundary to ensure genetic diversity is maintained. If feasible, species considered to have a high retention value, such as threatened orchids, may be translocated from the Disturbance Area to elsewhere in the Project Boundary that has similar site conditions, in accordance with the 'Guidelines for the Translocation of Threatened Plants in Australia'. Where possible, topsoil will be translocated from proposed disturbance areas to areas being rehabilitated/revegetated to conserve the native seed bank of local ecological communities. This will improve the quality and diversity of native growth in rehabilitation areas and maximise the establishment of a diversity of native species, particularly the understorey species that maintain the ecological function of native vegetation communities.

It is expected that improvement of habitat connectivity across offset lands, and from offset lands to adjacent native vegetation will occur in order to improve wildlife movement in the long term.

iii. Protection Mechanisms

The offset lands will be permanently protected by an appropriate mechanism. There are a number of options that are available to permanently protect land for conservation. Conservation measures, as listed under Section 126L of the TSC Act, include:

> *(a) the adoption or continuation of development controls under the Planning Act that limit or prohibit development on land or the taking of any other measures under that Act that conserve or enhance the natural environment,;*
>
> *(b) the entering into of a biodiversity certification agreement under this Part;*
>
> *(c) the entering into of a planning agreement under the Planning Act that makes provision for development contributions to be used or applied towards the conservation or enhancement of the natural environment;*

(d) the making of a State infrastructure contribution under the Planning Act for the conservation or enhancement of the natural environment;

(e) the entering into of a conservation agreement under the Environment Protection and Biodiversity Conservation Act 1999 of the Commonwealth;

(f) the reservation of land under Part 4 of the NPW Act;

(g) the entering into of a conservation agreement under the NPW Act in relation to land;

(h) the entering into of a trust agreement under the Nature Conservation Trust Act 2001;

(i) the entering into of a biobanking agreement under Part 7A of this Act;

(j) the acquisition or retirement of biodiversity credits under Part 7A of this Act;

(k) the adoption of a plan of management for a reserve under Division 6 of Part 5 of the Crown Lands Act 1989;

(l) the adoption of a plan of management for land under Division 2 of Part 2 of Chapter 6 of the Local Government Act 1993;

(m) the dedication or setting apart of any land as a flora reserve under section 16 of the Forestry Act 2012;

(n) consent to a property vegetation plan for land under the Native Vegetation Act 2003 (not being a plan that proposes broadscale clearing of native vegetation within the meaning of that Act); and

(o) any other measure that the Minister determines to be a conservation measure.

Further potential conservation measures include:

- Conservation Agreements (CA), which are a joint agreement between landowners and the Minister for the Environment under the *National Parks and Wildlife Act 1974*;
- Application to change zoning regulation that dictates land use;
- Dedication of land to the National Parks reserve estates; and
- Land acquisition and management of the land under private ownership with conditions of commitment.

The final method of security will be decided on by WACJV in consultation with OEH and other relevant agencies. The final mechanism to fund management of the offsets in perpetuity will be determined by WACJV, in consultation with OEH and other relevant agencies for inclusion in the Biodiversity Management Plan.

The BOS will thus maintain biodiversity values of the region by changing the tenure of private lands (where conservation is not assured) to conservation areas where provision is made for conservation in perpetuity. Furthermore the removal of weeds and feral animals and revegetation and rehabilitation of degraded areas within the offset properties will improve conditions of vegetation communities and fauna habitats thus improving the biodiversity values of the region.

iv. Costs of mitigation and management

The Project has made a significant contribution towards migitation of impacts via provision of land for the proposed offsets. Further costs for mitigation will include a variety of short term and long term expenses. Short term expenses include initial costs for measures such as construction of exclusion fences for feral pests while long term costs include ongoing monitoring over the the life of the Project. Assessments of costs for mitigation and monitoring will be detailed in the BMP in consultation with OEH and other relevant regulatory authorities.

8.5 Biodiversity Management Plan

In order to provide a comprehensive framework for the implementation of the proposed biodiversity impact mitigation and offset measures, a BMP will be developed for the Project. The BMP will ensure that the Project's conservation objectives are met and that impacts to biodiversity are adequately managed for the life of the Project.

The BMP will incorporate all of the impact mitigation measures as described in this Chapter that are proposed to be undertaken for the Project, and provide detailed specifications for their implementation. The BMP will include the following:

- A description and plan of onsite conservation measures (long and short term);
- Measures to protect local biodiversity values;
- Provisions to address specific issues such as the occurrence of threatened species;
- Details of appropriate areas for rehabilitation and conservation;
- Details of revegetation priorities and techniques;
- Details of monitoring methodology, and other contributions to conservation; including adaptive management plans for unlikely subsidence induced impacts and their potential implications for surface biodiversity;

- Description of key performance indicators against which to measure progress; and
- Specification of appropriate review periods where progress is reviewed and the document updated as required.

The BMP is intended to be a working document that guides all facets of biodiversity management and biodiversity mitigation for the Project, and will include clear objectives and actions. The BMP will specify what measures will be undertaken, how they will be undertaken, and will provide a timeline to ensure that all activities are conducted according to the plan.

The BMP will include, where appropriate, specifications for the following:

- Detailed design of mitigation measures such as fencing, rehabilitation and soil conservation;
- Pre-clearing surveys and fauna rescue or translocation, where practical. In particular pre-clearance surveys will be conducted for newly listed threatened species, (eg. *Corunastylis* sp. Charmhaven) during appropriate survey periods;
- Vegetation clearing protocols;
- Rehabilitation of habitat where possible;
- Control and ongoing management of environmental and noxious weeds;
- Control and ongoing management of feral animals;
- Rehabilitation methods and protocols; and
- Details of the monitoring program.

Upon the granting of developing consent, a BMP will be prepared in consultation with the OEH and other regulatory authorities for approval by DP&I. In addition to the BMP, several other management plans, designed to reduce the impact of the Project will be developed and implemented. These are anticipatory only and will be prepared as required by any development consent conditions in consultation with relevant regulatory departments as indicatively listed in **Table 8.5** below.

Table 8.5 Proposed Management Plans for the Project

Management Plan	Agencies to be Consulted
Water Management Plan	NSW Office of Water
Air Quality Management Plan	OEH
Noise Management Plan	OEH
Biodiversity Offset Strategy	OEH

Table 8.5 Proposed Management Plans for the Project

Management Plan	Agencies to be Consulted
Aboriginal Heritage Management Plan	OEH
Historic Heritage Management Plan	DP&I Heritage Branch
Land Management Plan	DP&I
Bushfire Management Plan	Rural Fire Services, WSC
Landscape Management Plan	DP&I, WSC
Extraction Plan	DTIRIS – DRE, DP&I

8.5.1 Compliance with OEH and SEWPaC Offsetting Principles

In order to achieve the best environmental outcomes, the BOS for the Project aims to meet NSW and Commonwealth standards in offsetting.

Table 8.6 and **Table 8.7** below show how the NSW and Commonwealth principles for offsetting have been addressed by the Wallarah BOS. The NSW principles are derived from *Guidelines for Biodiversity Certification of Environmental Planning Instruments Working Draft* (DECC 2007), and the Commonwealth Principles are taken from the *Draft Policy Statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999* (DEWR 2007).

Table 8.6 Assessment of Compliance with OEH Offsetting Principles

NSW Offsetting Principles	Assessment of Compliance
1. Impacts must be avoided first by using prevention and mitigation measures.	
Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.	A range of impact avoidance and mitigation measures are outlined in Chapter 6. The offsets will address the remaining impacts once these measures have been implemented.
2. All regulatory requirements must be met.	
Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).	The offsets are not being used to satisfy approvals under other legislation.
3. Offsets must never reward ongoing poor performance.	
Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.	The areas of land to be used as offsets have not been and will not be deliberately degraded.
4. Offsets will complement other government programs.	
A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.	The offset areas will provide for the conservation of native vegetation that will be managed for conservation in the long term. This is considered to be consistent with the NSW Governments conservation objectives and will complement other nature conservation programs.
5. Offsets must be underpinned by sound ecological principles.	
They must:	
include the consideration of structure, function and compositional elements of biodiversity, including threatened species	The proposed offsets will contain all the structural elements of biodiversity that will be impacted, including habitat for threatened

Table 8.6 Assessment of Compliance with OEH Offsetting Principles

NSW Offsetting Principles	Assessment of Compliance
	species.
enhance biodiversity at a range of scales	The offsets will enhance biodiversity at a local and regional scale.
consider the conservation status of ecological communities	Threatened communities to be impacted will be represented in the offset areas
ensure the long-term viability and functionality of biodiversity.	The proposed offsets are strategically located to ensure the long term viability and functionality and viability of ecological values to be impacted.
Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.	Existing habitat within the offset areas will be managed and enhanced for biodiversity conservation. No reconstruction of ecological communities will take place
6. Offsets should aim to result in a net improvement in biodiversity over time.	
Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.	The proposed offsets will result in a net improvement in biodiversity over time as habitats are managed and protected for conservation. The area of land in the offset areas is greater than the area to be impacted. Approximately 60 ha of native vegetation will be removed and a total of 208 ha will be conserved in the offset areas.
Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.	Existing habitat within the offset areas will be managed and enhanced for biodiversity conservation according to a BMP that will be prepared prior to the commencement of the project.
Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of	The offsets will be protected by conservation agreements and will

Table 8.6 Assessment of Compliance with OEH Offsetting Principles

NSW Offsetting Principles	Assessment of Compliance
conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.	include enhancing habitat in accordance with a BMP that will be prepared prior to the commencement of the project.
7. Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.	
As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.	The offsets will be protected by conservation agreements that will operate in perpetuity
8. Offsets should be agreed prior to the impact occurring.	
Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.	The proposed offsets have already been identified, and the total quantum will be agreed prior to the commencement of the project.
9. Offsets must be quantifiable - the impacts and benefits must be reliably estimated.	
Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include:	The area of proposed offsets are known and have been mapped, as has the impacts, and it is considered that the impacts and benefits have been reliably quantified.
the area of impact	Provided in Section 8.4
the types of ecological communities and habitat/species affected	Provided in Section 8.4
connectivity with other areas of habitat/corridors	Provided in Section 8.4

Table 8.6 Assessment of Compliance with OEH Offsetting Principles

NSW Offsetting Principles	Assessment of Compliance
the condition of habitat	Provided in Section 8.4
the conservation status and/or scarcity/rarity of ecological communities	Provided in Section 8.4
management actions	Provided in Section 8.4
level of security afforded to the offset site.	Provided in Section 8.4
The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:	
they protect land with high conservation significance	The offset areas have conservation significance as they are located directly adjacent to the Study Area and are contiguous with existing large tracts of vegetation.
management actions have greater benefits for biodiversity	Management actions will be specified in the BMP. These actions will have benefits to biodiversity by controlling threats such as weeds and feral animals and allow for the regeneration of native vegetation.
the offset areas are not isolated or fragmented	The offset areas are located directly adjacent to the Study Area
the management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).	The offset areas will be protected in perpetuity according to an appropriate agreement.
Management actions must be deliverable and enforceable.	Provisions for the management of the offset areas will be provided in the BMP. The actions in the BMP are considered likely to form conditions of consent and will therefore be enforceable
10. Offsets must be targeted.	
They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should	The proposed offsets contain very similar biodiversity values as the

Table 8.6 Assessment of Compliance with OEH Offsetting Principles

NSW Offsetting Principles	Assessment of Compliance
be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.	impacted areas and are located in close proximity to the impact areas. These values are equivalent in terms of value and the types of community that are impacted/offset.
11. Offsets must be located appropriately.	
Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.	The proposed offsets are located in close proximity to the impact areas (see Figures 6.1, 8.1 and 8.2)
12. Offsets must be supplementary.	
They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.	The proposed offsets are not funded under another scheme
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	
Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.	A monitoring strategy has been proposed for the offset strategy in order to verify that the actions to be undertaken in the offset areas lead to positive biodiversity outcomes.

Table 8.7 Assessment of Compliance with SEWPaC Offsetting Principles

SEWPaC Principles for Offsetting	Justification
1. Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.	The proposed offsets contain the same ecological communities that will be cleared for the proposal. They also contain high quality potential habitat for threatened species listed under the EPBC Act such as Litttejohn's Tree Frog (Litoria littlejohni)
2. A flexible approach should be taken to the design and use of environmental offsets to achieve long term and certain conservation outcomes which are cost effective for proponents.	The proposed offset areas have been chosen to target the communities being impacted. A comprehensive BMP has been developed for the design and use of these areas to achieve long term conservation outcomes.
3. Environmental offsets should deliver a real conservation outcome.	The proposed offset lands provide extensive areas of habitat that will be managed for long term conservation outcomes which will deliver a highly beneficial conservation outcome.
4. Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets.	The proposed BOP includes strategically located offset lands that provide for the long term conservation of large areas of land, as well as a range of impact mitigation and mitigation measures that provide a package of amelioration measures.
5. Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like-for-like'.	The proposed offsets comprise direct offsets in the form of like-for-like or better vegetation. The offsets package provides larger areas of habitat than that to be cleared
6. Environmental offsets should be located within the same general area as the development activity.	The offsets have been strategically located adjacent to the Study Area to maximize conservation outcomes.
7. Environmental offsets should be delivered in a timely manner and be long lasting.	The proposed offsets are being provided in advance of the disturbance and are proposed to be long lasting.

Table 8.7 Assessment of Compliance with SEWPaC Offsetting Principles

SEWPaC Principles for Offsetting	Justification
8. Environmental offsets should be enforceable, monitored and audited.	A comprehensive BMP has been prepared for monitoring and auditing the performance of the offset lands

Chapter 9

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 Project would remove approximately 60.51 ha of native forests and woodland communities from the Infrastructure areas including communities listed as threatened under the TSC Act. This includes approximately 5.9 ha of River Flat Eucalypt Forest (RFEF) EEC, 2.9 ha of Swamp Sclerophyll Forest (SSF) EEC and 4.5 of Lower Hunter Spotted Gum Ironbark Forest (LHSGIF) EEC.

Vegetation communities, including approximately 728.33 ha of TSC Act EECs in the western parts of the Project Boundary and 82.1 ha of TSC Act EECs just outside the Project Boundary will also potentially be impacted by subsidence. This includes a total of approximately 582.3 ha of Lowland Rainforest (LF) EEC, 25.5 ha of RFEF EEC, 26.7 ha of SSF EEC, 1.2 ha of Freshwater wetlands and 174.7 ha of LHSGIF EEC.

A total of 17 threatened plant species listed under the TSC Act and/or EPBC Act, known to occur in the region, have potential habitat within the Project Boundary and six have been recorded. The Project will remove approximately 80 individuals of *Angophora inopina*, listed as Vulnerable under the TSC Act and EPBC Act and known individuals of *Tetratheca juncea*, listed as Vulnerable under the TSC Act and EPBC Act from 28 locations.

Further potential impacts from subsidence, such as surface cracking and changes in water tables could occur, could affect vegetation communities, GDEs and threatened flora and fauna species in the western parts of the Project.

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. Of these, 29 threatened species and 8 migratory species 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.

Detailed predictive modelling of subsidence impacts have been conducted and impacts from subsidence are considered to be negligible in light of the mine layout measures taken to manage subsidence, such as at the main creek confluence, and the technological revisions to the longwall design that will significantly reduce surface expression of subsidence.

Notwithstanding this, monitoring programs, conducted before, during and after subsidence occurring are recommended to record conditions to the floodplain and threatened species, such as the Giant Barred Frog (*Mixophyes iteratus*).

In recognition of the potential ecological impacts from clearing in the Infrastructure Area, substantial mitigation and amelioration measures have been proposed. The considerations for reducing the ecological impacts follow a hierarchy of principles:

- Avoid – to the extent possible, the developments has been designed to avoid or minimize ecological impacts;
- Mitigate – where 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.

Mitigation measures that will be implemented include:

- Measures to minimise the loss of vegetation and habitat, as far as practicable;
- Avoidance of subsidence near the confluence of Jilliby Jilliby and Little Jilliby Jilliby Creeks and ensuring advanced longwall mining design to minimise subsidence impacts;
- Retention of key habitat attributes within the Study Area that will not be disturbed;
- Revegetation activities; and
- Ongoing monitoring.

Furthermore, a BOS is proposed to be implemented. The BOS identifies large patches of remnant vegetation in the locality of the Project Boundary that will be protected for permanent conservation.

The BOS will protect over 200 ha of forest and woodland habitat for native flora and fauna, including 83 ha of State Listed EECs. In the long term, approximately 42.4 ha of grassland (11 ha of DNG and 31.4 ha of exotic grassland) within the offset land is proposed to be regenerated to woodland, in particular woodland habitat for *Angophora inopina*.

Importantly, these areas would provide upfront mitigation of the Project's impacts on locally occurring biodiversity. The inclusion of these lands as biodiversity offsets would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented.

The proposed avoidance, mitigation and offset measures are likely to sufficiently ameliorate the impacts of the Project to the extent that no threatened species are likely to become extinct as a result of the Project. Moreover, the long term objective of the Biodiversity Offset Package is to provide for a net benefit to flora and fauna within the locality and region. When the mitigation and offsetting package is considered, no significant impacts are predicted to occur to threatened species as a result of the Project, and the Project will provide a major ecological benefit in the medium to long term.

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Appendix A

Director General's Requirements Relevant to Ecological Assessment

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
Description of the existing environment		
3 – A description of the existing environment of the proposal location and the surrounding areas that may be affected by the action, including:		
a)	surveys using accepted methodology for targeting listed threatened species, ecological communities and their respective habitat, including but not limited to OEH's Survey and assessment guidelines and the SEWPaC species-specific survey guidelines for nationally threatened species	Chapter 4 presents the survey methodology utilised to survey in the Project Boundary.
In addition to the requirements outlined in OEH's Survey and assessment guidelines (2009) and SEWPaC survey guidelines for relevant species, the following must also be included:		
b)	a description of the distribution and abundance of threatened species and ecological communities, as well as suitable habitat (including breeding, foraging, roosting habitat, habitat critical to the survival of threatened species) within the site and in surrounding areas that may be impacted by the proposal. Specifically, this must include but not be limited to the Charmhaven Apple (Angophora inopina), Black-eyed Susan (Tetratheca juncea), Spotted-tailed Quoll (Dasyurus maculates maculatus) and Giant Barred Frog (Mixophyes iteratus);and	Chapter 5 present the results of the field surveys and desktop assessments, including specific consideration of these species.
c)	the regional distribution and abundance of suitable and potential habitat for EPBC Act listed species surrounding the site	Chapter 5 and Chapter 7
Description of the relevant impacts of the controlled action		
4 - An assessment of all relevant impacts with reference to the EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance (2009) that the controlled action has, will have or is likely to have on relevant threatened species and/or threatened ecological communities listed under section s18 and s18A of the EPBC Act. This includes relevant impacts such as vegetation removal, ground hydrological processes on species including but not limited to Charmhaven Apple (Angophora inopina), Black-eyed Susan (Tetratheca juncea), Spotted-tailed Quoll (Dasyurus		

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
maculates maculatus) and Giant Barred Frog (Mixophyes iteratus). Information must include:		
a)	A description of the relevant impacts of the action on Matters of National Environmental Significance	Chapter 7
b)	A detailed assessment of the nature and extent of the likely short term and long term relevant impacts	Chapter 6
c)	A statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible	Chapter 7
d)	Analysis of the significance of the relevant impacts	Chapter 7 and Appendix H
e)	Any technical data and other information used or needed to make a detailed assessment of the relevant impacts	Technical data utilised has been referenced throughout, and a list of all technical data used is presented in the Reference List
5 - A description of the relevant impacts on the Charmhaven Apple (Angophora inopina) should include an analysis of the current distribution on the site, as well as the methods by which this was determined. It should also include direct, indirect, cumulative and facilitative impacts on the:		
	extent of the Charmhaven Apple population, including connectivity of the species on the site and surrounding areas (specify quantity or area covered by the species in hectares or number of individuals);	The extent of the Charmhaven Apple population is provided in Section 5.5.1 Impacts to this species are described in Section 6.7.2 and Appendix H
	quality or integrity of the Charmhaven Apple population including, but not limited to impacts such as, vegetation removal, assisting invasive species that are harmful to the species to become established, causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the habitat that may kill or inhibit the growth of species, or alteration of vegetation communities resulting in increased competition or shading of the species;	Section 6.7.2, Appendix H
	abiotic (non-living) factors (such as water, nutrients or soil) necessary for the survival of the Charmhaven Apple, including, but not limited to impacts such as, soil disturbance, alteration of shading/light levels, altering groundwater levels, or substantial	Section 6.7.2, Appendix H

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	alteration of surface water drainage patterns.	
	These impacts should be described for both the construction and operational phases of the controlled action.	
6 - A description of the relevant impacts on the Giant Barred Frog (Mixophyes iteratus) should include an analysis of the current and potential habitat on the site, as well as the methods by which this was determined. It should also include direct, indirect, cumulative and facilitative impacts on the:		
a)	extent of the Giant Barred Frog population, including connectivity with other populations;	The extent of the Giant Barred Frog population is provided in 6.8.1
b)	quality or integrity of the Giant Barred Frog population;	Impacts to this species are described in Section 6.8.1and Appendix H
c)	abiotic (non-living) factors (such as water, nutrients or soil) necessary for the survival of the Giant Barred Frog, including, but not limited to impacts such as, ground subsidence, altering groundwater levels, water quality or substantial alteration of surface water drainage patterns.	Section 4.8.1and Appendix D
	i) impacts associated with ground subsidence and alteration to ground and surface hydrology should be ascertained through adequate assessment and modelling studies.	Impacts of subsidence are addressed in Section 6.2
These impacts should be described for both the construction and operational phases of the controlled action.		
Proposed Safeguards and Mitigation Measures		
7 - A description of feasible mitigation measures, changes to the action or procedures, which have been proposed by the proponent or suggested in public submissions, and which are intended to prevent or minimise relevant impacts. Information must include		
a)	a description of the mitigation measures that will be undertaken to prevent or minimise the relevant impacts of the action. These mitigation measure should be substantiated and based on best available practices;	Chapter 8
b)	an assessment of the expected or predicted effectiveness of the mitigation measures including the effect on abundance and	Chapter 8

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	condition of species, suitable habitat and ecological communities;	
c)	any statutory or policy basis for the mitigation measures;	Chapter 6
d)	the cost of the mitigation measures;	HB to complete
e)	an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs (including any relevant thresholds for corrective actions) for the relevant impacts of the action. Include the person or agency responsible for implementing these programs and the effectiveness of all mitigation measures, including any provisions for independent environmental auditing;	Section 8.5
f)	the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;	HB to complete
g)	identification of mitigation measures proposed to be undertaken by State governments, local governments or the proponent;	Chapter 8 outlines the mitigation measures proposed to be undertaken by the proponent. No mitigation measures are proposed to be undertaken by the local government or State Government
h)	any changes to the action which prevent or minimise relevant impacts on listed threatened species and communities.	A discussion of the changes to the project that have been made to reduce impacts on threatened species or communities is presented in Section 8.1
Offsets		
8 - Should any residual impact exist that cannot be mitigated it may be necessary for offset measures to be considered in order to ensure the protection of matters of National Environmental Significance in perpetuity. If required, the department may negotiate offsets with you during the assessment phase. Reference should be made to the Department's draft policy statement, including any revisions to this statement, at :		

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
http://www.environment.gov.au/epbc/publications/draft-environmental-offsets.html		
a)	the description of any offset package should include how the offset compensates for the residual impacts, when the offset will be delivered and how the offset will be managed;	Section 8.4 presents the proposed offset package
b)	an assessment of the impact of the offsets on other matters of environmental, economic, or social significance; and	Section 6.4 presents the proposed offset package
c)	analysis of cost, both financial and other, related to offsets.	HB to complete
Other approvals and conditions		
9 - Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. Information must include:		
a)	Details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:	
	i) what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy	The project will be assessed under the EP&A Act in accordance with the Gateway assessment process for this project.
	ii) how the scheme provides for the prevention, minimisation and management of any relevant impacts	
b)	A description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action	No approval has been obtained for this project
c)	A statement identifying any additional approval that is required	Approval is required under the EP&A Act in accordance with the Gateway assessment process for this project.
d)	A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action	These are detailed in Section 8.3

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
Environmental record of person proposing to take the action		
11 - Provide details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:		
a)	The proponent	No legal action has been taken against the proponent for environmental issues
b)	For an action for which a person has applied for a permit, the person making the application	N/A
12 – Details of the proponent's environmental policy and planning framework		HB to complete
Information sources		
13 - For information given in an environmental assessment, the draft must state:		
a)	The source of the information	All sources are references throughout the document and a complete list of all references provided in the Reference List
b)	How recent the information	Each reference is cited and dated. The date of record of species recorded from the locality and/or the Project Boundary have been included in the document.
c)	How the reliability of the information was tested	Much of the data regarding species occurrences comes from Government databases and there is no way to test the reliability of this data. Nevertheless, these sources are considered reliable.

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
d)	What uncertainties (if any) are in the information	This has been indicated throughout the document.
	DEPARTMENT OF PLANNING & INFRASTRUCTURE – GENERAL REQUIREMENTS	
1	detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment, which includes:	
	a description of the existing environment, using sufficient baseline data;	Chapter 3
	an assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant guidelines, policies, plans and statutes; and	Chapter 6
	a description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment; and	Chapter 8
	DEPARTMENT OF PLANNING & INFRASTRUCTURE – KEY ISSUES	
2	The EIS must address the following specific issues:	
	Subsidence - including a detailed quantitative and qualitative assessment of the potential conventional and non-conventional subsidence impacts of the development that includes:	Subsidence modelling report
	the identification of the natural and built features (both surface and subsurface) within the area that could be affected by subsidence, and an assessment of the respective values of these features using any relevant statutory or policy documents;	An identification of the natural features that may be affected by subsidence is presented in Chapter 4. This includes ecological communities and flora and

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
		fauna species. The conservation value of these entities has been assessed using their listing under the TSC Act and/or the EPBC Act where appropriate
	accurate predictions of the potential subsidence effects and impacts of the development, including a robust sensitivity analysis of these predictions;	An assessment of the potential effects of subsidence has been provided in Chapter 6
	a detailed assessment of the potential environmental consequences of these effects and impacts on both the natural and built environment, paying particular attention to those features that are considered to have significant economic, social, cultural or environmental values; and	An assessment of the potential impacts of subsidence on the ecological values of the Study Area has been provided in Chapter 6
	a detailed description of the measures that would be implemented to avoid, minimise, remediate and/or offset subsidence impacts and environmental consequences (including adaptive management and proposed performance measures);	Subsidence modelling report
4	Biodiversity - including:	
	o measures taken to avoid, reduce or mitigate impacts on biodiversity;	Chapter 8
	o accurate estimates of proposed vegetation clearing;	Chapter 6
	o a detailed assessment of potential impacts of the development on any:	
	terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems (including the following threatened species: Angophora inopina, Cryptostylis hunteriana, Mixophyes iterates - the Giant Barred Frog, Mixophyes balbus - the Stuttering Frog, Litoria littlejohnni- the Littlejohns tree Frog);	Chapter 6
	migratory bird species listed under CAMBA, JAMBA and/or ROKAMBA; and	Chapter 7
	regionally significant remnant vegetation, or vegetation corridors;	Chapter 6

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	o impacts on Jilliby State Conservation Area - including impacts on the conservation and recreational values of the reserve and landowner consent issues; and	Section 6.4
	o a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term;	Chapter 8
	OFFICE OF ENVIRONMENT & HERITAGE – SPECIFIC ISSUES: BIODIVERSITY	
1.	Biodiversity Impacts can be assessed using either the BioBanking Assessment Methodology (Scenario 1) or a detailed biodiversity assessment (Scenario 2). The requirements for each of these approaches are detailed below.	Scenario 2 was used to assess this Project
2.	The BioBanking Assessment Methodology can be used either to obtain a BioBanking statement or to assess impacts of a proposal and to determine required offsets without obtaining a statement. In the latter instances, if the required credits are not available for offsetting, appropriate alternative options may be developed in consultation with OEH officers and in accordance with OEH policy.	n/a
3.	OEH recommends that the location of any proposed biodiversity offsets for this proposal are located within a significant biodiversity corridor or regionally significant vegetation (Draft Central Coast Regional Strategy: Department of Planning. 2006) such as the 'Green Corridor' identified In the Draft North Wyong Structure Plan (Department of Planning, 2010); which links the uplands of Wyong Shire to the coast.	Chapter 8
	Scenario 1 - Where a proposal is assessed using the BioBanking Assessment Methodology (BBAM):	n/a
4.	1. Where a BioBanking Statement is being sought under Part 7 A of the Threatened Species Conservation Act 1995 (TSC Act), the assessment must be undertaken by an accredited BioBanking assessor (as specified under Section 142B (1)(c) of the TSC Act 1995) and done in accordance with the BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECCW, 2008). To qualify for a BioBanking Statement a proposal must meet the 'improve or maintain' standard.	n/a
5.	1a. The EIS should include a specific Statement of Commitments that reflects all requirements of the BioBanking Statement	n/a

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	including the number of credits required and any DG approved variations to impact on Reef Flags.	
6.	2. Where the BioBanking Assessment Methodology is being used to assess impacts of a proposal and to determine required offsets, and a BioBanking Statement is not being obtained, the EA should contain a detailed biodiversity assessment and all components of the assessment must be undertaken in accordance with the BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECCW, 2008).	n/a
	2a. The EIS should include a specific Statement of Commitments which:	n/a
	□ is informed by the outcomes of the proposed BioBanking assessment offset package;	n/a
	□ sets out the ecosystem and species credits required by the BioBanking Assessment Methodology and how these ecosystem and/or species credits will be secured and obtained;	n/a
	□ if the ecosystem or species credits cannot be obtained, provides appropriate alternative options to offset expected impacts, noting that an appropriate alternative option may be developed in consultation with OEH officers and in accordance with OEH policy;	n/a
	□ demonstrates how all options have been explored to avoid red flag areas;	n/a
7.	□ includes all relevant 'BioBanking files (e.g. *.xml output files), data sheets and documentation (including maps, aerial photographs, GIS shape files, other remote sensing imagery etc.) to ensure that OEH can conduct an appropriate review of the assessment.	n/a
8.	3. Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby NSW estate reserved under the National Parks and Wildlife Act 1974 or any marine and estuarine protected· areas under the Fisheries Management Act 1994 or the Marine Parks Act 1997 should be considered. Please refer to the Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECCW, 2010).	Section 6.4
9.	4. With regard to the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, the assessment should	Chapter 7

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	identify and assess any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or already determined to be a controlled action.	
	Scenario 2 - Where a proposal is assessed outside the BioBanking Assessment Methodology:	
10.	1. The EIS should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. This assessment should address the matters included in the following sections.	This document comprises a detailed biodiversity assessment of the project.
	2. A field survey of the site should be conducted and documented in accordance with relevant guidelines, including:	Chapter 4 contains details of the field surveys that were conducted in the study area
	□ the Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna - Amphibians (DECCW, 2009);	Field surveys were conducted in accordance to the relevant guidelines
	□ Threatened Biodiversity Survey and Assessment· Guidelines for Developments and Activities - Working Draft (DEC, 2004); and	
	· Threatened species survey and assessment guideline information on www.environment.nsw.gov.au/threatenedspecies/suryeyassessmentgdins.htm	
11.	If a proposed survey methodology is likely to vary significantly from the above methods, the proponent should discuss the proposed methodology with OEH prior to undertaking the EIS, to determine whether OEH considers that it is appropriate.	The field survey method did not vary significantly from these guidelines
12.	Recent (less than five years old) surveys and assessments may be used. However, previous surveys should not be used if they have:	Recent survey results have been used in this assessment. Surveys older than 5 years were used as supplementary material and were not relied upon.
	□ been undertaken in seasons, weather conditions or following extensive disturbance events when the subject species are	

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	unlikely to be detected or present; or	
	□ utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate for detecting the target subject species,	
	Unless these differences can be clearly demonstrated to have had an insignificant impact upon the outcomes of the surveys. If a previous survey is used, any additional species listed under the TSC Act since the previous survey took place, must be surveyed for determining the list of potential threatened species for the site must be done in accordance with the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC, 2004) and the Guidelines for Threatened Species Assessment (Department Of Planning, July 2005). The OEH Threatened Species website	All currently listed species listed under the TSC Act have been considered in the preparation of this assessment.
	http://www.environment.nsw,gov.au/threatenedspecies/ and the Atlas of NSW Wildlife database must be the primary information sources for the list of threatened species present. The BioBanking Threatened Species Profile Database, the Vegetation Types databases (available on OEH website at http://www.environment.nsw.gov.au/resources/biobanking/08287tspd.pdf and	These databases were consulted in the preparation of this assessment
	http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm. respectively) and other data sources (e.g. PlantNET, Online Zoological Collections of Australian Museums (http://www.ozcam.org/),previous or nearby surveys etc.) may also be used to compile the list.	n/a
13.	3. The EIS should contain the following Information as a minimum:	
	a. The requirements set out in the Guidelines for Threatened Species Assessment (Department of Planning, July 2005);	
14.	b. Description and geo-referenced mapping of study area (and spatial data files), e.g., overlays on topographic maps, satellite images and/or aerial photos, including details of map datum, projection and zone, all survey locations, vegetation communities (including classification and methodology used to classify), key habitat features and reported locations of threatened species,	These maps are presented in this report in Chapters 4, 5, 6 and 8
	populations and ecological communities present in the subject site and study area;	Chapter 5

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
15.	c. Description of survey methodologies used, including timing, location and weather conditions;	Chapter 4
16.	d. Details, including qualifications and experience of all staff undertaking the surveys, mapping and assessment of impacts as part of the EIS;	Appendix I. OzArk personnel mentioned in Chapter 1
17.	e. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status;	Chapter 5 and Chapter 7
18.	f. Description or the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor;	Chapter 6
19.	g. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed;	Chapter 8
20.	h. Description of the residual impacts of the proposal if the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below); and	Section 8.4
21.	i. Provision of specific Statement of Commitments relating to biodiversity.	
22.	4. An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the study area based on the presence of suitable habitat. This assessment must take into account:	
	a. the factors identified in s.5A of the EP&A Act; and	Appendix H
23.	b. the guidance provided by The Threatened Species Assessment Guideline - The Assessment of Significance (DECCW, 2007)	This has been taken into consideration in

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	which is available at:	the assessments of significance
	http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf	
24.	5. Where an offsets package is proposed by a proponent for impacts to biodiversity (and a BioBanking Statement has not been Bought) this package should:	
	a) Meet OEH's Principles for the use of biodiversity offsets in NSW which are available at:	Table 8.3 and 8.4
	www.environment.nsw.gov.au/biocertification/offsets.htm.	
25.	b) Identify the conservation mechanisms to be used to ensure the long term protection and management of the offset sites.	Section 8.4.3iii
26.	c) Include an appropriate Management Plan (such as vegetation or habitat) that has been developed as a key amelioration measure to ensure any proposed compensatory offsets, retained habitat enhancement features within the development footprint and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs) are appropriately managed and funded.	Section 8.5
27.	6. Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby NSW estate reserved under the National Parks and Wildlife Act 1974 or any marine and estuarine protected areas under the Fisheries Management Act 1994 or the Marine Perks Act 1997 should be considered. Refer to the Guidelines (or developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECC, 2010).	Section 6.4
28.	7. With regard to the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, the assessment should identify any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or already determined to be a controlled action.	Chapter 7
OFFICE OF ENVIRONMENT & HERITAGE – SPECIFIC ISSUES: WATER & SOILS		
29.	11. Assess impacts on groundwater and groundwater dependent ecosystems.	Groundwater impacts are discussed in the

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
		Mackie Report. Impacts to GDEs are addressed in Section 6.6
	Monitoring	
	13. Describe how predicted impacts will be monitored and assessed over time.	Section 8.3
	□ For relatively large and/or high risk developments, proponents should develop a water quality and aquatic ecosystem monitoring program to monitor the responses for each component or process that affects the Water Quality Objectives that includes, for example:	n/a
	o adequate data for evaluating compliance with water quality standards and/or Water Quality Objectives	
	o measurement of pollutants identified or expected to be present in any discharge	
30.	□ Water quality monitoring should be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutant in NSW (2004) (http://www.environment.nsw.gov.au/resources/legislation/approvedmethods-water.pdf).	Provision of water quality monitoring is provided in WRM Report
WYONG SHIRE COUNCIL		
31.	Council's most significant concerns are in respect to the serious risk posed by any large scale extractive industry within the Dooralong and Yarramalong Valleys to the security of the Central Coast region's water supply. In addition, Council has grave concerns relating to the potential irreparable environmental damage which may be created by the proposed coal mine, including the failure of creek systems and resultant impact on flora and fauna.	Impacts of subsidence are provided in Section 6.2
WYONG SHIRE COUNCIL – FLORA & FAUNA IMPACTS		
	Issues:	
32.	□ Mining is a “key threatening process” for the extensive vegetation communities in the region that includes many threatened species.	

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	There are likely impacts arising on:	
	Wetlands.	
	Wildlife.	
	Corridors.	
	Threatened species, populations, endangered ecological communities and their habitats.	
	The development is likely to have far reaching impacts on vegetation beyond the immediate area of the mine head and stock piles, e.g. the complete rail loop of weeds, pests and diseases, altered hydrology.	
	(See #9 – Acoustic and vibration).	
	What is needed:	
	Results of flora and fauna surveys conducted within the last 5 years. Surveys must be conducted in accordance with Council's and the Office of Environment and Heritage's respective survey guidelines. The study area must include the entire extraction area, all servicing routes into and out of the project and receiving environments likely to be indirectly impacted by the proposal.	Chapter 5
	Ecological impact assessments prepared in accordance with State Threatened Species Assessment Guidelines.	Appendix H
	Conservation offsets that address the State offsetting principals and the latest version of the 'Biobanking Assessment Methodology and Credit Calculator Operation Manual'. Offsets should be located within the green corridor contained in the draft North Wyong Structure Plan.	The offset package has been prepared in compliance with the OEH offsetting principles. See Table 8.3
	A Conservation Assessment in accordance with Council's Development Control Plan Chapter 30- Wetlands.	Section 5.4
	Measures to mitigate the impact of the development, including (but not limited to) a vegetation management program, a wildlife management strategy, strategies to minimise habitat alteration due to subsidence/altered hydrology/fragmentation of	Chapter 8

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	wildlife corridors, and an ecological monitoring program for the lifetime of the project. Mitigation measures must be measurable and specify the timing and duration of implementation. Security for funding of mitigation measures for the lifetime of the project must be demonstrated.	
WYONG SHIRE COUNCIL – CUMULATIVE ASPECTS		
33.	Issues:	
	□ The collective effect of small impacts which individually may be acceptable could well prove to be unacceptable.	
	What is needed:	
	□ The application needs to ensure that the analysis combines all potential risks into a single analytical process.	This document has assessed all of the potential impacts of the project in one process
DIVISION OF RESOURCES & ENERGY – SUBSIDENCE PREDICTION		
34.	The EIS should identify if the predicted subsidence will result in fracture connectivity to the surface, and the environmental consequence to the ground surface, groundwater aquifers and groundwater dependant ecosystems of the predicted subsidence. Baseline assessment of the surface features above the proposed Extraction Areas must be sufficient to identify environmental features at risk, and appropriate setback or protection zones if necessary for sensitive features.	Impacts of subsidence are provided in Section 6.2
PREVIOUS SUBMISSIONS		
35.	Subsidence and the resulting degradation of the river systems will have a negative impact on the habitat of many endangered and threatened species, populations and ecological communities of State and National and in some cases International significance. Many of these species are protected by conservation acts and/or international treaty agreements.	This document comprises a detailed biodiversity assessment of the project that assesses the potential impact on these species, populations and communities
36.	Fugitive venting of coal seam gases from subsidence cracking presents an immediate threat to arboreal mammals, avian	This is not considered to be likely to occur

Table A.1 DGRs Directly and Indirectly Relevant to Ecological Assessment

ID	DGR	Section(s) in document where DGR addressed
	species, and raptors, in terrestrial habitats. As a result a high mortality rate is envisaged to occur within these contaminated pristine riparian areas.	
37.	W2CP have not presented any plausible determinations to deal with the serious situation (arising) for maintaining protection of Riparian Vegetation corridors which currently provide critical habitats, refuge areas, food and forage areas for terrestrial and aquatic wildlife species.	Riparian corridors will not be impacted by the project
38.	Have not considered the impact of the mine on groundwater dependent ecosystems	Section 6.6 addresses the potential impact on GDEs

Appendix B

Likelihood of Occurrence of Threatened and Migratory Species

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
Threatened Flora Species											
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	2		12	35	Confirmed
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	>50	+	77	140	Confirmed
Flora	*Asterolasia elegans*			E	Found in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to	Some suitable habitat					Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					gullies which support sheltered forest	present					
Flora	*Caladenia tessellata*	Thick Lip Spider Orchid	E1	V	Generally found in grassy sclerophyll woodland on clay loam or sandy soils	Some suitable habitat present				6	Possible
Flora	*Callistemon linearifolius*	Netted Bottle Brush	V		Grows in dry sclerophyll forest on the coast and adjacent ranges	Suitable habitat present			4	8	Possible
Flora	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	Grows in dry sclerophyll forest on the coast and adjacent ranges	Suitable habitat present	1			5	Confirmed
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	36	Possible
Flora	*Eucalyptus parramattensis*	Eucalyptus parramattensis	E2		Found in dry sclerophyll woodland on sandy soils in	Some suitable			58	60	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
	subsp. parramattensis	C. Hall. subsp. parramattensis in Wyong and Lake Macquarie local government areas			low, often wet sites	habitat present					
Flora	*Genoplesium insignis*	Variable Midge Orchid	E1		Grows in patches of *Themeda australis* (Kangaroo Grass) amongst shrubs and sedges in heathland and forest.	Suitable habitat present			1	3	Possible
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	~9		118	119	Confirmed
Flora	*Maundia*		V		Grows in swamps or shallow	Some			1	3	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
	triglochinoides				freshwater on heavy clay;	suitable habitat present					
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	2	+	100	364	Confirmed
Flora	*Pelargonium sp. Striatellum*	Omeo Stork's-bill		E	Known to occur in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes	No suitable habitat present					Unlikely
Flora	*Prostanthera junonis*	Somersby Mintbush	E1	E	Occurs in vegetation communities that are broadly classified as the Hawkesbury Sandstone complex in landscapes characterised by gently undulating to rolling	No suitable habitat present				4	Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					rises on weathered Hawkesbury Sandstone						
Flora	*Rhizanthella slateri*	Eastern Underground Orchid		E	The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available	Potential habitat present					Possible
Flora	*Rutidosis heterogama*	Heath Wrinklewort	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 openforest and woodland.	Some suitable habitat present			48	183	Possible
Flora	*Streblus pendulinus*	Sia's Backbone	E	E	Found chiefly along watercourses in well developed rainforest, gallery	Potential habitat present					Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					forest and drier, more seasonal rainforest						
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	72	Possible
Flora	*Tetratheca glandulosa*	Glandular Pink-bell	V	V	Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches.	No suitable habitat present				12	Unlikely
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-	Suitable habitat present	>50	+	116	192	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					loam soils, low nutrients; and clayey soil from conglomerates						
Flora	*Thelymitra sp. adorata*	Wyong Sun Orchid	E4A		The species occurs in woodland with grassy understorey in well-drained clay loam or shale derived soils	Suitable habitat present			5	18	Possible
Threatened and Migratory Fauna Species											
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	3	+	38	103	Confirmed
Amphibia	*Heleioporus australiacus*	Giant Burrowing Frog	V	V	Inhabits heath, woodland and open forest with sandy soils. Generally lives in the heath or	Suitable habitat present				47	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					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	10	Confirmed
Amphibia	*Litoria brevipalmata*	Green-thighed Frog	V		Found in rainforests, wet sclerophyll forests and swamp forests	Suitable habitat present		+	5	22	Confirmed
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 is not associated with any specific vegetation	Suitable habitat present			0	15	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					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	107	Possible
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	3		10	10	Confirmed
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			5	60	Unlikely
Aves	*Anthochaera phrygia*	Regent Honeyeater	E4A	M,E	Patchy distribution in NSW and confined to two main breeding areas and	Some suitable habitat				14	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					fragmented woodland. Strongly nomadic in response to 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.	present					
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	7	Possible
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			1	3	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
Aves	*Calidris ferruginea*	Curlew Sandpiper	E1	M,C,J,K	Generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts	No suitable habitat present			2	34	Unlikely
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	Suitable habitat present			6	53	Possible
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-	Suitable habitat present	4	+	24	121	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					oak or Drooping She-oak occur. Dependent on large hollow-bearing eucalypts for nest sites.						
Aves	*Chthonicola sagittata*	Speckled Warbler	V		Typical habitat would include large, relatively undisturbed remnants of scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	Some marginal habitat present			1	1	Possible but unlikely
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	5	+	10	35	Confirmed
Aves	*Dasyornis brachypterus*	Eastern Bristlebird		E	Inhabits low dense vegetation in a broad range of habitat	Potential habitat					Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					types including sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest	present					
Aves	*Ephippiorhynchus asiaticus*	Black-necked Stork	E1		Inhabit permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries.	Some suitable habitat present		+	12	37	Confirmed
Aves	*Epthianura albifrons*	White-fronted Chat	V		Found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas	Some marginal habitat present					Confirmed
Aves	*Erythrotriorchis*	Red Goshawk		V	Inhabits a variety of forests	Potential					Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
	radiatus				and woodlands, including eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins. Requires areas with large prey populations (birds) and permanent water.	habitat present					
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	1	+	6	38	Confirmed
Aves	*Grantiella picta*	Painted Honeyeater	V		Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests.	Some suitable habitat			3	24	Possible but unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					Specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	present					
Aves	*Haematopus longirostris*	Pied Oystercatcher	E1		Favours intertidal flats of inlets and bays, open beaches and sandbanks	No suitable habitat present			2	39	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	1	+	3	8	Confirmed
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 water surface.	No suitable habitat present			2	5	Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
Aves	*Ixobrychus flavicollis*	Black Bittern	V		Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation	Suitable habitat present		+	2	19	Confirmed
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		+		2	Confirmed
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	3	Possible
Aves	*Ninox strenua*	Powerful Owl	V		Inhabits a range of vegetation	Suitable	3	+	19	90	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.	habitat present					
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	Potential habitat present			1	16	Possible but unlikely
Aves	*Petroica boodang*	Scarlet Robin	V		Found in dry eucalypt forests and woodlands with open, grassy understorey with few scattered shrubs. Occurs in both mature and regrowth vegetation and occasionally in	Some marginal habitat present			1	2	Possible but unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					malleor wet forest communities, or in wetlands and tea-tree swamps.						
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			1	1	Possible but unlikely
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.	Potential habitat present			1	2	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	Potential habitat present			1	5	Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.						
Aves	*Sternula nereis nereis*	Fairy Tern		V	Found in embayments of a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands and mainland coastline	No suitable habitat present					Unlikely
Aves	*Tyto novaehollandiae*	Masked Owl	V		Lives in dry eucalypt forests and woodlands from sea level to 1100m.	Suitable habitat present	1	+	10	27	Confirmed
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	4	+	3	45	Confirmed
Aves (Migratory)	*Apus pacificus*	Fork-tailed Swift		M,C,J,K	Non-breeding visitor to all parts of Australia. Mostly	Some suitable			2	11	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					found over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh of inland plains	habitat present					
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
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		+	16	57	Confirmed
Aves	*Gallinago*	Latham's		M,C,J,K	Inhabit permanent and	Some		+	3	17	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
(Migratory)	*hardwickii*	Snipe			ephemeral open, freshwater wetlands with low, dense vegetation and areas of mud which are either exposed or beneath a very shallow covering of water.	suitable habitat present					
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	3	+	8	105	Confirmed
Aves (Migratory)	*Hirundapus caudacutus*	White-throated Needletail		M,C,J,K	Non-breeding visitor to Australia. Occur over most types of habitat, particularly above wooded areas including open forest and rainforest, between trees or in	Some suitable habitat present	2	+	8	51	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					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,E	Inhabit open eucalypt forests and woodlands, including box–ironbark communities, and farmland with remnant patches of eucalypt woodland.	Suitable habitat present			2	118	Possible
Aves (Migratory)	*Merops ornatus*	Rainbow Bee-eater		M,J	Inhabit healthland, 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 lightly-timbered areas located in close proximity to permanent	Suitable habitat present			1	4	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					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	4				Confirmed
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					Possible
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	4	Confirmed
Aves (Migratory)	*Rhipidura rufifrons*	Rufous Fantail		M,B	Found in rainforest, dense wet eucalypt and monsoon	Suitable habitat	2	+			Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					forests, paperbark and mangrove swamps and riverside vegetation	present					
Aves (Migratory)	*Rostratula australis*	Australian Painted Snipe		M,V	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					Possible
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	1			16	Confirmed
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	Suitable habitat present			3	4	Possible

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					workings frequenting low to mid-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	42	Confirmed
Mammalia	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows.	Suitable habitat present	7	+	5	49	Confirmed
Mammalia	*Kerivoula papuensis*	Golden-tipped Bat	V		Typically inhabit rainforest and adjacent wet and dry	Suitable habitat			10	48	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					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.	present					
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	4	+	10	47	Confirmed
Mammalia	*Miniopterus schreibersii*	Eastern Bentwing-bat	V		Caves are the primary roosting habitat, but also use	Suitable habitat	1	+	31	118	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
	oceanensis				derelict mines, storm-water tunnels, buildings and other man-made structures	present					
Mammalia	*Mormopterus norfolkensis*	East Coast 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	1	+	18	45	Confirmed
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	2	+	9	48	Confirmed
Mammalia	*Petaurus australis*	Yellow-bellied Glider	V		Inhabit tall mature eucalypt forest generally in areas with	Suitable habitat	12	+	68	270	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					high rainfall and nutrient rich soils. Highly mobile with large home ranges (20-85 ha) to encompass dispersed and seasonally variable forage resources.	present					
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	3	+	59	147	Confirmed
Mammalia	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E1	V	Inhabit rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves	No suitable habitat present				2	Unlikely

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
					and ledges facing north.						
Mammalia	*Phascolarctos cinereus*	Koala	V	V	Inhabit eucalypt woodlands and 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.	Suitable habitat present			10	36	Possible
Mammalia	*Potorous tridactylus*	Long-nosed Potoroo	V	V	Inhabits dry/wet sclerophyll forests or coastal heaths with dense understorey and occasional open areas	Potential habitat present				2	Possible but unlikely
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				265	Unlikely
Mammalia	*Pteropus*	Grey-headed	V	V	Occur in subtropical and	Suitable	7		17	66	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
	poliocephalus	Flying-fox			temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops	habitat present					
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	1	+	3	4	Confirmed
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	4	+	16	72	Confirmed

Table B.1 Likelihood of Occurrence of Threatened and Migratory Species within the Study Area

Class	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat requirements	Habitat availability	OzArk surveys	ERM/ BHP surveys	BioNet Records (10 km locality)	Bionet Records (Wyong LGA)	Likelihood of occurrence (Unlikely, Possible but unlikely, Possible, confirmed)
Reptilia	*Hoplocephalus bungaroides*	Broad-headed Snake	E1	V	Inhabits rock crevices and under flat sandstone rocks on exposed 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.	No suitable habitat present			1	1	Unlikely
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	8	Possible

Appendix C

Previous Commissioned Studies - Threatened Species

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
ERM 1998a - Flora/Fauna Assessment of Precinct 15; Mar & Nov 1998	Tooheys Road Area, Hue Hue Road Offset Area	*Angophora inopina* (Charmhaven Apple)	*Rhipidura rufifrons* (Rufous Fantail)	*Eucalyptus camfieldii* (Camfield's Stringybark)	*Ixobrychus flavicollis* (Black Bittern)
		Tetratheca juncea (Black-eyed Susan)	*Petaurus norfolcensis* (Squirrel Glider)	*Cryptostylis hunteriana* (Leafless Tongue Orchid)	*Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat)
			Miniopteris australis (Little Bent-wing Bat)		*Dasyurus maculatus* (Spotted-tailed Quoll)
			Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)		*Phascolarctos cinereus* (Koala)
ERM 1998b - Flora/Fauna assessment of Precinct 15 and Pioneer Dairy	Tooheys Road Area, Hue Hue Road Offset Area	*Angophora inopina* (Charmhaven Apple)	*Crinia tinnula* (Wallum Froglet)		
		Tetratheca juncea (Black-eyed Susan)	*Epthianura albifrons* (White-fronted Chat)		
			Limosa limosa (Black-tailed Godwit)		
			Petaurus norfolcensis		

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
			(Squirrel Glider) *Miniopterus australis* (Little Bentwing Bat) *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) *Myotis macropus* (Southern Myotis) *Calyptorhynchus lathami* (Glossy Black-Cockatoo) *Ephippiorhynchus asiaticus* (Black-necked Stork)		
ERM 1999 - WACJV Proposed Surface Facilities F/F Assessment	Tooheys Road Area	*Angophora inopina* (Charmhaven Apple) *Tetratheca juncea* (Black-eyed Susan)	*Crinia tinnula* (Wallum Froglet) *Daphoenositta chrysoptera* (Varied Sittella) *Tyto novaehollandiae* (Masked Owl)		

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
			Petaurus norfolcensis (Squirrel Glider) *Miniopteris australis* (Little Bentwing Bat) *Myotis macropus* (Southern Myotis) Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat) Scoteanax rueppellii (Greater Broad-nosed Bat)		
ERM 2002 - Flora and Fauna Review	Tooheys Road Area, Hue Hue Road Offset Area	*Angophora inopina* (Charmhaven Apple)	*Crinia tinnula* (Wallum Froglet)	*Acacia bynoeana* (Bynoe's Wattle)	*Crinia tinnula* (Wallum Froglet)
		Tetratheca juncea (Black-eyed Susan)	*Calyptorhynchus lathami* (Glossy Black-Cockatoo)	*Cryptostylis hunteriana* (Leafless Tongue Orchid)	*Heleioporus australiacus* (Giant Burrowing Frog)
			Ephippiorhynchus asiaticus (Black-necked Stork)	*Melaleuca biconvexa* (Biconvex Paper bark)	*Litoria aurea* (Green and Golden Bell Frog)
			Ixobrychus flavicollis (Black	*Genoplesium insignis*	*Litoria brevipalmata* (Green-

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
			Bittern) *Ninox strenua* (Powerful Owl) *Tyto novaehollandiae* (Masked Owl) *Petaurus australis* (Yellow-bellied Glider) *Petaurus norfolcensis* (Squirrel Glider) *Miniopterus australis* (Little Bentwing Bat) *Myotis macropus* (Southern Myotis) *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) *Scoteanax rueppellii* (Greater Broad-nosed Bat)		thighed Frog) *Mixophyes balbus* (Stuttering Frog) *Mixophyes iteratus* (Giant Barred Frog) *Botaurus poiciloptilus* (Australasian Bittern)
ERM 2003 - Western Area	Extraction Area	*Melaleuca biconvexa*	*Mixophyes iteratus* (Giant	*Acacia bynoeana* (Bynoe's	*Crinia tinnula* (Wallum Froglet)

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
Summer surveys		(Biconvex Paper bark)	Barred Frog)	Wattle)	
			Ardea ibis (Cattle Egret)	*Grevillea parviflora ssp parviflora* (Small-flower Grevillea)	*Litoria aurea* (Green and Golden Bell Frog)
			Glossopsitta pusilla (Little Lorikeet)		*Mixophyes balbus* (Stuttering Frog)
			Rhipidura rufifrons (Rufous Fantail)		*Botaurus poiciloptilus* (Australasian Bittern)
			Mormopterus norfolkensis (East-coast Freetail Bat)		*Ephippiorhynchus asiaticus* (Black-necked Stork)
			Myotis macropus (Southern Myotis)		*Ixobrychus flavicollis* (Black Bittern)
					Gallinago hardwickii (Latham's Snipe)
BHP 2002 - Concept Study Extraction Area		*Melaleuca biconvexa* (Biconvex Paperbark)	*Litoria aurea* (Green and Golden Bell Frog)	*Syzygium paniculatum* (Magenta Lilly-Pilly)	
		Tetratheca juncea (Black-eyed Susan)	*Litoria brevipalmata* (Green-thighed Frog)	*Tetratheca glandulosa* (Glandular Pink-bell)	

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
			Ephippiorhynchus asiaticus (Black-necked Stork) *Ixobrychus flavicollis* (Black Bittern) *Tyto novaehollandiae* (Masked Owl) *Tyto tenebricosa* (Sooty Owl) *Dasyurus maculatus* (Spotted-tailed Quoll) *Petaurus australis* (Yellow-bellied Glider) *Petaurus norfolcensis* (Squirrel Glider) *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)		
BHP 2003 - Feasibility report	Infrastructure Areas	*Angophora inopina* (Charmhaven Apple) *Tetratheca juncea*	*Crinia tinnula* (Wallum Froglet) *Tyto novaehollandiae*	*Acacia bynoeana* (Bynoe's Wattle) *Cryptostylis hunteriana*	

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
		(Black-eyed Susan)	(Masked Owl)	(Leafless Tongue Orchid)	
			Petaurus norfolcensis (Squirrel Glider)	*Genoplesium insignis*	
			Myotis macropus (M. adversus) (Southern Myotis)		
	Extraction Area	*Melaleuca biconvexa* (Biconvex Paperbark)	*Litoria aurea* (Green and Golden Bell Frog)	*Syzygium paniculatum* (Magenta Lilly-Pilly)	*Anthochaera phrygia* (Regent Honeyeater)
		Tetratheca juncea (Black-eyed Susan)	*Litoria brevipalmata* (Green-thighed Frog)		
			Ephippiorhynchus asiaticus (Black-necked Stork)		
			Ixobrychus flavicollis (Black Bittern)		
			Tyto novaehollandiae (Masked Owl)		
			Tyto tenebricosa (Sooty Owl)		
			Dasyurus maculatus		

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
			(Spotted-tailed Quoll)		
			Petaurus australis (Yellow-bellied Glider)		
Unreported surveys	Study Area	*Angophora inopina* (Charmhaven Apple)	*Crinia tinnula* (Wallum Froglet)		
		Melaleuca biconvexa (Biconvex Paperbark)	*Ardea alba* (Great Egret)		
			Ardea ibis (Cattle Egret)		
			Daphoenositta chrysoptera (Varied Sittella)		
			Ephippiorhynchus asiaticus (Black-necked Stork)		
			Gallinago hardwickii (Latham's Snipe)		
			Glossopsitta pusilla (Little Lorikeet)		
			Haliaeetus leucogaster (White-bellied Sea-eagle)		
			Hieraaetus morphnoides		

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area	Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna
			(Little Eagle) *Hirundapus caudacutus* (White-throated Needletail) *Ixobrychus flavicollis* (Black Bittern) *Plegadis falcinellus* (Glossy Ibis) *Tyto novaehollandiae* (Masked Owl) *Petaurus australis* (Yellow-bellied Glider) *Petaurus norfolkensis* (Squirrel Glider) *Minopterus australis* (Little Bentwing Bat) *Myotis macropus* (Southern Myotis) *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)		

Table C.1 Recorded and Potentially Occurring Threatened Species from Previous Commissioned Studies

Study	Relevant Project Area		Recorded threatened Species		Potential Threatened Species	
		Flora	Fauna	Flora	Fauna	
			Scoteanax rueppellii (Greater Broadnosed Bat)			

Appendix D

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D.1 Survey guidelines and species specific publications utilised by OzArk Pty. Ltd. to guide field surveys

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Appendix E

Recorded Flora Species

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats						OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Toohey's Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Toohey's Road	Meander - Buttonderry	Meander - Hue Hue Road
Acacia brownii		+												
Acacia decurrens											+			
Acacia falcata		+												
Acacia implexa				+							+			
Acacia irrorata subsp. irrorata	+			+										
Acacia longifolia subsp. longifolia		+	+		+									
Acacia myrtifolia									+					
Acacia schinoides								+						
Acacia suaveolens		+			+									
Acacia suaveolens (shrub)									+					
Acacia terminalis subsp. longiaxialis		+												
Acacia ulicifolia				+										
Acrotriche divaricata									+					
Actinotus helianthi		+												
Actinotus minor		+			+				+					

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Adiantum aethiopicum		+			+					+				
Adiantum formosum								+						
Adiantum hispidulum								+		+				
*Ageratina adenophora**		+												
Allocasuarina littoralis	+	+	+	+	+							+		
Allocasuarina paludosa?									+					
Allocasuarina torulosa		+		+						+				
Allocasuarina torulosa (shrub)										+				
Allocasuarina torulosa (small tree)										+				
*Anagallis arvensis**		+								+				
*Andropogon virginicus**		+								+	+			
Angophora costata		+		+	+							+	+	
Angophora costata (shrub)										+				
Angophora floribunda		+												
Angophora inopina		+	+							+		+		

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Anisopogon avenaceus	+	+	+											
Aristida vagans	+	+		+	+									
Aristida warburgii		+	+		+									
Arthrochilus prolixus							+							
Arthropodium minus		+												
Asplenium australasicum								+						
Astrotricha latifolia								+						
Austrodanthonia setacea		+												
Austrodanthonia sp									+					
Austrodanthonia tenuior		+		+					+			+		
Austrostipa pubescens					+							+		
Austrostipa ramosissima		+												
Austrostipa scabra subsp. falcata	+													
Austrostipa verticillata				+										
*Axonopus fissifolius**		+			+				+		+	+		

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Azolla pinnata												+			
Backhousia myrtifolia								+							
Baeckea diosmifolia		+													
Banksia cunninghamii ssp. cunninghamii									+						
Banksia oblongifolia		+	+		+					+			+		
Banksia robur									+						
Banksia serrata		+													
Banksia spinulosa var. collina		+			+										
Banksia spinulosa var.spinulosa									+						
Bauera rubioides									+						
Baumea articulata									+						
Baumea juncea															+
Baumea rubiginosa									+						
*Bidens pilosa**									+						
Billardiera scandens		+		+	+					+					

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Toohey's Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Toohey's Road	Meander - Buttonderry	Meander - Hue Hue Road
Blandfordia grandiflora							+							
Blechnum ambiguum								+						
Blechnum aspera										+				
Boronia polygalifolia		+		+										
Bossiaea ensata		+												
Bossiaea heterophylla		+							+	+				
Bossiaea obcordata		+							+					
Bossiaea prostrata	+	+												
Bossiaea rhombifolia subsp. rhombifolia		+												
Bossiaea scolapendria								+						
Brachyscome linearifolia		+												
Breynia oblongifolia		+							+	+				
*Briza minor**									+					
Briza subaristata												+		
Brunoniella australis	+	+		+										

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology						
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Brunoniella pumilio		+												
Burchardia umbellata		+			+				+					
Bursaria longisepala		+		+										
Bursaria spinosa	+	+		+										
Caesia parviflora var. parviflora		+												
Caesia parviflora var. vittata		+												
Caladenia catenata	+													
Callistemon citrinus		+												
Callistemon linearis		+							+					
Callistemon salignus		+										+		
Callistemon shiressii								+		+				
Calochilus paludosus		+												
Calochilus robertsonii						+								
Calochlaena dubia		+		+	+									
Carex appressa?											+			

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Carex longebrachiata										+					
Cassinia uncata	+	+		+											
Cassytha glabella f. glabella		+	+		+										
Caustis flexuosa									+						
*Centaurium tenuiflorum**										+					
Centella asiatica		+		+	+					+		+			
Centella cordifolia		+													
Ceratopetalum apetalum								+							
Ceratopetalum gummiferum					+										
Cheilanthes sieberi subsp. sieberi		+		+						+					
Choricarpia leptopetala								+		+					
Chorizandra cymbaria		+													
*Chrysanthemoides monilifera subsp. rotundata**						+									
*Cinnamomum camphora**										+		+			

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
*Cirsium vulgare**									+		+			
Cissus antarctica								+		+				
Cissus hypoglauca								+	+					
Citriobatus pauciflorus									+					
Claoxylon australe								+						
Clematis aristata									+					
Clerodendrum tomentosum								+						
Comesperma ericinum		+			+							+		
Comesperma sphaerocarpum		+			+									
Commelina cyanea											+			
Commersonia fraseri								+						
Conyza bonariensis									+					
*Conyza sp.**														
Corymbia gummifera		+			+							+		
Corymbia gummifera (shrub)									+					

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Corymbia maculata	+	+		+						+					
Corymbia maculata (shrub)										+					
Corymbia maculata (small tree)										+					
*Cotula coronopifolia**						+									
Cryptandra ericoides									+						
Cryptostylis erecta							+								
Cryptostylis hunteriana		+													
Cryptostylis subulata		+													
Cyathochaeta diandra		+	+		+					+			+		
Cymbidium suave		+													
Cymbopogon refractus				+						+					
Cynodon dactylon								+		+		+			
*Cyperus brevifolius**										+					
Cyperus caespiticus										+					
Cyperus eragrostis												+			

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Cyperus polystachyos									+	+					
Cyperus sp										+					
Dampiera stricta		+	+							+					
Daviesia genistifolia									+						
Daviesia squarrosa		+			+					+					
Daviesia ulicifolia subsp. ulicifolia	+	+		+						+					
Daviesia umbellulata				+											
Dendrophthoe vitellina		+		+						+					
Desmodium rhytidophyllum		+		+						+					
Deyeuxia parviseta var. parviseta		+													
Deyeuxia quadriseta		+													
Dianella caerulea var. assera	+	+		+	+										
Dianella caerulea var. caerulea		+													
Dianella caerulea var. producta									+						
Dianella revoluta var. revoluta		+		+	+					+					

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology								
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road			
Dichelachne micrantha		+		+	+					+				+				
Dichelachne rara										+								
Dichondra repens		+																
Dichopogon fimbriatus?									+									
Digitaria diffusa		+																
Digitaria parviflora									+									
Digitaria ramularis				+														
Dillwynia glaberrima									+									
Dillwynia parviflora													+					
Dillwynia retorta		+			+					+								
Dioscorea transversa								+		+								
Diospyros australis								+		+								
Diploglottis cunninghamii								+										
Dipodium punctatum		+		+														
Diuris alba						+												

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats						OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology						
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Diuris aurea						+									
Dodonaea triquetra		+			+										
Doodia aspera								+							
Drosera auriculata		+													
Drosera peltata									+						
Drosera pygmaea													+		
Echinopogon caespitosus var. caespitosus		+								+					
Echinopogon ovatus		+													
Elaeocarpacus reticulatus									+		+				
Eleocharis sphacelata													+		
Embelia australiana								+							
Empodisma minus		+													
Entolasia stricta	+	+	+	+	+					+			+		
Epacris microphylla					+								+		
Epacris obtusifolia									+						

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Species name	OzArk Quadrats					OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology					
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Epacris pulchella		+	+	+	+				+					
Epaltes australis		+		+	+									
Epaltes sp									+					
Eragrostis brownii		+	+	+	+									
Eragrostis leptostachya		+												
Eragrostis sp.									+					
Eucalyptus acmenoides								+	+					
Eucalyptus acmenoides (small tree)									+					
Eucalyptus amplifolia subsp. amplifolia		+												
Eucalyptus capitellata		+			+				+			+		
Eucalyptus deanei								+	+		+			
Eucalyptus fergusonii subsp. dorsiventralis								+						
Eucalyptus fibrosa	+	+		+										
Eucalyptus globoidea	+	+		+										
Eucalyptus haemastoma		+	+		+							+		

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Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Eucalyptus haemastoma (Shrub)										+					
Eucalyptus paniculata										+					
Eucalyptus pilularis					+										
Eucalyptus placita								+							
Eucalyptus punctata				+											
Eucalyptus racemosa		+													
Eucalyptus resinifera subsp. resinifera		+		+	+								+	+	
Eucalyptus robusta		+									+	+			
Eucalyptus saligna								+				+			
Eucalyptus siderophloia				+											
Eucalyptus tereticornis												+			
Eucalyptus umbra	+	+		+											
Euchiton sp.										+					
Eustrephus latifolius	+			+											
Gahnia aspera														+	

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats						OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
	2005	2006	2007	2009	2011	Toohey's Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Toohey's Road	Meander - Buttonderry	Meander - Hue Hue Road	
Gahnia clarkei		+		+	+					+			+			
Gahnia radula		+		+	+											
Gahnia sieberana										+						
Gamochaeta purpurea (formerly Gnaphalium americanum)										+			+			
Geitonoplesium cymosum										+	+					
Genoplesium fimbriatum							+									
Gleichenia dicarpa						+							+			
Glochidion ferdinandi var. ferdinandi		+			+					+	+					
Glycine clandestina	+	+		+	+											
Glycine microphylla		+												+		
Glycine tabacina				+												
Gnaphalium sp.										+						
Gompholobium glabratum		+														
Gompholobium grandiflorum										+						

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	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Gompholobium latifolium		+												
Gompholobium pinnatum		+	+		+				+					
Gonocarpus micranthus subsp. ramosissimus		+			+				+			+		
Gonocarpus tetragynus	+	+		+	+				+				+	
Gonocarpus teucrioides									+					
Goodenia bellidifolia subsp. bellidifolia		+	+		+				+					
Goodenia hederacea subsp. hederacea		+												
Goodenia heterophylla subsp. heterophylla	+	+		+					+				+	
Goodenia paniculata									+					
Grevillea parviflora subsp. parviflora				+										
Grevillea sericea subsp. sericea		+	+	+	+									
Grevillea speciosa									+	+				
Guioa semiglauca										+				
Gymnostachys anceps								+		+				

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

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	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Haemodorum planifolium									+						
Hakea bakeriana		+													
Hakea dactyloides									+						
Hakea laevipes subsp. laevipes		+	+		+					+					
Hakea sericea		+													
Hakea teretifolia									+				+		
Hardenbergia violacea	+	+		+											
Hemarthria uncinata var. uncinata		+												+	
Hibbertia aspera subsp. aspera		+													
Hibbertia dentata					+										
Hibbertia empetrifolia subsp. empetrifolia		+													
Hibbertia obtusifolia										+					
Hibbertia pedunculata		+		+											
Hibbertia riparia										+					
Hibbertia rufa?									+						

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Hibbertia scandens		+													
Hibbertia vestita		+	+		+										
Hibiscus heterophyllus subsp. heterophyllus								+							
Hovea linearis		+													
Hovea purpurea									+						
Hybanthus monopetalus		+		+											
Hydrocotyle laxiflora		+		+	+										
*Hydrocotyle sibthorpioides**		+			+										
Hydrocotyle tripartita		+			+										
Hypericum gramineum	+	+								+			+		
Hypericum japonicum										+					
*Hypochaeris radicata**		+								+			+		
Imperata cylindrica		+		+	+					+					
Isopogon anemonifolius		+	+												
Joycea pallida	+	+		+	+										

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Species name	2005	2006	2007	2009	2011	Toohey's Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Toohey's Road	Meander - Buttonderry	Meander - Hue Hue Road
Juncus ?krausii, caespiticius												+			
*Juncus cognatus**		+								+			+		
Juncus continuus					+					+		+	+		
Juncus planifolius									+	+					
Juncus prismocarpus									+						
Juncus sp										+					
Juncus subsecundus		+													
Kunzea ambigua						+				+					+
Kunzea capitata		+													
Lachnagrostis filiformis		+													
Lachnagrostis sp.										+					
Lagenophora stipitata	+	+		+											
Lambertia formosa		+	+		+					+			+		
*Lantana camara**								+							
Laxmannia gracilis		+		+											

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Species name	OzArk Quadrats					OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Lepidosperma concavum		+												
Lepidosperma elatius								+						
Lepidosperma gunnii	+													
Lepidosperma laterale		+		+										
Lepidosperma quadrangulatum									+					
Lepidosperma urophorum									+			+		
Leptocarpus tenax									+					
Leptospermum continentale									+					
Leptospermum juniperinum		+			+				+					
Leptospermum laevigatum									+					
Leptospermum petersonii						+								
Leptospermum polygalifolium subsp. cismontanum		+	+		+				+					
Leptospermum trinervium		+	+		+				+					
Lepyrodia muelleri		+												

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Lepyrodia scariosa		+	+		+					+			+		+
Leucopogon attenuatus		+													
Leucopogon esquamatus		+	+							+			+		
Leucopogon juniperinus										+					
Leucopogon lanceolatus var. lanceolatus	+										+				
Leucopogon microphyllous									+						
Lindsaea linearis		+	+		+					+					
Lindsaea microphylla				+						+					
Lissanthe strigosa subsp. strigosa				+											
Lissanthe strigosa subsp. subulata		+													
Livistona australis		+			+										
Lobelia anceps		+											+		
Lobelia gibbosa							+								
Lobelia sp.													+		
Logania albiflora					+										

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals		ERM surveys	Cumberland Ecology						
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Logania pusilla		+		+										
Lomandra confertifolia subsp. pallida	+	+		+										
Lomandra confertifolia subsp. rubiginosa								+						
Lomandra cylindrica		+		+	+									
Lomandra filiformis subsp. coriacea		+		+										
Lomandra filiformis subsp. filiformis	+	+		+					+					
Lomandra glauca		+							+					
Lomandra longifolia	+	+		+	+				+			+		
Lomandra multiflora subsp. multiflora	+	+		+					+					
Lomandra obliqua		+		+	+									
Lomatia silaifolia		+												
*Lotus corniculatus**									+					
Ludwigia peploides											+			
Macrozamia flexuosa							+							
Macrozamia reducta							+							

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Macrozamia spirilis									+						
Marsdenia flavescens								+							
Maytenus silvestris		+								+					
Melaleuca decora		+		+											
Melaleuca erubescens						+									
Melaleuca linariifolia		+			+							+		+	
Melaleuca nodosa	+	+	+	+	+					+				+	
Melaleuca quinquenervia												+			+
Melaleuca sieberi		+	+		+					+				+	
Melaleuca stypheliioides	+	+		+								+			
Melaleuca thymifolia		+			+										
Melichrus procumbens		+			+										
Melicope micrococca								+		+					
Microlaena stipoides var. stipoides	+	+		+	+					+					
Mirbelia rubiifolia		+			+					+					

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Mitrasacme polymorpha		+			+					+					
Monotoca scoparia		+		+						+					
Morinda jasminoides		+								+					
Myrsine variabilis										+					
Notelaea longifolia f. longifolia		+													
Notodanthonia longifolia		+													
Olearia tormentosa											+				
Opercularia diphylla		+		+											
Opercularia varia	+	+			+										
Oplismenus aemulus										+					
Oplismenus imbecillis		+			+										
Orthoceras strictum							+								
Ottelia ovalifolia ssp ovalifolia												+			
Oxalis perennans	+	+		+											
Ozothamnus diosmifolius									+						

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

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Pandorea pandorana		+								+					
Panicum bicolor									+						
Panicum simile	+	+	+	+	+					+					
Parsonsia straminea		+									+				
Parsonsia straminea (juvenile)										+					
Paspalidium aversum					+										
Paspalidium distans		+		+	+									+	
Paspalum dilatatum										+					
Paspalum orbiculare									+						
Paspalum radiatum									+						
*Paspalum urvillei**								+							
*Passiflora edulis**								+							
Patersonia glabrata		+			+										
Patersonia longifolia									+						
Patersonia sericea		+	+	+	+					+					

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Pellaea falcata						+								
Pellaea paradoxa										+				
Persicaria hydropiper/strigosa?											+			
Persicaria lapathifolia											+			
Persicaria praetermissa											+			
Persoonia levis		+			+									
Persoonia linearis	+	+		+	+					+				
Petrophile pulchella		+		+	+					+		+		
Petrophile sp.									+					
Phragmites australis									+					
Phylidrum lanuginosum									+			+		+
Phyllanthus hirtellus		+		+	+									
Pimelea linifolia subsp. linifolia		+	+							+				
Pittosporum multiflorum								+						
Pittosporum revolutum										+				

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology							
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Pittosporum sp										+					
Pittosporum undulatum						+									
*Plantago lanceolata**										+			+		
Platysace ericoides		+		+	+										
Platysace lanceolata									+						
Platysace linearifolia		+													
Plectranthus parviflorus								+							
Plinthanthesis paradoxa		+													
Poa affinis		+			+										
*Poa annua**										+					
Poa labillardierei var. labillardierei		+		+						+					
Podolobium ilicifolium		+		+											
Podolobium scandens	+	+		+											
Podolobium sp										+					
Polygala sp													+		

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Polymeria calycina				+											
*Polypogon monspeliensis**									+						
Polyscias sambucifolia									+		+				
Polystichum australiense								+							
Pomax umbellata					+										
Poranthera ericifolia		+													
Prasophyllum elatum						+									
Pratia purpurascens	+	+		+											
Pseuderanthemum variabile										+					
Pteridium esculentum					+					+					
Ptilothrix deusta		+	+	+	+					+					
Ptilothrix sp.										+					
Pultenaea daphnoides									+						
Pultenaea elliptica									+						
Pultenaea ferruginea		+													

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology							
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Pultenaea paleacea		+	+		+										
Pultenaea polifolia									+						
Pultenaea retusa				+						+					
Pultenaea stipularis									+						
Pultenaea tuberculata		+	+	+	+										
Ranunculus inundatus		+										+			
Ranunculus plebeius		+													
Restio fastigiatus									+						
Rhodamnia rubescens								+			+				
Romulea rosea										+					
Rubus moluccanus var. trilobus								+							
Rubus sp.											+				
Sacciolepis indica									+						
Sarcopetalum harveyanum											+				
Scaevola ramosissima		+													

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Schizaea bifida		+			+										
Schoenoplectus mucronatus									+						
Schoenus apogon		+								+			+		
Schoenus brevifolius		+													
Schoenus melanostachys									+						
Schoenus paludosus									+						
Selaginella uliginosa		+													
*Senecio madagascariensis**										+		+	+		
Senecio prenanthoides				+											
*Sida rhombifolia**										+					
Sisymbrium sp										+					
Sisyrinchium iridiflolium										+					
Smilax australis								+		+					
Smilax glyciphylla					+										
*Solanum mauritianum**									+						

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
*Sonchus oleraceus**									+						
Sowerbaea juncea						+									
Sphaerolobium minus		+													
Spirodela sp.												+			
Sporobolus indicus										+					
Sprengelia incarnata									+						
Stackhousia nuda		+								+					
Stenocarpus salignus								+							
Stenotaphrum secundatum													+		
Stephania japonica var. discolor								+							
Sticherus flabellatus									+						
Stylidium graminifolium		+			+					+					
Syncarpia glomulifera (small tree)										+					
Syncarpia glomulifera subsp. glomulifera		+		+	+					+					
Synoum glandulosum subsp. glandulosum								+							

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

	OzArk Quadrats					OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology					
Species name	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
*Taraxacum officinale**		+													
Tetratheca juncea		+													
Thelionema caespitosum						+									
Thelymitra ixioides var. ixioides			+												
Thelymitra pauciflora						+									
Themeda australis	+	+		+	+					+			+	+	
Thysanotus tuberosus subsp. tuberosus		+								+					
Trachymene incisa subsp. incisa		+			+										
Tricoryne elatior		+		+											
Tricoryne simplex						+									
Trifolium repens										+					
Triglochin procera												+			
Triglochin rheophilum												+			
Trochocarpa laurina								+							
Trophis scandens										+					

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats					ERM surveys	OzArk Meanders/Incidentals		Cumberland Ecology						
	2005	2006	2007	2009	2011		Toohey's Road	Buttonderry	Western Shaft	2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Toohey's Road	Meander - Buttonderry	Meander - Hue Hue Road
Typha orientalis						+									
Vernonia cinerea var. cinerea		+		+						+					
Villarsia exaltata		+													
Viola betonicifolia subsp. betonicifolia		+		+											
Viola hederacea		+			+										
*Vulpia muralis**										+			+		
Wahlenbergia communis				+											
Wilkiea huegeliana									+						
Xanthorrhoea fulva		+													
Xanthorrhoea latifolia subsp. latifolia		+	+	+	+					+					
Xanthorrhoea macronema	+			+											
Xanthorrhoea media ssp. media						+				+			+		
Xanthorrhoea resinosa		+													
Xanthorrhoea sp										+					
Xanthosia tridentata		+													

Table E.1 Flora species Recorded in the Study Area and Surrounding Locality

Species name	OzArk Quadrats						OzArk Meanders/Incidentals			ERM surveys	Cumberland Ecology						
	2005	2006	2007	2009	2011	Tooheys Road	Buttonderry	Western Shaft		2012 quadrats	Meander - Western Shaft	Meander – Honeysuckle park Park	Meander - Tooheys Road	Meander - Buttonderry	Meander - Hue Hue Road
Xylomelum pyriforme		+													
Xyris gracilis					+										
Xyris operculata										+					
Xyris sp.															
Zieria smithii										+					

Table E.2 Recorded Threatened Flora numbers

Surveyor	Species	Location	# plants (includes quadrat counts and incidental sightings)
OzArk	*Acacia bynoeana*	Tooheys Road Impact	1
		Project Boundary (not within impact or offset areas)	1
	Cryptostylis hunteriana	Tooheys Road Northern Offset	1
	Grevillea parviflora subsp parviflora	Hue Hue Road offset	6
	Tetratheca Juncea	Tooheys Road Impact	36
		Tooheys Road Southern Offset	4
		Tooheys Road Northern Offset	31
		Hue Hue Road Offset	40
		Project Boundary (not within impact or offset areas)	36
	Angophora inopina	Tooheys Road Impact	49
		Tooheys Road Southern Offset	6
		Tooheys Road Northern Offset	8
		Project Boundary (not within impact or offset areas)	24
Cumberland Ecology	*Angophora inopina*	Tooheys Road Impact	88
		Tooheys Road Southern Offset	13
		Tooheys Road Northern Offset	37
	Melaleuca biconvexa	Project Boundary (not within impact or offset areas)	144*

Note: * Counts for *Melaleuca biconvexa* are the total number of stems recorded,

Appendix F

Tree Hollow Data

Table F.1 Tree Hollow Densities within vegetation communities

Site	Community	Total # Hollows	# large hollows	# medium hollows	# small hollows
Buttonderry Impact	Exotic Grassland	0.0	0.0	0.0	0.0
Buttonderry Impact	Smooth-barked Apple	0.0	0.0	0.0	0.0
Buttonderry Impact	Spotted Gum - Broad-leaved Ironbark	10.0	5.0	5.0	0.0
Hue Hue Road offset	Blackbutt	30.0	0.0	6.7	23.3
Hue Hue Road offset	Derived Native Grassland	0.0	0.0	0.0	0.0
Hue Hue Road offset	Exotic grassland	0.0	0.0	0.0	0.0
Hue Hue Road offset	Scribbly Gum	0.0	0.0	0.0	0.0
Hue Hue Road offset	Smooth Barked Apple - Red Bloodwood	24.0	2.0	8.0	14.0
Hue Hue Road offset	Spotted Gum Broad leaved Ironbark	30.0	4.0	20.0	6.0
Tooheys Road Impact	Blackbutt	20.0	3.3	6.7	10.0
Tooheys Road Impact	Derived Native Grassland	0.0	0.0	0.0	0.0
Tooheys Road Impact	Exotic Grassland	0.0	0.0	0.0	0.0
Tooheys Road Impact	Paperbark swamp	0.0	0.0	0.0	0.0
Tooheys Road Impact	Scribbly Gum	17.5	0.0	10.0	7.5
Tooheys Road Impact	Smooth-barked Apple	0.0	0.0	0.0	0.0
Tooheys Road Impact	Swamp Mahogany	0.0	0.0	0.0	0.0
Tooheys Road North Offset	Paperbark swamp	10.0	0.0	10.0	0.0

Table F.1 Tree Hollow Densities within vegetation communities

Site	Community	Total # Hollows	# large hollows	# medium hollows	# small hollows
Tooheys Road North Offset	Scribbly Gum	13.3	0.0	0.0	13.3
Tooheys Road North Offset	Smooth-barked Apple	23.3	0.0	13.3	10.0
Tooheys Road North Offset	Swamp Mahogany	0.0	0.0	0.0	0.0
Tooheys Road South Offset	Blackbutt	13.3	0.0	10.0	3.3
Tooheys Road South Offset	Derived Native Grassland	0.0	0.0	0.0	0.0
Tooheys Road South Offset	Exotic Grassland	0.0	0.0	0.0	0.0
Tooheys Road South Offset	Paperbark swamp	10.0	0.0	0.0	10.0
Tooheys Road South Offset	Scribbly Gum	33.3	0.0	6.7	26.7
Tooheys Road South Offset	Swamp Mahogany	20.0	0.0	10.0	10.0

*Note: Data are mean number of hollows/ha in the different communities.

Appendix G

Recorded Fauna Species

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Amphibia	*Adelotus brevis*	Tusked Frog	+		
Amphibia	*Crinia signifera*	Common Eastern Froglet	+	+	
Amphibia	*Crinia tinnula*	Wallum Froglet	+	+	
Amphibia	*Limnodynastes dumerilii*	Eastern Banjo Frog	+		
Amphibia	*Limnodynastes peronii*	Striped Marsh Frog	+	+	
Amphibia	*Limnodynastes tasmaniensis*	Spotted Grass Frog	+	+	
Amphibia	*Litoria aurea*	Green and Golden Bell Frog		+	
Amphibia	*Litoria dentata*	Bleating Tree Frog	+	+	
Amphibia	*Litoria ewingii*	Brown Tree Frog	+		
Amphibia	*Litoria fallax*	Dwarf Tree Frog	+	+	
Amphibia	*Litoria freycineti*	Frecinet's Frog	+	+	
Amphibia	*Litoria latopalmata*	Broad-palmed Frog	+	+	
Amphibia	*Litoria lesueuri*	Lesueur's Frog	+	+	
Amphibia	*Litoria nasuta*	Rocket Frog	+		
Amphibia	*Litoria peronii*	Peron's Tree Frog	+	+	
Amphibia	*Litoria phyllochroa*	Leaf Green Tree Frog	+	+	
Amphibia	*Litoria tyleri*	Tyler's Tree Frog	+	+	
Amphibia	*Litoria verreauxii*	Verreaux's Tree Frog	+		
Amphibia	*Mixophyes fasciolatus*	Barred Frog	+		
Amphibia	*Mixophyes iteratus*	Giant Barred Frog	+	+	
Amphibia	*Pseudophryne bibronii*	Brown Toadlet	+		
Amphibia	*Uperoleia fusca*	Dusky Toadlet	+	+	
Amphibia	*Uperoleia laevigata*	Smooth Toadlet	+	+	
Aves	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	+	+	
Aves	*Acanthiza lineata*	Striated Thornbill	+		
Aves	*Acanthiza nana*	Yellow Thornbill	+	+	
Aves	*Acanthiza pusilla*	Brown Thornbill	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Acanthiza reguloides*	Buff-rumped Thornbill	+		
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	+	+	
Aves	*Accipiter cirrocephalus*	Collared Sparrowhawk	+		
Aves	*Accipiter fasciatus*	Brown Goshawke		+	
Aves	*Accipiter novaehollandiae*	Grey Goshawk	+	+	
Aves	*Acridotheres tristis*	* Common Myna	+	+	+
Aves	*Acrocephalus stentoreus*	Clamorous Reed-warbler	+	+	
Aves	*Aegotheles cristatus*	Australian Owlet-nightjar	+		+
Aves	*Ailuroedus crassirostris*	Green Catbird	+		
Aves	*Alcedo azurea*	Azure Kingfisher		+	
Aves	*Alectura lathami*	Australian Brush Turkey	+		
Aves	*Alisterus scapularis*	Australian King Parrot	+		+
Aves	*Anas castanea*	Chestnut Teal	+	+	
Aves	*Anas gracilis*	Grey Teal	+	+	
Aves	*Anas platyrhynchos*	Mallard		+	
Aves	*Anas rhynchotis*	Australasian Shoveler		+	
Aves	*Anas superciliosa*	Pacific Black Duck	+	+	
Aves	*Anhinga melanogaster*	Darter	+	+	
Aves	*Anthochaera carunculata*	Red Wattlebird	+	+	
Aves	*Anthochaera chrysoptera*	Little (Brush) Wattlebird	+	+	
Aves	*Anthochaera lunulata*	Little Wattlebird	+	+	
Aves	*Anthus novaeseelandiae*	Richard's Pipit		+	+
Aves	*Aquila audax*	Wedge-tailed Eagle	+		

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Ardea alba*	Great Egret	+	+	
Aves	*Ardea gazetta*	Little Egret	+	+	
Aves	*Ardea ibis*	Cattle Egret	+	+	
Aves	*Ardea pacifica*	White-necked Heron	+	+	+
Aves	*Artamus leucorynchus*	White-breasted Woodswallow	+	+	
Aves	*Artamus superciliosus*	White-browed Woodswallow	+	+	
Aves	*Aythya australis*	Hardhead	+	+	
Aves	*Biziura lobata*	Musk Duck		+	
Aves	*Butorides striatus*	Striated Heron		+	
Aves	*Cacatua galerita*	Sulfur-crested Cockatoo	+	+	
Aves	*Cacatua sanguinea*	Little Corella	+		
Aves	*Cacatua tenuirostris*	Long-billed Corella	+		
Aves	*Cacomantis flabelliformis*	Fan-tailed Cuckoo		+	
Aves	*Calidris acuminata*	Sharp-tailed Sandpiper		+	
Aves	*Calidris melanotos*	Pectoral Sandpiper		+	
Aves	*Calyptorhynchus funereus*	Yellow-tailed Black Cockatoo	+		
Aves	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	+		+
Aves	*Carduelis chloris*	European Greenfinch		+	
Aves	*Centropus phasianinus*	Pheasant Coucal	+	+	
Aves	*Chenonetta jubata*	Australian Wood Duck	+	+	
Aves	*Chrysococcyx basalia*	Horsefelds Bronze Cuckoo	+	+	
Aves	*Chrysococcyx lucidus*	Shining Bronze-Cuckoo	+	+	
Aves	*Circus approximans*	Swamp Harrier	+	+	
Aves	*Cisticola exilis*	Golden-headed	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
		Cisticola			
Aves	*Colluricincla harmonica*	Grey Shrike-thrush	+	+	
Aves	*Columba leucomela*	White-headed Pigeon	+		
Aves	*Columba livia*	* Rock Dove	+	+	+
Aves	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	+	+	
Aves	*Coracina tenuirostris*	Cicadabird	+	+	
Aves	*Corcorax melanorhamphos*	White-winged Chough	+		
Aves	*Cormobates leucophaeus*	White-throated Treecreeper	+	+	+
Aves	*Corvus coronoides*	Australian Raven	+	+	
Aves	*Corvus orru*	Torresian Crow	+		
Aves	*Coturnix ypsilophora*	Brown Quail	+	+	
Aves	*Cracticus nigrogularis*	Pied Butcherbird	+		+
Aves	*Cracticus torquatus*	Grey Butcherbird	+	+	
Aves	*Cuculus flabelliformis*	Fan-tailed Cuckoo	+		
Aves	*Cuculus pallidus*	Pallid Cuckoo		+	
Aves	*Cuculus variolosus*	Brush Cuckoo	+		
Aves	*Cygnus atratus*	Black Swan	+	+	
Aves	*Dacelo novaeguineae*	Laughing Kookaburra	+	+	
Aves	*Daphoenositta chrysoptera*	Varied Sitella	+	+	
Aves	*Dicaeum hirundinaceum*	Mistletoebird	+	+	
Aves	*Dicrurus bracteatus*	Spangled Drongo		+	
Aves	*Egretta garzetta*	Little Egret		+	
Aves	*Egretta intermedia*	Intermediate Egret	+	+	
Aves	*Egretta novaehollandiae*	White-faced Heron	+	+	
Aves	*Elanus axillaris*	Black-shouldered Kite	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Elseyornis melanops*	Black-fronted Dotterel		+	
Aves	*Eolophus roseicpilla*	Galah	+	+	
Aves	*Eopsaltria australis*	Eastern Yellow Robin	+	+	
Aves	*Ephippiorhynchus asiaticus*	Black-necked Stilt		+	
Aves	*Epthianura albifrons*	White-fronted Chat		+	
Aves	*Erythrogonys cinctus*	Red-kneed Dotterel		+	
Aves	*Eudynamys scolopacea*	Common Koel	+	+	
Aves	*Eurostopodus mysticalis*	White-throated Nightjar	+		
Aves	*Eurystomus orientalis*	Dollarbird	+	+	
Aves	*Falco berigora*	Brown Falcon	+		
Aves	*Falco cenchroides*	Nankeen Kestrel	+	+	
Aves	*Falco longipennis*	Australian Hobby		+	
Aves	*Falco peregrinus*	Peregrine Falcon		+	
Aves	*Falcunculus frontatus*	Crested Shrike-tit	+		
Aves	*Fulica atra*	Eurasian Coot	+	+	
Aves	*Gallinago hardwickii*	Latham's Snipe		+	
Aves	*Gallinula tenebrosa*	Dusky Moorhen	+	+	
Aves	*Geopelia humeralis*	Bar-shouldered Dove	+	+	
Aves	*Geopelia striata*	Peaceful Dove	+		
Aves	*Geophaps lophotes*	Crested Pigeon		+	
Aves	*Gerygone mouki*	Brown Gerygone	+		
Aves	*Gerygone olivacea*	White-throated Gerygone	+		
Aves	*Glossopsitta concinna*	Musk Lorikeet	+		
Aves	*Glossopsitta pusilla*	Little Lorikeet	+	+	
Aves	*Grallina cyanoleuca*	Australian Magpie-lark	+	+	
Aves	*Gymnorhina tibicen*	Australian Magpie	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Haliaeetus leucogaster*	Sea Eagle	+	+	
Aves	*Haliastur sphenurus*	Whistling Kite		+	
Aves	*Hieraaetus morphnoides*	Little Eagle	+		
Aves	*Himantopus himantopus*	Black-winged Stilt		+	
Aves	*Hirundapus caudacutus*	White-throated Needletail	+	+	
Aves	*Hirundo ariel*	Fairy Martin	+	+	
Aves	*Hirundo neoxena*	Welcome Swallow	+	+	
Aves	*Hirundo nigricans*	Tree Martin	+	+	
Aves	*Ixobrychus flavicollis*	Black Bittern		+	
Aves	*Lalage sueurii*	White-winged Triller	+		
Aves	*Larus novaehollandiae*	Silver Gull		+	
Aves	*Leucosarcia melanoleuca*	Wonga Pigeon	+		
Aves	*Lichenostomus chrysops*	Yellow-faced Honeyeater	+	+	
Aves	*Lichenostomus leucotis*	White-eared Honeyeater	+		
Aves	*Lichmera indistincta*	Brown Honeyeater	+		
Aves	*Limosa limosa*	Black-tailed Godwit		+	
Aves	*Lonchura punctulata*	Nutmeg Mannikin		+	
Aves	*Lopholaimus antarcticus*	Topknot Pigeon	+		
Aves	*Macropygia amboinensis*	Brown Cuckoo-dove	+		
Aves	*Malacorhynchus membranaceus*	Pink-eared Duck		+	
Aves	*Malurus cyaneus*	Superb Fairy Wren	+	+	+
Aves	*Malurus lamberti*	Variegated Fairy-wren	+	+	
Aves	*Manorina melanocephala*	Noisy Miner	+	+	
Aves	*Manorina melanophrys*	Bell Miner	+		

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Megalurua gramineus*	Little Grassbird		+	
Aves	*Megalurus timoriensis*	Tawny Grassbird	+	+	
Aves	*Meliphaga lewinii*	Lewins Honeyeater	+	+	
Aves	*Melithreptus brevirostris*	Brown-headed Honeyeater	+		
Aves	*Melithreptus validirostris*	Strong-billed Honeyeater		+	
Aves	*Menura novaehollandiae*	Superb Lyrebird	+		
Aves	*Microeca fascinans*	Jacky Winter	+	+	
Aves	*Monarcha melanopsis*	Black-faced Monarch	+		
Aves	*Myiagra cyanoleuca*	Satin Flycatcher	+		
Aves	*Myiagra inquieta*	Restless Flycatcher	+		
Aves	*Myiagra rubecula*	Leaden Flycatcher	+	+	
Aves	*Myzomela sanguinolenta*	Scarlet Honeyeater	+	+	
Aves	*Neochmia temporalis*	Red-browed Finch	+	+	+
Aves	*Ninox novaeseelandiae*	Southern Boobook	+	+	
Aves	*Ninox strenua*	Powerful Owl	+		
Aves	*Nycticorax caledonicus*	Nankeen Night Heron		+	
Aves	*Ocyphaps lophotes*	Crested Pigeon	+	+	
Aves	*Oriolus sagittatus*	Olive-backed Oriole	+	+	
Aves	*Pachycephala pectoralis*	Golden Whistler	+	+	
Aves	*Pachycephala rufiventris*	Rufous Whistler	+	+	+
Aves	*Pardalotus punctatus*	Spotted Pardalote	+	+	
Aves	*Pardalotus striatus*	Striated Pardalote	+		+
Aves	*Passer domesticus*	House Sparrow		+	
Aves	*Pelecanus conspicillatus*	Australian Pelican		+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Phalacrocorax carbo*	Great Cormorant	+	+	
Aves	*Phalacrocorax melanoleucos*	Little Pied Cormorant	+	+	
Aves	*Phalacrocorax sulcirostris*	Little Black Cormorant	+	+	
Aves	*Phalacrocorax varius*	Pied Cormorant	+	+	
Aves	*Phaps chalcoptera*	Common Bronzewing	+		
Aves	*Philemon corniculatus*	Noisy Friarbird	+	+	
Aves	*Phylidonyris nigra*	White Cheeked Honeyeater	+	+	
Aves	*Phylidonyris novaehollandiae*	New Holland Honeyeater		+	
Aves	*Pitta versicolor*	Noisy Pitta	+		
Aves	*Platalea flavipes*	Yellow-billed Spoonbill		+	
Aves	*Platalea regia*	Royal Spoonbill	+	+	
Aves	*Platycercus elegans*	Crimson Rosella	+		
Aves	*Platycercus eximius*	Eastern Rosella	+	+	
Aves	*Plectorhyncha lanceolata*	Striped Honeyeater		+	
Aves	*Plegadis falcinellus*	Glossy Ibis		+	
Aves	*Pluvialis fulva*	Pacific Golden Plover		+	
Aves	*Podargus strigoides*	Tawny Frogmouth	+	+	
Aves	*Poliocephalus poliocephalus*	Hoary-headed Grebe		+	
Aves	*Porphyrio porphyrio*	Purple Swamphen	+	+	
Aves	*Psophodes olivaceus*	Eastern Whipbird	+	+	+
Aves	*Ptilonorhychus violaceus*	Satin Bowerbird	+	+	
Aves	*Pycnonotus jocosus*	* Red-whiskered Bulbul	+	+	
Aves	*Rallus pectoralis*	Lewin's Rail	+		
Aves	*Rhipidura fuliginosa*	Grey Fantail	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Aves	*Rhipidura leucophrys*	Willie Wagtail	+	+	
Aves	*Rhipidura rufifrons*	Rufous Fantail	+	+	
Aves	*Scythrops novaehollandiae*	Channel-billed Cuckoo	+	+	
Aves	*Sericornis citreogularis*	Yellow-throated Scrubwren	+		
Aves	*Sericornis frontalis*	White-browed Scrubwren	+	+	
Aves	*Sericornis magnirostris*	Large-billed Scrubwren	+		
Aves	*Sericornis pyrrhophanus*	Chestnut-rumped Hylacola		+	
Aves	*Sphecotheres viridis*	Figbird	+	+	
Aves	*Stipiturus malachurus*	Southern Emu-wren		+	
Aves	*Strepera graculina*	Pied Currawong	+	+	
Aves	*Streptopelia chinensis*	* Spotted Turtle-dove	+	+	
Aves	*Sturnus vulgaris*	* Common Starling	+	+	
Aves	*Tachybaptus novaehollandiae*	Australasian Grebe	+	+	+
Aves	*Threskiornis molluca*	Australian White Ibis	+	+	
Aves	*Threskiornis spinicollis*	Straw-necked Ibis	+		
Aves	*Todiramphus sanctus*	Sacred Kingfisher	+	+	+
Aves	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet		+	
Aves	*Trichoglossus haematodus*	Rainbow Lorikeet	+	+	
Aves	*Turnix varia*	Painted Button-quail	+		
Aves	*Tyto novaehollandiae*	Masked Owl	+	+	
Aves	*Tyto tenebricosa*	Sooty Owl	+		
Aves	*Vanellus miles*	Masked Lapwing	+	+	
Aves	*Zoothera lunulata*	Bassian (Ground) Thrush	+		
Aves	*Zosterops lateralis*	Silvereye	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Mammalia	*Acrobates pygmaeus*	Feathertail Glider	+		
Mammalia	*Antechinus stuartii*	Brown Antechinus	+	+	
Mammalia	*Antechinus swalnsonii*	Dusky Antechinus	+	+	
Mammalia	*Austronomus australis*	White-striped Freetail Bat	+		
Mammalia	*Canis familiaris*	*Dog	+	+	
Mammalia	*Capra hircus*	*Goat	+		
Mammalia	*Cercartetus nanus*	Eastern Pygmy Possum	+		
Mammalia	*Chalinolobus gouldii*	Gould's Wattled Bat	+	+	
Mammalia	*Chalinolobus morio*	Chocolate Wattled Bat	+	+	
Mammalia	*Falsistrellus tasmaniensis*	Eastern Falsistrelle	+		
Mammalia	*Felis catus*	*Feral Cat	+		
Mammalia	*Isoodon macrourus*	Northern Brown / Long-nosed Bandicoot	+		
Mammalia	*Kerivoula papuensis*	Golden-tipped Bat	+		
Mammalia	*Macropus giganteus*	Eastern Grey Kangaroo	+	+	+
Mammalia	*Macropus robustus*	Common Wallaroo	+		+
Mammalia	*Macropus rufogriseus*	Red-necked Wallaby	+	+	+
Mammalia	*Micronomus norfolkensis*	East-coast Freetail Bat	+		
Mammalia	*Miniopterus (schreibersii) orianae oceanensis*	Eastern Bentwing Bat	+		
Mammalia	*Miniopterus australis*	Little Bentwing Bat	+	+	
Mammalia	*Mormopterus ridei*	Eastern Freetail Bat	+		
Mammalia	*Mormopterus species 3*	Freetail Bat	+		
Mammalia	*Mus musculus*	House Mouse		+	
Mammalia	*Myotis macropus*	Southern Myotis	+	+	

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Mammalia	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	+		
Mammalia	*Nyctophilus gouldi*	Gould's Long-eared Bat	+	+	
Mammalia	*Nyctophilus sp.*	Long-eared Bat species	+		
Mammalia	*Oryctolagus cuniculus*	*Rabbit	+		+
Mammalia	*Perameles nasuta*	Long-nosed Bandicoot		+	
Mammalia	*Petauroides volans*	Greater Glider	+	+	
Mammalia	*Petaurus australis*	Yellow-bellied Glider	+		
Mammalia	*Petaurus breviceps*	Sugar Glider	+		
Mammalia	*Petaurus norfolcensis*	Squirrel Glider	+	+	
Mammalia	*Pseudocheirus peregrinus*	Common Ringtail Possum	+	+	
Mammalia	*Pteropus poliocephalus*	Grey-headed Flying-fox	+		
Mammalia	*Rattus fuscipes*	Bush Rat	+	+	
Mammalia	*Rattus lutreolus*	Swamp Rat	+	+	
Mammalia	*Rattus rattus*	*Black Rat	+	+	
Mammalia	*Rhinolophus megaphyllus*	Eastern Horseshoe Bat	+		
Mammalia	*Saccolaimus flaviventris*	Yellow-bellied Sheathtailbat	+	+	
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	+	+	
Mammalia	*Scotorepens orion*	Eastern Broad-nosed Bat	+	+	
Mammalia	*Suis suis*	*Pig	+		
Mammalia	*Tachyglossus aculeatus*	Short-beaked Echidna	+		
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	+	+	+
Mammalia	*Vespadelus darlingtoni*	Large Forest Bat	+	+	
Mammalia	*Vespadelus pumilus*	Eastern Forest Bat	+		

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Mammalia	*Vespadelus vulturnus*	Little Forest Bat	+	+	
Mammalia	*Vombatus ursinus*	Common Wombat	+		
Mammalia	*Vulpes vulpes*	*Fox	+		+
Mammalia	*Wallabia bicolor*	Swamp Wallaby	+	+	+
Reptilia	*Amphibolurus muricatus*	Jacky Lizard	+	+	
Reptilia	*Chelodina longicollis*	Eastern Snake-necked Turtle	+		
Reptilia	*Cryptoblepharus pulcher*	Wall Skink	+		
Reptilia	*Ctenotus robustus*	Robust Skinnk	+		
Reptilia	*Demansia psammophis*	Yellow-faced Whip Snake	+		
Reptilia	*Egernia cunninghami*	Cunningham's Skink	+		
Reptilia	*Eulamprus quoyii*	Eastern Water Skink	+	+	
Reptilia	*Lampropholis delicata*	Grass Skink	+	+	+
Reptilia	*Lampropholis guichenoti*	Garden Skink	+		
Reptilia	*Notechis scutatus*	Eastern Tiger Snake	+		
Reptilia	*Phyllurus platurus*	Broad-tailed Gecko	+		
Reptilia	*Physignathus lesueurii*	Eastern Water Dragon	+	+	+
Reptilia	*Pogona barbata*	Bearded Dragon	+		
Reptilia	*Pseudechis porphyriacus*	Red-bellied Black Snake	+	+	
Reptilia	*Pseudonaja textilis*	Eastern Brown Snake	+	+	
Reptilia	*Ramphotyphlops nigrescens*	Blind or Worm Snake	+		
Reptilia	*Saiphos equalis*	Three-toed Skink	+		
Reptilia	*Saproscincus mustelinus*	Weasel Skink	+		
Reptilia	*Tiliqua scincoides*	Blue-tongue Lizard		+	
Reptilia	*Varanus gouldii*	Goulds Monitor	+		

Table G.1 Recorded Fauna Species

Class	Scientific Name	Common Name	OzArk Surveys	ERM surveys	Cumberland Ecology
Reptilia	*Varanus varius*	Lace Monitor	+		

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
Amphibia	Giant Barred Frog	*Mixophyes iteratus*	E	E	Extraction Area/SIL	21/02/2012	Spotlighting
Amphibia	Giant Barred Frog	*Mixophyes iteratus*	E	E	Extraction Area/SIL	23/02/2012	Calls heard
Amphibia	Giant Barred Frog	*Mixophyes iteratus*	E	E	Extraction Area/SIL	24/02/2012	Incidental Observation - heard calling
Amphibia	Giant Barred Frog	*Mixophyes iteratus*	E	E	Extraction Area/SIL	23/02/2012	Spotlighting
Amphibia	Wallum Froglet	*Crinia tinnula*	V		Tooheys Rd	16/09/2006	Calls recorded
Amphibia	Wallum Froglet	*Crinia tinnula*	V		Tooheys Rd	16/09/2006	Calls recorded
Amphibia	Wallum Froglet	*Crinia tinnula*	V		Tooheys Rd	16/09/2006	Calls recorded
Aves	Glossy Black Cockatoo	*Calyptorhynchus lathami*	V		Hue Hue Rd Offset	19/10/2011	Diurnal bird survey observation
Aves	Glossy Black Cockatoo	*Calyptorhynchus lathami*	V		Hue Hue Rd Offset	19/10/2011	Diurnal bird survey observation
Aves	Glossy Black Cockatoo	*Calyptorhynchus lathami*	V		Tooheys Rd	17/10/2011	Incidental sighting
Aves	Glossy Black Cockatoo	*Calyptorhynchus lathami*	V		Tooheys Rd	17/10/2011	Incidental sighting
Aves	Glossy Black Cockatoo	*Calyptorhynchus lathami*	V		Hue Hue Rd Offset	17/10/2011	Incidental sighting
Aves	Glossy Black Cockatoo	*Calyptorhynchus lathami*	V		Tooheys Rd	22/11/2012	Incidental sighting - Cumberland Ecology
Aves	Glossy Black	*Calyptorhynchus lathami*	V		Tooheys Rd	18/12/2012	Incidental sighting - Cumberland Ecology

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
	Cockatoo						
Aves	Little Eagle	*Hieraaetus morphnoides*	V		Extraction Area/SIL	9/12/2011	Diurnal bird survey - observed
Aves	Little Lorikeet	*Glossopsitta pusilla*	V		Hue Hue Rd Offset	21/10/2012	Incidental sighting
Aves	Masked Owl	*Tyto novaehollandiae*	V		Tooheys Rd	17/10/2006	Call playback response
Aves	Powerful Owl	*Ninox strenua*	V		Buttonderry	20/10/2006	Call playback response
Aves	Powerful Owl	*Ninox strenua*	V		Extraction Area/SIL	7/12/2011	Call playback response
Aves	Powerful Owl	*Ninox strenua*	V		Tooheys Rd	18/10/2006	Call playback response
Aves	Sooty Owl	*Tyto tenebricosa*	V		Extraction Area/SIL	6/12/2011	Call playback response
Aves	Sooty Owl	*Tyto tenebricosa*	V		Extraction Area/SIL	5/12/2011	Call playback response
Aves	Sooty Owl	*Tyto tenebricosa*	V		Extraction Area/SIL	26/10/2011	Call playback response
Aves	Sooty Owl	*Tyto tenebricosa*	V		Extraction Area/SIL	24/10/2011?	Songmeter recording.
Aves	Sooty Owl	*Tyto tenebricosa*	V		Extraction Area/SIL	24/10/2011 & 25/10/2011	Songmeter recording
Aves	Varied Sittella	*Daphoenositta chrysoptera*	V		Buttonderry	18/10/2011	Incidental sighting
Aves	Varied Sittella	*Daphoenositta chrysoptera*	V		Hue Hue Rd Offset	18/10/2011	Diurnal bird survey - observed
Aves	Varied Sittella	*Daphoenositta chrysoptera*	V		Hue Hue Rd Offset	20/10/2011	Diurnal bird survey - observed
Aves	Varied Sittella	*Daphoenositta chrysoptera*	V		Hue Hue Rd Offset	19/10/2011	Diurnal bird survey - observed
Aves	Varied Sittella	*Daphoenositta chrysoptera*	V		Tooheys Rd	2/03/2012	Incidental sighting
Mammalia	East-coast Freetail Bat	*Mormopterus norfolkensis*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	East-coast	*Mormopterus*	V		Hue Hue	17/10/2011	Anabat

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
	Freetail Bat	*norfolkensis*			Rd Offset		
Mammalia	East-coast Freetail Bat	*Mormopterus norfolkensis*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	East-coast Freetail Bat	*Mormopterus norfolkensis*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	East-coast Freetail Bat	*Mormopterus norfolkensis*	V		Extraction Area/SIL	27/10/2011	Anabat
Mammalia	East-coast Freetail Bat	*Mormopterus norfolkensis*	V		Extraction Area/SIL	8/12/2011	Anabat
Mammalia	Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	V		Extraction Area/SIL	24/10/2011	Anabat
Mammalia	Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	V		Extraction Area/SIL	5/12/2011	Anabat
Mammalia	Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	V		Extraction Area/SIL	6/12/2011	Anabat
Mammalia	Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	V		Extraction Area/SIL	7/12/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	23/02/2012	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Tooheys Rd	18/10/2006	Anabat
Mammalia	Eastern	*Falsistrellus*	V		Tooheys	28/02/2012	Anabat

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
	false pipistrelle	*tasmaniensis*			Rd		
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Tooheys Rd	28/02/2012	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Tooheys Rd	18/10/2006	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Hue Hue Rd Offset	17/10/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Hue Hue Rd Offset	19/10/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	24/10/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	26/10/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	27/10/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	7/12/2011	Anabat
Mammalia	Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V		Extraction Area/SIL	8/12/2011	Anabat
Mammalia	Eastern Pygmy Possum	*Cercartetus nanus*	V		Extraction Area/SIL	21/02/2012	Hair funnel wafer
Mammalia	Golden-tipped Bat	*Kerivoula papuensis*	V		Hue Hue Rd Offset	17/10/2011	Anabat

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Hue Hue Rd Offset	19/10/2011	Anabat
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Extraction Area/SIL	23/02/2012	Anabat
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Hue Hue Rd Offset	19/10/2011	Anabat
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Extraction Area/SIL	8/12/2011	Anabat
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Outside boundaries	22/02/2012	Call playback response
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	5/12/2011	Spotlighting
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	5/12/2011	Spotlighting
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	6/12/2011	Call playback response
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	21/02/2012	Spotlighting
Mammalia	Grey-headed	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	22/02/2012	Spotlighting

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
	Flying-fox						
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	8/12/2011	Spotlighting
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V		Extraction Area/SIL	23/02/2012	Spotlighting
Mammalia	Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Extraction Area/SIL	23/02/2012	Heard calling
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	21/02/2012	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	21/02/2012	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Hue Hue Rd Offset	18/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Hue Hue Rd Offset	19/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	24/10/2011	Anabat

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	24/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	26/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	26/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	27/10/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	5/12/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	6/12/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	7/12/2011	Anabat
Mammalia	Little Bentwing Bat	*Miniopterus australis*	V		Extraction Area/SIL	8/12/2011	Anabat
Mammalia	Southern Myotis	*Myotis macropus*	V		Extraction Area/SIL	22/02/2012	Anabat
Mammalia	Southern Myotis	*Myotis macropus*	V		Tooheys Rd	18/10/2012	Anabat
Mammalia	Southern Myotis	*Myotis macropus*	V		Hue Hue Rd Offset	17/10/2011	Anabat
Mammalia	Southern Myotis	*Myotis macropus*	V		Hue Hue Rd Offset	17/10/2011	Anabat
Mammalia	Southern Myotis	*Myotis macropus*	V		Hue Hue Rd Offset	18/10/2011	Anabat
Mammalia	Southern Myotis	*Myotis macropus*	V		Hue Hue Rd Offset	20/10/2011	Anabat
Mammalia	Southern	*Myotis macropus*	V		Extraction	24/10/2011	Anabat

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
	Myotis				Area/SIL		
Mammalia	Southern Myotis	*Myotis macropus*	V		Extraction Area/SIL	7/12/2011	Anabat
Mammalia	Squirrel Glider	*Petaurus norfolcensis*	V		Tooheys Rd	18/10/2006	Spotlighting
Mammalia	Squirrel Glider	*Petaurus norfolcensis*	V		Tooheys Rd	29/02/2012	Elliot Trap
Mammalia	Squirrel Glider	*Petaurus norfolcensis*	V		Tooheys Rd	2/03/2012	Elliot Trap
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Hue Hue Rd Offset	18/10/2011	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Outside boundaries	22/02/2012	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	6/12/2011	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	27/10/2011	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	6/12/2011	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	5/12/2011	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	5/12/2011	Call playback response
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	6/12/2011	Spotlighting
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	6/12/2011	Call playback response
Mammalia	Yellow-	*Petaurus australis*	V		Extraction	26/10/2011	Spotlighting

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
	bellied Glider				Area/SIL		
Mammalia	Yellow-bellied Glider	*Petaurus australis*	V		Extraction Area/SIL	7/12/2011	Spotlighting
Mammalia	Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V		Hue Hue Rd Offset	19/10/2011	Anabat
MIGRATORY SPECIES							
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Outside boundaries	22/02/2012	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	23/02/2012	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	23/02/2012	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	22/02/2012	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	6/12/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	6/12/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	7/12/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	7/12/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	26/10/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	26/10/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	26/10/2011	Diurnal bird survey
Aves	Black-faced Monarch	*Monarcha melanopsis*		M	Extraction Area/SIL	26/10/2011	Diurnal bird survey
Aves	Cattle Egret	*Ardea ibis*		M	Extraction	26/10/2011	Diurnal bird survey

Table G.2 Threatened/Migratory Fauna Recording methods

Class	Common name	Scientific name	TSC Act	EPBC Act	Study Area	Date	Method
					Area/SIL		
Aves	Cattle Egret	*Ardea ibis*		M	Hue Hue Rd Offset	18/10/2011	Incidental sighting
Aves	Cattle Egret	*Ardea ibis*		M	Extraction Area/SIL	24/10/2011	Incidental sighting
Aves	Great Egret	*Ardea alba*		M	Extraction Area/SIL	6/12/2011	Diurnal bird survey
Aves	Great Egret	*Ardea alba*		M	Extraction Area/SIL	9/12/2011	Diurnal bird survey
Aves	Great Egret	*Ardea alba*		M	Extraction Area/SIL	25/10/2011	Incidental sighting
Aves	Intermediate Egret	*Ardea intermedia*		M	Extraction Area/SIL	8/12/2011	Diurnal bird survey
Aves	Intermediate Egret	*Ardea intermedia*		M	Extraction Area/SIL	8/12/2011	Diurnal bird survey
Aves	Rufous Fantail	*Rhipidura rufifrons*		M	Extraction Area/SIL	23/02/2012	Diurnal bird survey
Aves	Rufous Fantail	*Rhipidura rufifrons*		M	Extraction Area/SIL	24/02/2012	Incidental sighting
Aves	Rufous Fantail	*Rhipidura rufifrons*		M	Extraction Area/SIL	23/02/2012	Diurnal bird survey
Aves	Rufous Fantail	*Rhipidura rufifrons*		M	Extraction Area/SIL	7/12/2011	Diurnal bird survey
Aves	Rufous Fantail	*Rhipidura rufifrons*		M	Extraction Area/SIL	25/10/2011	Diurnal bird survey
Aves	White-bellied Sea-eagle	*Haliaeetus leucogaster*		M	Hue Hue Rd Offset	1/10/2006	Incidental sighting
Aves	White-bellied Sea-eagle	*Haliaeetus leucogaster*		M	Tooheys Rd	1/10/2006	Incidental sighting
Aves	White-throated Needletail	*Hirundapus caudacutus*		M	Extraction Area/SIL	24/02/2012	Incidental sighting
Aves	White-throated Needletail	*Hirundapus caudacutus*		M	Tooheys Rd	2/03/2012	Incidental sighting

Appendix H

Assessments of Significance

H.1 Endangered Ecological Communities

The following Assessment of Significance has been prepared as a composite test for a number of EECs listed under the TSC Act that are known to occur within the Study Area. These include the following:

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

H.1.1 Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Several vegetation communities recorded from the Study Area correspond to the definition of Swamp Sclerophyll Forest including Paperbark Swamp Forest of the Coastal Lowland 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.

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

This vegetation community is limited to a small drainage line within the Toohey's Road Site. The vegetation consists of thickets of *Melaleuca linariifolia (*Flax-leaved Paperbark*)*, under scattered emergents of *Angophora costata (*Smooth-barked Apple*)* and *Eucalyptus resinifera (*Red Mahogany*)*. There are indications that this community may have developed from within a wider *Eucalyptus robusta* (Swamp Mahogany) swamp forest in response to past agricultural clearing, especially as several areas of this community area consist of young, regrowth vegetation.

Detailed floristic surveys were not conducted for this community during the current surveys (OzArk 2012 but Bell (2002) distinguished these stands of paperbarks as a variant (MU 26e) of the parent swamp forest complex (Narrabeen Alluvial Drainage Line Complex) for the Wyong LGA. 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.

ii. Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin

Swamp Mahogany swamp forest predominantly occurs in two locations within the Study Area – Toohey's Road and Buttonderry – although small patches are present

Vegetation at Toohey's Road site occures along a broad drainage line and supports vegetation dominated by the canopy species *Eucalyptus robusta (*Swamp Mahogany*)*, *Angophora floribunda (*Rough-barked Apple*)* and *Eucalyptus resinifera (*Red Mahogany). The sub-canopy mainly consists of species such as *Melaleuca linariifolia (*Flax-leaved Paperbark*)* and *Melaleuca decora* along with a scattered shrub layer of *Leptospermum juniperinum (*Prickly Tea-tree*),* and juvenile *Melaleuca* and *Eucalyptus* species. The understorey is characterised by a dense layer of sedges *Gahnia clarkei (*Tall Saw-sedge*), Empodisma minus,* and grasses such as *Entolasia stricta (*Wiry Panic*), Hemarthia uncinata (*Matgrass*), Panicum simile (*Two Colour Panic).

Vegetation at the Buttonderry site occurs in the north-eastern corner of the property and is dominated by the canopy species *Eucalyptus robusta (Swamp Mahogany), Angophora floribunda (Rough-barked Apple)* and *Eucalyptus tereticornis (Forest Red Gum).* The understorey is dominated by *Lomandra longifolia (Spiky-headed Mat-rush)* and various grasses. Areas subject to past light-to-moderate grazing pressure over the years are characteristed by regrowth vegetation.

Swamp Mahogany swamp forest community is considered the equivalent of two Wyong LGA vegetation units – Alluvial Floodplain Shrub Swamp Forest (MU 20) and Narrabeen Alluvial Drainage Line Complex (MU 26). Swamp Mahogany swamp forest is considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC.

iii. Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin

Woollybutt – Paperbark sedge forest is found only within the SIL in the upper areas of Porters Wetland catchement. The community was not studied during OzArk surveys due to access restrictions (OzArk 2012) and definitions for this community have been limited to descriptions in the Wyong LGA vegetation mapping by Bell (2002).

This community has been mapped as the Wyong LGA community Alluvial Woollybutt-Melaleuca Sedge Forest (MU19) (Bell 2002). It is characterised by the presence of Woollybutt (*Eucalyptus longifolia*) and various Melaleuca species such as *Melaleuca decora, Melaleuca linariifolia (*Flax-leaved Paperbark*), Melaleuca nodosa (*Ball Honey Myrtle*), Melaleuca sieberi, Melaleuca ericifolia (*Swamp Paperbark*), Melaleuca thymifolia (*Thyme Honey Myrtle) in the canopy or shrub layer. Associated canopy species often include *Eucalyptus resinifera (*Red Mahogany*), Eucalyptus robusta (*Swamp Mahogany*)* or *Angophora costata (*Smooth-barked Apple*)*. The understorey predominantly consists of sedges such as *Gahnia clarkei (*Tall Saw-sedge*), Schoenus brevifolius (*Bog-rush*),*

*Lepidosperma quadrangulatum, Juncus prismatocarpus (*Branching Rush*)* and *Chorizandra cymbaria (*Heron Bristle Rush).

Woollybutt – Paperbark sedge forest is considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

H.1.2 Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions

This EEC is represented in the Study Area by Coachwood – Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin. Coachwood - Crabapple rainforest is found only within the Mining Area of the Project Boundary. The community was not studied during OzArk surveys due to access restrictions (OzArk 2012) and definitions for this community have been limited to descriptions in the Wyong LGA vegetation mapping by Bell (2002).

This vegetation occurs in sheltered hilly terrain in the Mining Area. The area is characterised by alluvial soils which provide adequate moisture-retention. This community occurs as two variants MU40 - Riverine Alluvial Gallery Rainforest-Moist Forest (Alluvial soil variant) and MU42 - Narrabeen Warm Temperate-Subtropical Rainforest (sheltered gully variant) (Bell 2002). Coachwood - Crabapple rainforest has a restricted distribution within the to Wyong LGA.

H.1.3 River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions

This EEC is represented in the Study Area by two communities; Blackbutt - Turpentine open forest of the foothills of the North Coast and Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin. These are described below.

i. Blackbutt - Turpentine open forest of the foothills of the North Coast

Blackbutt - Turpentine open forest of the foothills of the North Coast is present along the bulk of Buttonderry Creek, including where it passes through the study area on the Tooheys Road, Buttonderry and Hue Hue Road properties.

Canopy species include *Eucalyptus pilularis* (Blackbutt)*, Corymbia maculata* (Spotted Gum)*, Syncarpia glomulifera* (Turpentine) and, in some places, *Eucalyptus saligna* (Sydney Blue Gum) with a well developed sub-canopy of *Melaleuca linariifolia* (Flax-leaved Paperbark)*.* Buttonderry areas also have a well developed sub-canopy of *Melaleuca biconvexa* (Biconvex Paperbark) a listed Vulnerable species under the EPBC and TSC Acts). A variety of sedges and herbs occur in the understorey with *Gahnia clarkei* (Tall Saw-sedge) being the prominent species. Some vegetation patches are characterised by the presence of only the canopy species.

This vegetation type occupies a limited habitat niche, mainly along major creek lines on the Wyong sub-coastal plain. Narrow bands of Blackbutt, Turpentine and Spotted Gum are generally restricted to Wyong LGA, with only 237 ha extant being mapped (Bell 2002a).

ii. Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin

Rough-barked Apple – Red Gum grassy woodland occurs as a small area of remnant vegetation at the corner of Kiar Ridge and Hue Hue Roads (Hue Hue Road portion). This stand has been partially cleared and grazed in the past, but still retains important diagnostic elements. Previous vegetation mapping by Bell (2002) also found scattered remmant strands present in predominantly disturbed areas within the Subsidence Impact Limit, east of the Wyong SF. These remnants were not surveyed during OzArk surveys.

The canopy in the Hue Hue Road area is dominated by *Eucalyptus tereticornis* (Red Gum), *Eucalyptus resinifera* (Red Mahogany) and *Angophora floribunda* (Rough-barked Apple), over a mid-storey of *Melaleuca decora, M. linariifolia* (Snow in Summer) and *M. nodosa* (Prickly-leaved Paperbark). Ground layer vegetation consists of various grasses, sedges and herbs which could not be sampled due to access restrictions at the time of survey (OzArk 2012).

Within Wyong LGA, Rough-barked Apple – Red Gum grassy woodland is highly restricted and has suffered from fragmentation and clearing, with estimates of 86% loss having been made (as Alluvial Footslopes Redgum Forest, Bell 2002a). Within the regional NPWS classification (2000), this community falls into the Wyong Paperbark Swamp Forest, and is considered part of the River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (RFEFCF).

H.1.4 Lower Hunter Spotted Gum – Ironbark Forest

This EEC is represented in the Study Area by Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin. This community occurs predominantly in the low lying lands in the eastern parts of the Study Area, mainly in the Hue Hue Road offset area and parts of the Buttonderry site. Some scattered patches also occur in the eastern parts of the Mining Area.

This community is an open forest dominated by *Corymbia maculata* (Spotted Gum) and Ironbarks, mainly *Eucalyptus fibrosa*. The understorey is sparse and consists of shrubs such as *Daviesia ulicifolia (*Gorse Bitter Pea*)* and *Podolobium ilicifolium (*Prickly Shaggy Pea*)*, and grasses such as *Themeda australis (*Kangaroo Grass*), Entolasia stricta (*Wiry Panic*), Imperata cylindrica* var. *major (*Blady Grass*),* and *Microlaena stipoides* var. *stipoides (*Weeping Rice Grass*).* Several areas have been impacted by clearing or under-scrubbing which has greatly reduced the understorey and groundcover, although canopy species still persist. These cleared and/or under-scrubbed areas also support dense thickets of *Melaleuca nodosa (*Ball Honey Myrtle*).*

This community is equivalent to a variant of the Wyong LGA community Narrabeen Dooralong Spotted Gum-Ironbark Forest (Bell 2002). Based on the ongoing work on the

classification of communities dominated by Spotted Gum in the region, the Warnervale area in particular (Bell submitted), this community is considered to be part of the Lower Hunter Spotted Gum – Ironbark Forest EEC.

H.1.5 Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

This EEC is represented in the Study Area by the community known as *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin.

This community was recorded by Cumberland Ecology in a modified grassland/paddock area known as Honeysuckle Park within the Dooralong Valley section of the Mining area. Surrounding paddocks could not be assessed due to access restrictions but it is assumed that further patches of this community occur as scattered billabongs and farm dams in the Dooralong Valley floodplain.

The Freshwater wetland surveyed was characteristed by dense growth of *Azolla sp* on the water surface along with aquatic species such as *Persicariaspp* and *Triglochin procera* (Water ribbons). The banks are dominated by *Carex appressa*, *Juncus spp* and *Cyperus eragrostis*.

This community conforms to the Freshwater Wetlands (MU16) mapped by Bell (2002) and is considered to be part of the Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC.

Assessment of Significance

(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

Not applicable to endangered communities.

(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 endangered communities.

(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

The Project is considered unlikely to have an adverse affect on or substantially and adversely modify the composition or extent of the local occurrence of these EECs. Relatively small areas of EEC will be removed, and the majority of these communities will remain in the Study Area and locality. Furthermore, a substantial offset package has been developed that will protect larger areas than those being removed. Some subsidence is predicted to occur in areas where these EECs are present, however current modelling indicates that this is unlikely to adversely affect native vegetation communities.

(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

Approximately 3 ha of Swamp Sclerophyll Forest, 4.5 ha of Lower Hunter Spotted Gum – Ironbark Forest, and 6 ha of River Flat Eucalypt Forest will be removed by the Project. This is for the surface infrastructure components of the Project. Other areas of EEC are within the SIL, however this is not expected to modify these communities.

No areas of habitat will become fragmented or isolated as a result of the Project. The areas to be removed are located predominantly adjacent to cleared land. Remaining areas of these communities are contiguous and no area will become isolated from other areas of EEC.

The areas of EEC to be removed are not considered to be important to the long term survival of these communities. Much larger areas will remain outside the disturbance area within the Study Area, and locality, and significantly larger areas than those being disturbed are being protected in the offset areas.

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

No critical habitat for these EECs has been identified by the Director-General of OEH under the TSC Act. The study area does not constitute critical habitat for these EECs and large areas are present in reserves and nearby lands.

(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 EECs. The main objective of recovery planning for EECs is to avoid further loss of these communities and to facilitate their recovery. The Project is considered to be consistent with these objectives as

only a relatively small area of EEC vegetation will be removed and much larger areas of each EEC will be protected for conservation in the offset areas.

(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 following KTP have potential to operate as a result of the Project and impact the EECs in the Study Area:

- **Clearing of native vegetation** as this directly removes and reduces the extent of these ecological communities;
- **Loss of hollow-bearing trees** as this directly removes remnant trees of these communities and reduces the abundance of nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of these communitis and reduces the abundance of important ground foraging and nesting habitat;
- **Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands** as this can significantly reduce the ecological function of ecological communities; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters these communities.

Conclusion

The Project will result in the direct loss of approximately 13.2 ha of vegetation listed as several EECs, and there is potential for further impacts of retained vegetation as a result of subsidence. This is considered to be a very small area of EEC vegetation, and many times this area will be retained within the Study Area and will be protected for conservation in the offset areas. Modelling indicates that minimal effects are expected as a result of subsidence, and the areas of EEC vegetation that will remain outside the surface disturbance area are expected to remain viable. No significant impact is predicted to occur to EEC vegetation as a result of the Project.

H.2 Angophora inopina

Angophora inopina (Charmhaven Apple) is a small to large tree, up to 8 m high and is often multi-stemmed. The bark is grey to grey-brown and consists of short fibres while the leaves are slightly glossy and leathery (OEH 2012l). The flowers are creamy white (Benson and McDougall 1998). Flowering is poor and sporadic and generally occurs between mid-December and mid-January.

Angophora inopina is found in open dry sclerophyll woodland of *Eucalyptus haemastoma* and *Corymbia gummifera* with a dense shrub understorey. The woodland occurs on deep white sandy soils over sandstone, often with some gravelly laterite (NSW Scientific Committee 1998a).

Large numbers of this small tree occur within the Tooheys Road Site, predominantly in Scribbly Gum Red Bloodwood woodland with some scattered individuals in cleared areas, Swamp Mahogany forest, or Paperbark Swamp forest. Density estimates for *Angophora inopina* within the Impact areas of Tooheys Road was calculated at approximately 14 individuals per hectare whereas that for the Offset areas was calculated at approximately 22 individuals per hectare (approximately 31 and 13 individuals per hectare in the Tooheys Road South and Tooheys Road North offsets respectively).

Assessment of Significance

(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 known and potential habitat for this species. However this is a very small area and approximately 48 ha of suitable habitat for this species will be removed. An offset package has been developed which will protect approximately 135 ha of suitable habitat for *Angophora inopina*. Large areas of similar habitat will remain in the Study Area and the locality and the removal of this small area is not considered likely to place a viable local population of this 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

(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

Approximately 48 ha of habitat for this species wil be removed. A further 99 ha of habitat occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for this species.

No fragmentation will occur to *Angophora inopina* habitat as a result of the Project. This community occurs in the Tooheys Road site, and this area is already fragmented by the road passing through it and there is not expected to be significant additional fragmentation as a result of the Project.

The habitat to be removed is not considered to be important for the long term survival of this species. Significant areas 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 this 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 *Angophora inopina*. A total of 14 Priority Actions have been identified for this species as follows:

- Assess the relative conservation significance of sites to determine recovery priorities;
- Prepare species profile and EIA guidelines;
- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements. Retain vegetative linkages between sites where possible;
- Ensure that sites on crown land are appropriately classified and managed;
- Incorporate site specific threat abatement measures for the species into Plans of Management for on-park sites;
- Prepare and implement management plans for sites that are located on non DEC public land;

- Liaise with private and public landmanagers to facilitate the preparation and implementation of management plans that address threatening processes;
- Incorporate appropriate fire regime into land management practices;
- Restrict vehicular and pedestrian access to sites, where necessary;
- Undertake targeted bush regeneration works, where required;
- Fence sites and exclude livestock, where required;
- Public authorities and landowners undertaking road, trail, or easement maintenance activities in potential habitat are to ensure that planning and maintenance staff are aware of the species and that processes are in place to avoid impacting upon it;
- Identify, map and survey potential habitat, particularly in Port Stephens and Great Lakes LGAs; and
- Undertake management focused ecological studies (including seed production and the level of threat posed by introgressive hybridisation with Angophora floribunda).

The project is considered to be consistent with these actions.

(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. This is relevant to *Angophora inopina* as this reduces the area of habitat available for this species.

Conclusion

The Project is expected to remove approximately 33.38 ha of habitat for this species. This includes the removal of known individuals. However, large areas of habitat for this species is present in surrounding areas and a total of approximately 40 ha of habitat will be conserved within the offset areas. It is expected that the species will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.3 Assessment of Significance – Threatened Flora Species

The following Assessment of Significance has been prepared as a composite test for a number of threatened flora species known to occur or with potential to occur within the Study Area.

i. Acacia bynoeana (Bynoe's Wattle)

Acacia bynoeana (Bynoe's Wattle) is a decumbent shrub, spreading up to 50 cm across and 1 m high. The shrub has stiff, shiny phyllodes and hairy brachlets (OEH 2012j) . This species produces few flowers, seed production is minimal and seedlings are rare (NSW NPWS 1999). *Acacia bynoeana* occurs mainly in heath and dry sclerophyll forest, typically in sand and sandy clay substrates, often with ironstone gravels, which are usually very infertile and well-drained. The species seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds (from grading) and in recently burnt open patches (NSW NPWS 1999). *Acacia bynoeana* was recorded at two locations, in Scribbly Gum Red Bloodwood woodland and in Smooth-barked Apple – Red Bloodwood forest, at the Tooheys Road Site. Several individuals have been recorded near the Study Area, on the eastern side of the F3 freeway (OzArk 2012). There are 26 records of this species in the locality (OEH 2012a).

ii. Cryptostylis hunteriana (Leafless Tongue Orchid)

Cryptostylis hunteriana is a small perennial terrestrial orchid. This species lacks leaves and has a 10 – 45 cm long flowering stem, usually with five to 10 flowers. The distinctive labellum for *Cryptostylis hunteriana* is erect, dark red with a wide central black band that becomes four black lines, and is covered with dense glandular hairs on the upper surface (SEWPaC 2012f). This species inhabits a range of habitats, mostly coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest in soils that include moist sands or moist to dry clay loam (Jones 2006, OEH 2012~). A single *Cryptostylis hunteriana* individual was recorded within the Project Boundary, north of the Tooheys Road Site in Scribbly Gum Red Bloodwood woodland. There are two records of this species within the locality (OEH 2012a).

iii. Grevillea parviflora subsp. parviflora (Small-flower Grevillea)

Grevillea parviflora subsp. *parviflora* is a low open to erect shrub, 0.3-1m tall. Major branches are ascending to erect and leaves are narrow, mostly 0.8-1.3 mm wide. Flowers are small, spider-like and clustered in groups of 6–12, and are white or pinkish with rusty-brown hairs (NSW NPWS 2002). It occurs in heathy associations or shrubby woodland, in sandy or light clay soils, usually over thin shales often with lateritic ironstone gravels which are often infertile and poorly drained. Most populations are found in open, slightly disturbed sites, particularly close to roads and tracks (OEH 2012^). *Grevillea parviflora* subsp. *parviflora* was recorded at six locations within the Hue Hue road offset site in Spotted Gum – Broadleaved Ironbark. Some patches of this species are also present outside Project Boundary, east of the F3 Freeway (OzArk 2012). There are 119 records of this species in the locality (OEH 2012a).

iv. Melaleuca biconvexa (Biconvex Paperbark)

Melaleuca biconvexa is a shrub to small tree, up to 10 m tall, with papery bark. The leaves are small with a centre-vein in a groove and leaf blades curving upwards on either side of the centre-vein. The flowers are white and usually clustered in dense heads. Flowering occurs

over 3 – 4 weeks in September and October (OEH 2012d). The species grows in damp places, often near streams and rivers or low-lying areas on alluvial soils of low slopes or sheltered aspects. Dense, narrow stands, often in association with other *Melaleuca* species, can occur adjacent to watercourses (NSW Scientific Committee 1998b, OEH 2012d). Several stands of *Melaleuca biconvexa* were recorded within the Project Boundary, east of Buttonderry impact Site in Blackbutt – Turpentine forest. Stands were largely confined to within 4 m of creeklines and wet depressions except between the eastern side of the creek and Hue Hue Road where the species was found in areas damp from surface runoff. The species showed variable abundance within the area of occupancy, ranging from scattered stems to dense thickets. Overall cover abundance was medium and included mature, young and immature stems as well as saplings. Previous studies have also recorded *Melaleuca biconvexa* individuals in the Extraction Area (ERM 2003) but these stands were not located within accessible areas surveyed. There are 279 records of this species in the locality (OEH 2012a).

v. Tetratheca juncea (Black-eyed Susan)

Tetratheca juncea is a low shrub that grows in clumps of single or multiple stems. Stems are usually leafless with two or three narrow wings that give them an angular appearance. Plants are usually sprawling and can be difficult to detect amongst other vegetation when not flowering. The flowers face downwards and range in colour from white to pink to dark purple with a dark centre (OEH 2012e). The species is usually occurs on ridges but is also found on upper slopes, midslopes and occasionally in gullies (NSW NPWS 2000a). It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover (OEH 2012e). It is found in sandy, occasionally moist heath and in dry sclerophyll vegetation communities, in sandy skeletal soil on sandstone, sandy-loam soils and clayey soil from conglomerates. Numerous patches and diffuse occurrences of this species were recorded within the Tooheys Road Site and Hue Hue Road offset site, predominantly in Scribbly Gum Red Bloodwood woodland and Smooth-barked Apple – Red Bloodwood forest but with some occurrences in Swamp Mahogany Forest and Blackbutt – Turpentine forest. There are 121 records of this species in the locality (OEH 2012a).

vi. Caladenia tessellata (Thick Lip Spider Orchid)

Caladenia tessellata is a perennial orchid that sprouts annually from an underground tuber. This species generally flowers from September – November and has a single, hairy 30 cm tall flowering stem (SEWPaC 2012e). The flower is characterised by five long spreading cream coloured petals with reddish stripes and a broad down-curled labellum with darker stripes (OEH 2012□). This species favours dry, sclerophyll woodland with a heathy or sometimes grassy understorey on clay loams or sandy soils (SEWPaC 2012e). The species has not been recorded in the locality. However there are six records for this species in the Wyong LGA (OEH 2012a) and it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

vii. Callistemon linearifolius (Netted Bottle Brush)

Callistemon linearifolius is a shrub, about 3-4 m tall, with linear to linear-lanceolate leaves with a sharp tip, thickened margins, and distinct lateral veins. Flowers are clustered into the typical "bottlebrushes" of Callistemons. The brushes are red and usually 9-10 cm long and approximately 50 mm in diameter. The stem upon which the filaments occur are covered in a soft downy hair at flowering (OEH 2012†). This species grows in dry sclerophyll forest on the coast and adjacent ranges (OEH 2012†). There are 4 records for this species in the locality and a total of 8 records for the Wyong LGA (OEH 2012a), with most individuals occurring within Munmorah SCA. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

viii. Eucalyptus camfieldii (Camfield's Stringybark)

Eucalyptus camfieldii is a mallee shrub/small tree ranging from 4 – 9 m in height. The bark is greyish-brown, rough, fibrous and stringy. The flowers are white while the fruit is flattened and globe-shaped. This species occurs mostly in exposed areas of on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heaths or low open woodland (OEH 2012k). This species occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (OEH 2012k). It grows in shallow sandy soils overlying Hawkesbury sandstone or Coastal heath, on exposed sandy ridges (SEWPaC 2012h). There are 7 records for this species in the locality and a further 36 records for the Wyong LGA (OEH 2012a), with most individuals occurring on the eastern side of Tuggerah Lake. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

ix. Genoplesium insignis (Variable Midge Orchid)

Genoplesium insignis is a terrestrial orchid with a solitary cylindrical leaf about 6 to 15 cm long that encloses the flowering stem, which is about 9 to 18 cm tall. The leaf is dark green with a reddish base. The flowering stem bears 5 to 12 dark purple flowers in a moderately dense spike. The flowering period is from September to October (OEH 2012‘). This species grows in patches of *Themeda australis* (Kangaroo Grass) amongst shrubs and sedges in heathland and forests. Associated vegetation is described as dry sclerophyll woodland dominated by *Eucalyptus haemastoma* (Scribbly Gum), *Corymbia gummifera* (Red Bloodwood), *Angophora costata* (Smooth-barked Apple) and *Allocasuarina littoralis* (Black She-oak). There is 1 record for this species in the locality and a total of 3 records for the Wyong LGA (OEH 2012a). All records occur east of the F3 freeway, with 2 occurring within Munmorah SCA. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area

x. Maundia triglochinoides

Maundia triglochinoides is an erect rhizomatous perennial herb that grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, with low nutrients. It is restricted to coastal NSW and extends into southern Queensland. The current southern limit

is Wyong; former sites around Sydney are now extinct (OEH 2012…). There is one record for this species in the locality and a further two records from the Wyong LGA (OEH 2012a). No individuals were recorded within the Study Area but are considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xi. Rutidosis heterogama (Heath Wrinklewort)

Rutidosis heterogama is a perennial herb with decumbent to erect stems, 30 cm high, growing from a woody base. The leaves are narrow and stalkless with curved edges and a rough texture. This species mainly flowers in Autumn (March – April) but occasionally from November – January. The flower heads are tiny and yellow. The species mostly inhabits heath, and is often found along disturbed roadsides (OEH 2012{). There are 66 records for this species in the locality and a total of 183 records in the Wyong LGA in two disjunct locations, Munmorah State Conservation Area (SCA) and around the Woongarrah area, south east of the Study Area (OEH 2012a). The species was previously recorded in the vicinity of the Study Area but was not recorded during OzArk surveys (OzArk 2012). However it is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xii. Syzygium paniculatum (Magenta Lilly Pilly)

Status: Vulnerable (EPBC Act); Vulnerable (TSC Act).

This rainforest species can form a tree to 15 m tall, but is generally 3–8 m high and shrubby in form. The stem is without conspicuous buttresses. The bark is flaky to almost tessellated, with the outer blaze cream, pale brown or pink, and fibrous in texture leaves are lanceolate to obovate, 4.5–10 cm long. Leaves are generally dark green and glabrous (smooth) on the upper surface and paler underneath (OEH 2012*f*). This species is found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (SEWPaC 2012t). Rainforests are often remnant stands of littoral or gallery rainforest. There are eight records for this species in the locality and a total of 70 records for the Wyong LGA (OEH 2012a). The species has not been recorded in the Study Area but has been assessed as potentially occurring based on the similarity of available habitats in the study area to recorded locations elsewhere within the Wyong LGA (BHP 2002). It is therefore considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xiii. Thelymitra sp. adorata (Wyong Sun Orchid)

Status: Critically Endangered (TSC Act)

Thelymitra sp. adorata is a hairless terrestrial herb. A single, erect, linear to linear-lanceolate leaf, emerges from the ground in about May and dies back annually around November to a tuberous rootstock. The leaf is green with a purplish base and sheathes the dark bluish-purple flowering stem at its base (NSW Scientific Committee 2008). Flowers are borne on slender stalks 1-14 mm long. Individual flowers are 15-27 mm across, pale to dark blue and only open in warm, sunny weather (OEH 2012•). The species is restricted to the Wyong area and occurs in woodland with grassy understorey in well-drained clay loam or shale derived soils. The majority of populations occur in vegetation described regionally (Bell 2002a) as

Dooralong Spotted Gum - Ironbark Forest (OEH 2012•). There are 18 records in the locality, (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

xiv. Eucalyptus parramattensis subsp. parramattensis (Eucalyptus parramattensis C. Hall. subsp. parramattensis in Wyong and Lake Macquarie local government areas)

Eucalyptus parramattensis subsp. parramattensis is a small to medium sized tree, growing up to 15 m high. The bark is white or grey, smooth and sheds in large plates or flakes. Leaves are lanceolate and dull green, 7 – 20 cm long. Flowers are white and grow in clusters of 7. The species is locally frequent alongside drainage lines and adjacent to wetlands, on sandy soils in low, often moist woodland sites (OEH 2012q). The population of *Eucalyptus parramattensis* subsp. *parramattensis* in Wyong and Lake Macquarie local government areas is at the north eastern limit of the species range and is disjunct from other known populations of the subspecies (NSW Scientific Committee 2003). There are 58 records in the locality, mostly from the Porters Creek and the Wallarah Creek catchments. Trees in the vicinity of the Study Area are predominantly clustered between the F3 Freeway and Main Northern Railway along Sparks Road (OEH 2012a). No individuals were recorded within the Study Area but are considered to have potential to occur based on the availability of suitable habitat in the Study Area.

(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 known and potential habitat for these species. Conservatively, the entire area of native vegetation to be removed in the surface infrastructure areas may be considered as potential habitat for these threatened flora species, however the area of suitable habitat for each species is likely to be considerably smaller than this.

Approximately 60.5 ha of native vegetation will be removed. An offset package has been developed which will protect approximately 208 ha of native vegetation. 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

The Project will remove potential habitat for the endangered population of *Eucalyptus parramattensis*. Conservatively, the entire area of native vegetation to be removed in the surface infrastructure areas may be considered as potential habitat for this threatened

population, however the area of suitable habitat for each species is likely to be considerably smaller than this.

Approximately 60.5 ha of native vegetation will be removed. An offset package has been developed which will protect approximately 208 ha of native vegetation. 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.

(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 or populations.

(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

Approximately 60.5 ha of native vegetation that may provide habitat for these species wil be removed. A further 2879.1 ha of habitat occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for these species.

No fragmentation will occur to flora species habitat as a result of the Project. Vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project.

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 60.5 ha of habitat for these species. However, large areas of habitat will remain in surrounding areas and a total of approximately 208 ha of native vegetation 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.

H.4 Giant Barred Frog

Giant Barred Frogs are large frogs, reaching lengths of up to 115 mm. The skin is finely granular. The dorsal surfaces are olive to dark brown with paler or darker blotches while the ventral surface is usually cream to pale yellow. Their distinguishing feature among barred frogs are the black thighs with smaller yellow spots, distinct barring on the limbs, dark blotches on the sides and absence of a creamy stripe on the upper lip (OEH 2012s). This species is found amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest (OEH 2012s). This species is a stream-breeding species with eggs deposited out of the water, under overhanging banks or on steep banks of large pools (SEWPaC 2012n). Giant Barred Frogs were recorded at four locations within the Extraction Area in Mountain Blue Gum – Turpentine Forest. Two to three individuals were visually recorded at one location while individuals were heard calling at the other locations. Previous studies have also recorded Giant Barred frogs within the Extraction Area (ERM 2003). There are 10 records of the species within the locality (OEH 2012a), with most occurring within Jilliby SCA.

Assessment of Significance

(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 known and potential habitat for this species. However this is a very small area and large areas (over 1,000 ha) of the same vegetation community will remain in the Study Area. Accordingly, the removal of this small area is not considered likely to place a viable local population of this 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

There are currently no endangered populations of the Giant Barred Frog listed under Part 2 of Schedule 1 of the TSC Act.

(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

Approximately 1.7 ha of Mountain Blue Gum – Turpentine Moist Shrubby Open Forest will be removed that is known to provide habitat for this species. A further 1040.7 of this community occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for this species. No impacts related to subsidence are expected to occur to waterways as a result of this project and therefore breeding habitat for this species will not be impacted.

No fragmentation will occur to habitat for this species as a result of the Project. Vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project. Breeding habitat in the waterways within the Study Area will remain.

The habitat to be removed is not considered to be important for the long term survival of the Giant Barred Frog. 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 the Giant Barred Frog 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 this species. Five Priority Actions have been identified for the Giant Barred Frog:

- Continue preparation of the recovery plan for the species to be completed in 2008;
- Monitor population size, habitat condition and threats at known sites;
- Protect habitat from impacting activities;
- Ensure species is considered in Plans of Management, environmental planning instruments and environmental impact assessment;
- Control weeds in riparian areas.

The Project is considered to be consistent with these actions.

(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 following KTP have potential to operate as a result of the Project and impact the Giant Barred Frog:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for this species;
- **Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands** as this can reduce habitat for this species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat for this species

Conclusion

The Project is expected to remove approximately 1.7 ha of known habitat for this species, however over 1,000 ha of suitable habitat (based on the community this species was recorded in) will remain in the Study Area. Additional areas of habitat will be subject to subsidence, however modelling indicates that this will not affect waterways or communities dependent on groundwater, that are important to the Giant Barred Frog.

Large areas of habitat will remain in surrounding areas and a total of approximately 200 ha of native vegetation will be conserved within the offset areas. It is expected that the Giant Barred Frog will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.5 Amphibians

The following Assessment of Significance has been prepared as a composite test for a number of threatened amphibians known to occur or with potential to occur within the Study Area.

i. Wallum Froglet (Crinia tinnula)

Wallum Froglet is a small frog species, usually less than 15 mm long. Their colour varies from brown to light or dark grey above and cream to dark grey below. The species' distinctive feature is a fine white line on the underside extending from the tip of the snout to the base of the abdomen (OEH 2012"). This species is found only in sedge swamps and acid paperbark swamps of the coastal 'wallum' country (OEH 2012"). Wallum Froglets were recorded at three locations in Swamp Mahogany/Paperbark swamp forests and Blackbutt – Turpentine forest at the Tooheys Road Site. Previous studies have also recorded Wallum Froglets in the vicinity of the Project Boundary (ERM 1998b, 1999, 2002, 2003, BHP 2003). There are 46 records of the species in the locality. Further records for the Wyong LGA (OEH 2012a), indicate occurrences predominantly on the eastern side of the F3 Freeway, including within Munmorah SCA.

ii. Green and Golden Bell Frog (Litoria aurea)

The Green and Golden Bell Frog is a stout frog, ranging in size from about 45 mm - 100 mm snout to vent length. Body colour is generally a vivid pea-green, with blue or bluish-green thighs and splotchy golden-brown markings that vary in their level of coverage. Their distinctive features are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye (OEH 2012y). This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.) (OEH 2012y). There are 8 records for the Green and Golden Bell Frog in the locality and a total of 10 for the Wyong LGA, with most occurring on the eastern side of the F3 Freeway. Although recent OzArk surveys did not locate this species, previous studies have recorded this species in the vicinity of the Extraction Area (BHP 2002, 2003) and historic records have located this species within the Hue Hue Road area (OEH 2012a).

iii. Green-thighed Frog (Litoria brevipalmata).

The Green-thighed Frogs are small frogs reaching lengths of up to 40mm. The body colour varies from rich brown to chocolate brown on the back, occasionally with small black flecks, and a broad black stripe running from the snout to the flank. The distinguishing feature is the bright green or blue-green colour on the groin and back of the thighs (OEH 2012x). This species occurs in a range of habitats from rainforest and moist eucalypt forest to dry

eucalypt forest and heath, typically in areas where surface water gathers after rain (OEH 2012x). There are 6 records in the locality and a total of 22 records in the Wyong LGA, with most occurring within Ourimbah SF (OEH 2012a). Previous studies have recorded this species in the Extraction Area (BHP 2002) and historic records have located this species within the Hue Hue Road area (OEH 2012a).

iv. Giant Burrowing Frog (Heleioporus australiacus)

The Giant Burrowing Frog is a large, powerfully built frog, growing to about 10 cm long. It has muscular hind limbs and enlarged tubercles on the feet which are well adapted to burrowing. Colouration varies from a steely blue grey to black on the limbs and upper body with paler sides. The body surface is granular and adorned with creamy white to yellow warts. The underside is generally white but occasionally with a tinge of bluish grey or brown (OEH 2012t). This species is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based (OEH 2012t). There are 47 records in the Wyong LGA, with most occurring within Ourimbah SF (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

v. Littlejohn's Tree Frog (Litoria littlejohni)

The Littlejohn's Tree Frog is a small frog reaching snout-vent lengths of about 55 – 60 mm. The body is generally pale brown, with dark speckles and a broad, dark band down its back while the belly is white or cream. The groin, armpit and back of the thighs have large orange patches and a brown bar runs from the tip of the snout through the nostrils to the top of the arm (SEWPaC 2012l). This species is found in heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground (OEH 2012,). There are 15 records in the Wyong LGA, with most occurring within Jilliby SCA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

vi. Stuttering Frog (Mixophyes balbus)

The Stuttering Frog is a relatively large, muscular frog growing up to lengths of about 8 cm. The body colour is brown to olive-green, usually in an irregular blotchy pattern, with a creamy-white underside, barred hind legs and a black line from the snout, through the eye, and above the 'ear'. The eyes are large and black eyes with vertical pupils and a distinctive pale-blue crescent across the upper half (OEH 2012□). This species is found in rainforest and wet, tall open forest in foothills and escarpments on the eastern side of the Great Dividing Range. In non-breeding periods adults live in deep leaf litter and thick understorey vegetation on the forest floor (OEH 2012□). There are 69 records for this species in the locality and 107 for the Wyong LGA, distributed between Jilliby SCA, Olney SF and in the vicinity of Ourimbah SF (OEH 2012a). Previous studies have located suitable habitat for this species in the Extraction Area (ERM 2003) and historic records have located this species in the Extraction Area (OEH 2012).

Assessment of Significance

(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 a small area of known and potential habitat for amphibians, mostly consisting of swamp forests. No wetland habitat will be removed. However this is a very small area and large areas of similar habitat will remain in the Study Area and the locality. Accordingly, the removal of a small area of habitat 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

There are currently no endangered populations of these amphibians listed under Part 2 of Schedule 1 of the TSC Act.

(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

As a conservative estimate for the purposes of this assessment, it is assumed that all the native vegetation in the Study Area may provide habitat for amphibians. Approximately 10.4 ha of native vegetation will be removed that may provide habitat for these species. A further 1624.9 ha of habitat occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for these species. Vegetation communities in the SIL are expected to remain intact and no impacts related to subsidence are expected to occur to important waterway habitat for amphibians as a result of the Project.

No fragmentation will occur to habitat for amphibians as a result of the Project. Vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project. Breeding habitat in the waterways within the Study Area will remain.

The habitat to be removed is not considered to be important for the long term survival of amphibians. Significant areas of native vegetation will be protected in the offset lands and large occurrences will remain outside the Study Area in the locality. No wetland areas will be impacted.

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

No critical habitat for these amphibians 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

A recovery plan has been prepared for the Green and Golden Bell Frog. This plan consists of five specific objectives that are:

- increase the security of key GGBF populations by way of preventing the further loss of GGBF habitat at key populations across the species range and where possible secure opportunities for increasing protection of habitat areas;
- ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the species;
- implement habitat management initiatives that are informed by data obtained through investigations into the general biology and ecology of the GGBF through a systematic and coordinated monitoring program;
- establish, within more than one institution, self sustaining and representative captive populations (particularly 'at risk' populations) of the Green and Golden Bell Frog for the primary purpose of maintaining 'insurance' colonies for re-establishment and supplementation of populations of the species; and
- increase the level of regional and local awareness of the conservation status of the Green and Golden Bell Frog and provide greater opportunity for community involvement in the implementation of this recovery plan.

The Project is considered to be consistent with these actions.

(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 following KTP have potential to operate as a result of the Project and impact these amphibian species:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat;
- **Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands** as this can reduce habitat for these species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat for these species

Conclusion

The Project is expected to remove approximately 10.4 ha of potential habitat for these species. Additional habitat will be subject to subsidence, however modelling indicates that this will not affect waterways or communities dependent on groundwater, that are important to amphibians.

Large areas of habitat will remain in surrounding areas and a total of approximately 208 ha of native vegetation will be conserved within the offset areas. It is expected that these amphibians will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.6 Wetland Birds

The following Assessment of Significance has been prepared as a composite test for a number of wetland bird species known or likely to occur within the Study Area.

i. Black-necked Stork (Ephippiorhynchus asiaticus)

The Black-necked Stork is a large bird about 1.3 m tall with a wingspan of around 2 m, and a massive, strong, black bill. The head and neck are black with an iridescent green and purple gloss while the rest of the body is white. The folded wings are largely black and cover much of the upperparts. The tail is short and black and the long legs are orange-red to bright red (OEH 2012f). This species is mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, extending into adjacent grasslands, paddocks and open savannah woodlands (OEH 2012f). There are 29 records in the locality and 37 for the Wyong LGA, concentrated mainly on the eastern side of the F3 Freeway, particularly around the southern area of Tuggerah Lake (OEH 2012a). Previous studies have recorded this species in the vicinity of Tooheys Road Site (ERM 1999) and within the Extraction Area (BHP 2002, 2003; ERM 2002, 2003).

ii. White-fronted Chat (Epthianura albifrons)

The White-fronted Chat is classified as a honeyeater and is similar in form to close relatives such as the Orange Chat, Yellow Chat and Crimson Chat. It has a distinguishing black and

white colouration, short slender bill, long spindly legs, a short square-tipped tail and rounded wings (OEH 2012"). This species occurs mostly in the southern half of NSW, in damp open habitats along the coast, and near waterways in the western part of the state. In coastal areas, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas (OEH 2012"). There are no recent records for this species within the locality or wider Wyong LGA. Although recent OzArk surveys did not locate this species, previous studies have recorded this species in the vicinity of Tooheys Road Site (ERM 1999).

iii. Black Bittern (Ixobrychus flavicollis)

The Black Bittern is a dark grey to black coloured heron with buff streaks on the throat and characteristic yellow streaks on the sides of the head and down the neck (OEH 2012h). This species inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. It is often found in flooded grassland, forest, woodland, rainforest and mangroves (OEH 2012h). There are seven records in locality and a total of 19 in the Wyong LGA, with most occurring near Tuggerah Lake (OEH 2012a). Although recent OzArk surveys did not locate this species, previous studies and historic records have recorded this species within the Extraction Area (BHP 2002, 2003; ERM 2002, 2003).

iv. Black-tailed Godwit (Limosa limosa)

The Black-tailed Godwit is a large wader with a distinctive long, straight bill that is pink with a black tip. There is a sharp demarcation between the white rump and the black tail. The wing has a white wing-bar across the dark flight feathers, and white underwing coverts. The non-breeding plumage, observed in Australia, is greyish-brown above and white below, and a grey breast (OEH 2012g). It is primarily a coastal species and is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. In inland areas, it can found on mudflats or in water less than 10 cm deep, around muddy lakes and swamps. Individuals have been recorded in wet fields and sewerage treatment works (OEH 2012g). There are 2 records in the Wyong LGA, near Tuggerah Lake (OEH 2012a). Although recent OzArk surveys did not locate this species, previous studies have recorded this species in the vicinity of Tooheys Road Site (ERM 1999).

v. Australasian Bittern (Botaurus poiciloptilus)

The Australasian Bittern is a large, stocky, heron-like bird with camouflage-like plumage. The upperparts are brown and dark brown to black, mottled buff in complex patterns that aid the bird's concealment in swamp vegetation; the underparts are streaked and scalloped brown and buff (OEH 2012b). In Australia, the Australasian Bittern mainly occurs in terrestrial wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (OEH 2012b). There are 2 records of this species in the locality with a total of 7 for the Wyong LGA (OEH 2012a) and suitable habitat for this species has been recorded within the Study Area (ERM 2003).

vi. Australian Painted Snipe (Rostratula australis)

The Australian Painted Snipe is a stocky wading bird with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye, and a white crown stripe, and metallic green back and wings, barred with black and chestnut (SEWPaC 2012s). The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (SEWPaC 2012s). There are no records of this species in the Wyong LGA but it was listed on the EPBC Protected Matters Search Tool. It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

Assessment of Significance

(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 may remove a small area of potential habitat for wetland birds, mostly consisting of low lying areas that may contain water from time to time, such as ephemeral drainage lines and poorly drained areas of grassland. Although some small wetland areas are present in the study area, none will be removed by the project. Much of the Study Area will be subject to impacts from subsidence, however modelling indicates that groundwater levels will change very little, and waterways will remain. Accordingly, the removal of a small area of potential habitat for wetland birds 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

There are currently no endangered populations of these wetland birds listed under Part 2 of Schedule 1 of the TSC Act.

(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

As a conservative estimate for the purposes of this assessment, it is assumed that all the native vegetation in the Study Area may provide habitat for wetland birds, although this is a vast overestimate. Approximately 60.5 ha of native vegetation will be removed for the surface infrastructure. A further 2879.1 ha of habitat occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for these species. Vegetation communities in the SIL are expected to remain intact and no impacts related to subsidence are expected to occur to waterway habitats as a result of the Project.

No fragmentation will occur to habitat for wetland birds as a result of the Project. No wetlands will be removed or modified and native vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project.

The habitat to be removed is not considered to be important for the long term survival of wetland birds. No wetland areas will be removed that are the primary habitats for these wetland birds. Although they have potential to forage in adjacent areas, particularly when they are waterlogged, they are not considered to be important foraging habitats and do not provide breeding habitat.

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

No critical habitat for these waterbirds 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 is considered to be consistent with these actions as no wetland areas will be impacted and the Project will result in the protection for conservation of approximately 208 ha of native vegetation.

(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 following KTP have potential to operate as a result of the Project and impact these wetland bird species:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat;
- **Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands** as this can reduce habitat for these species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat for these species

Conclusion

The Project is expected to remove approximately 60.5 ha of vegetation that does not provide important habitat for these species. Some habitat will be subject to subsidence, however modelling indicates that this will not affect waterways or communities dependent on groundwater, that are important to wetland birds.

Large areas of habitat will remain in surrounding areas and a total of approximately 208 ha of native vegetation will be conserved within the offset areas. It is expected that these waterbirds will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.7 Woodland and Forest Birds

i. Glossy Black Cockatoo (Calyptorhynchus lathami)

The Glossy Black-Cockatoo is a dusky brown to black cockatoo about 50 cm in length. It has a small crest, a large, bulbous bill and a broad red band with yellow edges and black bars along the tail (OEH 2012u). They are usually seen in pairs or small groups feeding quietly in she-oaks. This species is found along the coast and tablelands in eucalypt open forest and woodland with hollow-bearing trees and stands of she-oak species (Birds Australia 2011). The species feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species) (OEH 2012u). Glossy Black-Cockatoos were recorded at five locations in the Study Area by OzArk – three in Spotted Gum – Broad Leaved Ironbark Forest in the Hue Hue Road offset area and two in Scribbly Gum - Red Bloodwood woodland in the Tooheys Road Site. A further two incidental observations in Scribbly Gum - Red Bloodwood woodland within the Tooheys Road Site were made by Cumberland Ecology during the November and December survey periods. Two mated pairs (four birds in total) were recorded during the December observation. Previous studies have also recorded this species within the Project Boundary (ERM 1999, 2002). There are 47 records of the species in the locality (OEH 2012a). In the Wyong LGA, this species has been recorded predominantly from Watagans/Olney SF and Jilliby SCA (OEH 2012a).

ii. Varied Sittella (Daphoenositta chrysopter)

The Varied Sittella is a small (10 cm) songbird with a sharp, slightly upturned bill, grey head, yellow eyes and feet, and streaked dark brown. It has a white rump and orange wing-bar with are prominent during flight (OEH 2012'). This species is sedentary and inhabits eucalypt forests and woodlands. It prefers rough-barked tree species and mature smooth-barked gums with dead branches where it feeds on arthropods (OEH 2012'). Varied Sittellas were recorded at five locations in the Study Area – three in Smooth-barked Apple - Red Bloodwood forest in the Hue Hue Road offset area, one in cleared area within the Tooheys Road Site and one in Spotted Gum – Broadleaved Ironbark open forest at Buttonderry. Previous studies have also recorded this species within the Project Boundary (ERM 1999). There are 18 records of the species within the locality (OEH 2012a). In the Wyong LGA, this species is widely distributed among Jilliby SCA, Olney SF, Ourimbah SF and around Budgewoi, Mannering and Munmorah Lakes (OEH 2012a).

iii. Little Lorikeet (Glossopsitta pusilla)

The Little Lorikeet is a small parrot about 16-19 cm long. It is bright green with a red face, black bill, olive-yellow undertail and a mantle imbued with light brown (OEH 2012□). This species occurs mostly in dry, open eucalypt forests and woodlands but also moves into riparian habitats to forage. The species is partly nomadic (Higgins 1999), with movements occurring primarily in response to food availability (OEH 2012□). The Little Lorikeet was recorded from a single location in Smooth-barked Apple - Red Bloodwood forest at the Hue Hue Road offset area. Previous studies have also recorded this species within the Extraction Area (ERM 2003). There are 8 records of the species in the locality and 38 for the Wyong LGA (OEH 2012a), with majority occurring on the eastern side of the F3 Freeway, near Tuggerah, Budgewoi and Munmorah Lakes.

iv. Bush Stone-curlew (Burhinus grallarius)

The Bush Stone-curlew is about 55 cm tall with a grey to light brown back, marked with black blotches, and a streaked rump. The underparts are buff and white with dark streaks, and a black band that runs from near its eye down its neck. It has large, bright yellow eyes and a hunch-shouldered stance on long spindly legs (OEH 2012i). This species inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber (OEH 2012i). There is one record in the locality and 3 records in the Wyong LGA, distributed among Jilliby SCA, Ourimbah SF and the southern shores of Tuggerah Lake (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

v. Gang-gang Cockatoo (Callocephalon fimbriatum)

Gang-gang Cockatoos range in length from 32 to 37 cm, with a wingspan of 62 to 76 cm and are mostly slate-grey. Males have a distinctive scarlet head and wispy crest, while females have a grey head and crest and feathers edged with salmon pink on the underbelly (OEH 2012r). They are generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests but can migrate to lower altitudes, drier

more open eucalypt forests and woodlands in winter. They are often found in urban areas (OEH 2012r). There are 10 records in the locality and 53 records in the Wyong LGA, with most occurring within Olney SF but with some records within Jilliby SCA and Ourimbah SF (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

vi. Regent Honeyeater (Anthochaera phrygia)

The Regent Honeyeater has a black head, with a patch of warty, dirty yellowish to pinkish skin around its dark red-brown eye, and a sturdy, decurved, black bill. The upperparts of its body are black, but heavily scalloped with pale yellow, and the wings each have three conspicuous panels that are predominantly darker yellow. The upper tail, when closed, is black with a yellow tip and edge (SEWPaC 2012a). This species inhabits temperate woodland and dry open forest; Box-Ironbark woodland and riparian forests of River Sheoak. It sometimes occurs in coastal forest, especially in stands dominated by Swamp Mahogany, Spotted Gum, and Southern Mahogany (SEWPaC 2012a). There are 7 records of this species in the locality with a total of 14 for the Wyong LGA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

vii. Swift Parrot (Lathamus discolor)

The Swift Parrot is a small parrot about 25 cm long with a distinctive thin, long tail, about 12 cm. The body is bright green with a blue-purple crown, red tail, and red around the bill, throat and forehead. The red on its throat is edged with yellow and there are bright red patches under the wings (OEH 2012□). This species migrates to the Australian south-east mainland between March and October and is found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Their favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*) (OEH 2012□). There are 12 records in the locality and 118 records in the Wyong LGA, concentrated completely along the eastern side of the F3 Freeway, from the southern edge of Tuggerah Lake to the northern shores of Lake Munmorah (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Assessment of Significance

(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 a small area of potential habitat for woodland and forest depending birds, consisting of 60.5 ha of native vegetation. In excess of 2,500 ha of native vegetation will remain in the Study Area and large areas of woodland and forest habitat occur in the locality, much of it in reserves. Approximately 208 ha of native vegetation will be protected within the proposed offset areas. Accordingly, the removal of a small area of potential

habitat for woodland and forest dependent birds is not considered likely to place a viable local population of any 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

There is one population of the Gang Gang Cockatoo that is listed as an endangered population under the TSC Act; the Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas. The official limit of this population falls outside the study area to the south-east, however this is a highly mobile species and there is potential for individuals that form part of this population to occur in the Study Area from time to time.

An endangered population of the Glossy Black Cockatoo occurs in the Riverina, however this is remote from the study area and the individuals recorded are not part of this population.

There are currently no endangered populations of the other forest and woodland dependent birds listed under Part 2 of Schedule 1 of the TSC Act.

(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

All the native vegetation in the Study Area may provide habitat for the woodland and forest dependent birds. Approximately 60.5 ha of native woodland and forest vegetation will be removed for the surface infrastructure. A further 2879.1 ha of this kind of habitat occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for these species. Vegetation communities in the SIL are expected to remain intact and no impacts related to subsidence are expected to occur to forest and woodland vegetation as a result of the Project.

No fragmentation will occur to forest and woodland habitat as a result of the Project. Native vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project.

The habitat to be removed is not considered to be important for the long term survival of forest and woodland dependent birds. Over 2,500 ha of this kind of habitat will remain in the Study Area and over 200 ha will be conserved within the offset areas.

(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

A recovery plan has been prepared for the Bush Stone-curlew. The overall objective of this Recovery Plan is to manage at least five populations of the Bush Stonecurlew across NSW to ensure they are secure and consistently increasing in both extent of occurrence and area of occupancy over the 5 years of the plan.

No other 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 is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 207 ha of native vegetation.

(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 following KTP have potential to operate as a result of the Project:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important ground foraging and nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

Conclusion

The Project is expected to remove approximately 60.5 ha of vegetation that does not provide important habitat for these species. Some habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to these birds.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation 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 to woodland and forest dependent bird species as a result of the Project.

H.8 Raptors

The following Assessment of Significance has been prepared as a composite test for a number of threatened raptors (birds of prey) known to occur or with potential to occur within the Study Area.

i. Little Eagle (Hieraaetus morphnoides)

The Little Eagle is a small to medium sized raptor uncommon but with widespread distribution across mainland Australia (Birds Australia 2011). Body colour can either be a dark brown dorsal surface, rusty head, and pale undersurface with a distinctive rufous underwing pattern or a pale brown body with obscure underwing patterning. Both forms have a black-streaked head with a slight crest, a pale shoulder band on the upperwings, feathered legs and a rather short and square-tipped barred tail (OEH 2012□). The species is most commonly found in open eucalypt forest and woodland, She-oak or acacia woodlands and riparian woodlands with abundant prey availability (NSW Scientific Committee 2010). The Little Eagle was recorded at one location near Coachwood – Crabapple rainforest in the Extraction Area. There are 5 records of the species in the locality and 8 within the Wyong LGA (OEH 2012a), with most occurring near Tuggerah Lake.

ii. Powerful Owl (Ninox strenua)

The Powerful Owl is Australia's largest owl reaching lengths of 60 cm. The dorsal surface is dark, greyish-brown with indistinct off-white bars while the ventral surface is whitish with dark greyish-brown V-shaped markings. It has staring yellow eyes with no facial discs (OEH 2012‡). This species inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It requires large hollows up to 1 m wide and 2 m deep in large remnant trees for nesting (NSW Scientific Committee 2004e, Soderquist and Gibbons 2007). Powerful Owls were recorded at three locations in the Study Area – in Scribbly Gum – Red Bloodwood woodland at the Tooheys Road Site, Smooth-barked Apple – Red Bloodwood forest at Buttonderry and in Spotted Gum – Grey Ironbark forest in the Extraction Area. Previous studies have also located this species within the Tooheys Road Site (ERM 2002). There are 43 records of the species in the locality and a total of 90 for the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, Munmorah SCA, Olney SF, Ourimbah SF, and on the eastern side of the F3 Freeway towards Tuggerah Lake.

iii. Masked Owl (Tyto novaehollandiae)

The Masked Owl is medium-sized owl, reaching lengths of 40 - 50 cm. It has dark eyes set in a prominent flat, heart-shaped facial disc that is encircled by a dark border. The legs are feathered up to the toes and the feet are large. The plumage colouration varies from grey to dark brown upperparts and white to rufous-brown underparts. The upperparts generally have fine, pale spots and/or buff to rufous mottling while the underparts have variable dark spotting (OEH 2012„). This species occurs in dry eucalypt forests and woodlands but often hunts along the edges of forests, including roadsides (OEH 2012„). A single Masked Owl was recorded in Scribbly Gum - Red Bloodwood woodland at the Tooheys Road Site. Previous studies have also recorded this species at Tooheys Road, Hue Hue Road, Buttonderry (ERM 1999) and the Extraction Area (BHP 2002). There are 19 records of the species in the locality and 27 within the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, the western shores of Tuggerah Lake and along the F3 Freeway.

iv. Sooty Owl (Tyto tenebricosa)

The Sooty Owl is medium-sized owl, reaching lengths of 45 cm. It has dark eyes set in a prominent flat, heart-shaped facial disc. The plumage is dark sooty grey with fine white spots. The face is also grey whereas the abdomen is pale (OEH 2012‰). This species mainly occurs in rainforest areas, including dry rainforest, subtropical and warm temperate rainforest, but is also found in moist eucalypt forests (OEH 2012‰). Sooty Owls were recorded in Spotted Gum – Grey Ironbark forest at five locations within the Extraction Area. Previous studies have also recorded this species within the Project Boundary (BHP 2002, 2003). There are 43 records of the species in the locality and 110 within the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, Olney SF, Ourimbah SF, and along the F3 Freeway near the southern edge of Wyong LGA.

v. Barking Owl (Ninox connivens)

The Barking Owl is a medium-sized owl, about 42 cm long. It has bright yellow eyes and no facial-disc. The dorsal parts are brown or greyish-brown, and the white breast is vertically streaked with brown. The talons are large and yellow (OEH 2012c). This species inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. Hunting can extend in to closed forest and more open areas (OEH 2012c). There are 2 records in the locality and 3 records in the Wyong LGA, distributed around Tuggerah Lake (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Assessment of Significance

(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 known and potential forage and breeding habitat of these raptor species. However this is a very small area and approximately 44.5 ha of native vegetation will be removed. These species are highly mobile with large home ranges and have the

capacity to access resources from a wide area. Large areas of similar habitat will remain in the Study Area and the locality and 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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of the TSC Act.

(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

Approximately 44.5 ha of native vegetation that provides potential foraging habitat for these species wil be removed. A further 2240.9 may be affected by subsidence, however this is not expected to impact on habitat for these species as woodland vegetation will remain.

No areas of habitat will become isolated as part of the proposal. These are highly mobile birds that will be able to fly over disturbed areas to access other areas of habitat.

(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

A draft recovery plan has been prepared for the Barking Owl, and a final recovery plan has been prepared for Large Forest Owls, which covers the Masked Owl, the Sooty Owl and the Powerful Owl. No recovery plan has been prepared for the Little Eagle.

The overall objective of the NSW Large Forest Owl recovery plan is to ensure that viable populations of the three species continue in the wild in NSW in each region where they presently occur. The overall objective of the five-year draft Recovery Plan for the Barking Owl is to ensure the long-term persistence of the Barking Owl in NSW. The project is considered to be consistent with these objectives, as it is considered that the Project will not impact on a viable population of these owl species and they will persist in and near the Study Area.

(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 following KTP are relevant to raptors:

- **Clearing of native vegetation** as this reduces the area of forage and nesting habitat available for these species;
- **Loss of hollow-bearing trees** as this reduces the abundance of nesting habitat;
- **Removal of dead wood and dead trees** as this reduces the abundance of important ground foraging and nesting habitat; and
- **Competition from feral honey bees (*Apis mellifera*)** as they compete with native fauna for tree hollows and floral resources

Conclusion

The Project is expected to impact on approximately 44.5 ha of known and potential habitat for these species through the removal of woodland and forest vegetation for the surface infrastructure areas. Further areas of habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to these birds.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation 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 to raptors as a result of the Project.

H.9 Arboreal Mammals

i. Eastern Pygmy Possum (Cercartetus nanus)

Eastern Pygmy-possums is a small, active climber, with large, forward pointing ears and, a head and body length range of 70 – 110 mm. The tail is prehensile, almost bare and reaches

lengths of up to 105 mm. They have a light brown dorsal surface and a white ventral surface (OEH 2012p). They are found in a broad range of habitats such as rainforests, sclerophyll forests, woodlands and heath with a preference for woodlands/heath appear (OEH 2012p). Eastern Pygmy Possum was recorded at a single location in Coachwood – Crabapple rainforest within the Extraction Area. There are no previous records for this species in the locality but there are 16 records of the species within the Wyong LGA (OEH 2012a), with one occurring in Munmorah SCA and the others within Olney SF.

ii. Squirrel Glider (Petaurus norfolcensis)

Adult Squirrel Gliders are medium sized gliders, reaching head-body lengths of 20 cm. The fur is blue-grey to brown-grey on the dorsal surface and white on the belly. The tail is soft and busy, with black fur on the end third and reaches lengths of up to 27 cm. They have a dark stripe starting from between the eyes extending to the mid-back and distinct facial markings (OEH 2012Œ). Squirrel Gliders commonly inhabit Blackbutt-Bloodwood forest with heath understorey in coastal areas with a preference for mixed species strands with an open or shrubby understorey (OEH 2012Œ). Squirrel Gliders were recorded at 3 locations in the Tooheys Road Site, in Scribbly Gum – Red Bloodwood woodland and Blackbutt – Turpentine forest. Previous studies have also recorded this species in the Tooheys Road Site and Hue Hue Road offset area (ERM 1998a, 1998b, 1999; 2002; BHP 2002, 2003). There are 93 records of the species in the locality and 147 within the Wyong LGA (OEH 2012a), predominantly concentrated on the eastern side of the F3 Freeway but with scattered records within Jilliby SCA and Olney SF.

iii. Yellow-bellied Glider (Petaurus australis)

The Yellow-bellied Glider is a large, active, glider, reaching head-body lengths of about 30 cm. It has a large bushy tail which is about 45 cm long. The fur is grey to brown on the dorsal surface with a cream to yellow belly and a characteristic dark stripe down the back. It has a large, gliding membrane that extends from the wrist to the ankle (OEH 2012–). They generally occur in tall mature eucalypt forest, usually in areas with high rainfall and nutrient rich soils (OEH 2012–). Yellow Bellied gliders were recorded at nine locations within the Extraction Area in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest and one location in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road offset area. Previous studies have also recorded this species in the Tooheys Road Site (ERM 2002) and the Extraction Area (BHP 2002, 2003). There are 139 records of the species in the locality and 270 within the Wyong LGA (OEH 2012a), with most occurring on the western side of the F3 Freeway, distributed among Jilliby SCA, Olney SF and Ourimbah SF.

Assessment of Significance

(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 a small area of potential habitat for arboreal mammals, consisting of 46.6 ha of native vegetation. In excess of 2,500 ha of native vegetation will remain in the

Study Area and large areas of woodland and forest habitat occur in the locality, much of it in reserves. Approximately 208 ha of native vegetation will be protected within the proposed offset areas. Accordingly, the removal of a small area of potential habitat for woodland and forest dependent birds is not considered likely to place a viable local population of any 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

There is one population of the Yellow-bellied Glider that is listed as an endangered population under the TSC Act; the Yellow-bellied Glider population on the Bago Plateau. Two populations of the Squirrel Glider are listed as endangered populations under the TSC Act; Squirrel Glider population in the Wagga Wagga area, and the Squirrel Glider population on the Barrenjoey Peninsula north of Bushrangers Hill. These all fall outside the Study Area, however the Squirrel Glider population on the Barrenjoey Peninsula north of Bushrangers Hill is located relatively close to the Study Area to the east and there is potential for individuals that form part of this population to occur in the Study Area from time to time.

There are no endangered populations of the Eastern Pygmy Possum listed under Part 2 of Schedule 1 of the TSC Act.

(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

All the native vegetation in the Study Area may provide habitat for the arboreal mammals. Approximately 46.6 ha of native woodland and forest vegetation will be removed for the surface infrastructure. A further 2142.8 ha of this kind of habitat occurs in the SIL and may be subject to minor levels of subsidence, however this is not expected to impact on habitat for these species. Vegetation communities in the SIL are expected to remain intact and no

impacts related to subsidence are expected to occur to forest and woodland vegetation as a result of the Project.

No fragmentation will occur to native vegetation habitat as a result of the Project. Native vegetation will remain contiguous around each disturbance area and there is not expected to be significant additional fragmentation as a result of the Project.

The habitat to be removed is not considered to be important for the long term survival of arboreal mammals. Over 2,500 ha of this kind of habitat will remain in the Study Area and over 200 ha will be conserved within the offset areas.

(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

A recovery plan has been prepared for the Yellow-bellied Glider. The overall objective of this Recovery Plan is to achieve multiple viable populations of the Yellowbellied Glider dispersed throughout its range in NSW and across environmental gradients.

No recovery plan or threat abatement plan has been prepared for the other arboreal mammal 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 is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 200 ha of native vegetation.

(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 following KTP have potential to operate as a result of the Project:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes remnant trees of this community and reduces the abundance of denning habitat;
- **Removal of dead wood and dead trees** as this removes potential hollow bearing trees; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

Conclusion

The Project is expected to remove approximately 46.6 ha of vegetation that does not provide important habitat for these species. Some habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to these arboreal mammals.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation 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 to arboreal mammal species as a result of the Project.

H.10 Koala (Phascolarctos cinereus)

The Koala is an arboreal marsupial with fur ranging from grey to brown above, and white on the belly. It has large furry ears, a prominent black nose and no tail. It has long, sharp claws, adapted for climbing and spends most of its time in trees (OEH 2012|). Koalas inhabit eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species. They develop preferences for some species in any one area. They are generally inactive for most of the day, feeding and moving mostly at night (OEH 2012|). There are 11 records in the locality and 36 records in the Wyong LGA, spread across the LGA (OEH 2012a). It has not been previously recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat in the Study Area.

Assessment of Significance

(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 potential habitat for this species. However this is a very small area and only approximately 51.5 ha of native vegetation will be removed. Large areas of similar habitat will remain in the Study Area and the locality and 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

Two endangered populations of the Koala occur in NSW; the Koala population in the Pittwater LGA, and the Hawks Nest and Tea Gardens endangered population. These populations are remote from the Study Area and the individuals from these populations are unlikely to occur.

(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

Approximately 51.5 ha of native vegetation that provides potential foraging habitat for the Koala will be removed. A further 2240.9 may be affected by subsidence, however this is not expected to impact on habitat for this species as woodland vegetation will remain.

No areas of habitat will become isolated as part of the proposal. Native vegetation will remain contiguous around the disturbance areas.

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

No critical habitat for this 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

A recovery plan has been prepared for the Koala. The overall objective of this recovery plan is to reverse the decline of the koala in New South Wales, to ensure adequate protection, management and restoration of koala habitat, and to maintain healthy breeding populations of koalas throughout their current range. The Project is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 208 ha of native vegetation.

(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 KTP **Clearing of native vegetation** is relevant to the koala as this reduces the area of habitat available for this species.

Conclusion

The Project is expected to impact on approximately 51.5 ha of potential habitat for the Koala through the removal of woodland and forest vegetation for the surface infrastructure areas. Further areas of habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to this species.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation will be conserved within the offset areas. It is expected that the Koala will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.11 Spotted-tailed Quoll (Dasyurus maculatus)

The Spotted-tailed Quoll is about the size of a domestic cat. It has rich-rust to dark-brown fur on the dorsal side with irregular white spots on the back and tail, and a pale belly. The spotted tail is a distinguishing feature which is indistinct on juveniles (OEH 2012‹). This species is found across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (OEH 2012‹). There are 14 records of the species in the locality and 42 records in the Wyong LGA, spread across the LGA (OEH 2012a). Previous studies have recorded this species within the Extraction Area (BHP 2002, 2003).

Assessment of Significance

(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 potential habitat for this species. However this is a very small area and only approximately 48.4 ha of native vegetation will be removed. Large areas of similar habitat will remain in the Study Area and the locality and the removal of this small area is not considered likely to place a viable local population of the Spotted-tailed Quoll 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

No endangered populations of the Spotted-tailed Quoll occur in NSW.

(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

Approximately 48.4 ha of native vegetation that provides potential foraging habitat for the Spotted-tailed Quoll will be removed. A further 2725.8 may be affected by subsidence, however this is not expected to impact on habitat for this species as woodland vegetation will remain.

No areas of habitat will become isolated as part of the proposal. Native vegetation will remain contiguous around the disturbance areas.

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

No critical habitat for this 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

A recovery plan or a threat abatement plan has not been prepared for the Spotted-tailed Quoll. Priority Actions have been identified for this species, which have the overall aim of preventing it from declining further and promoting its recovery. The Project is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 208 ha of native vegetation.

(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 following KTP have potential to operate as a result of the Project:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for this species;
- **Removal of dead wood and dead trees** as this removes potential den sites; and

- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

Conclusion

The Project is expected to impact on approximately 48.4 ha of potential habitat for the Spotted-tailed Quoll through the removal of woodland and forest vegetation for the surface infrastructure areas. Further areas of habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to this species.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation will be conserved within the offset areas. It is expected that the Spotted-tailed Quoll will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.12 Grey-headed Flying-fox (Pteropus poliocephalus)

The Grey-headed Flying-fox is a large bat, with a head and body length of 23 - 29 cm and a wingspan of up to 1 m. It has black wing membrane, dark grey fur on the body and lighter grey fur on the head with a russet collar encircling the neck. A distinguishing feature is the leg fur which extends to the ankle (OEH 2012z). This species occurs in a variety of habitats, ranging from subtropical and temperate rainforests to tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. They have roosting camps, often in gullies with dense vegetation and nearby water, which are generally located within 20 km of a regular food source. Individual camps may have tens of thousands of animals and are used for mating, giving birth and rearing young (OEH 2012z). Grey-headed Flying-foxes were recorded at eight locations within the within the Extraction Area in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest. There are 30 records of the species in the locality and 66 within the Wyong LGA (OEH 2012a), with most occurring on the eastern side of the F3 Freeway, mainly around the Tuggerah Lake area and in Munmorah SCA.

Assessment of Significance

(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 potential foraging habitat for the Grey-headed Flying Fox. No breeding habitat occurs and no breeding camps are present in the Study Area. The area of vegetation to be removed is a very small area and only approximately 48.4 ha of native vegetation will be removed. Large areas of similar habitat will remain in the Study Area and the locality and the removal of this small area is not considered likely to place a viable local population of the Grey-headed Flying Fox 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

No endangered populations of the Grey-headed Flying Fox occur in NSW.

(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

Approximately 48.4 ha of native vegetation that provides potential foraging habitat for the Grey-headed Flying Fox will be removed. A further 2725.8 ha may be affected by subsidence, however this is not expected to impact on habitat for this species as woodland vegetation will remain.

No areas of habitat will become isolated as part of the proposal. Native vegetation will remain contiguous around the disturbance areas.

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

No critical habitat for this 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

A recovery plan or a threat abatement plan has not been prepared for the Grey-headed Flying Fox. Priority Actions have been identified for this species, which have the overall aim of preventing it from declining further and promoting its recovery. The Project is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 208 ha of native vegetation.

(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 following KTP have potential to operate as a result of the Project:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for this species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

Conclusion

The Project is expected to impact on approximately 48.4 ha of potential foraging habitat for the Grey-headed Flying Fox through the removal of woodland and forest vegetation for the surface infrastructure areas. Further areas of habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to this species. No breeding habitat occurs and no camps are located within the Study Area.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation will be conserved within the offset areas. It is expected that the Grey-headed Flying Fox will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.

H.13 Microchiropteran Bats

The following Assessment of Significance has been prepared as a composite test for a number of threatened microchiropteran bat species known to occur or with potential to occur within the Study Area.

i. Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris)

Yellow-bellied Sheathtail-bat is a large, insectivorous bat, growing up to 87 mm long. It has a glossy, jet-black back, a white to yellow belly extending to the shoulders and long, narrow wings. The tail is covered with an extremely elastic sheath and it has a distinctive flattened head with a sharply-pointed muzzle (OEH 2012—). This species is primarily a tree-hollow roosting species although it will roost in buildings. It forages in a wide range of habitats, both with and without trees, and appears to defend an aerial territory (NSW Scientific Committee 2004h). The Yellow-bellied Sheathtail-bat was recorded at 1 location in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road Site. Previous studies have also recorded this species in the within the Tooheys Road Site and Hue Hue Road offset area (ERM 1999). There are 3 records of the species in the locality (OEH 2012a), located on the eastern side of the F3 Freeway, near Sparks Road.

ii. East-coast Freetail Bat (Mormopterus norfolkensis)

The East-coast Freetail-bat is a solitary, insectivorous bat (Churchill 2008) with dark brown to reddish brown fur on the back and slightly paler underparts. It has a long bare tail protruding from the tail membrane which can be about 3 – 4 cm long (OEH 2012o). This species is most commonly found in open spaces in dry sclerophyll forests, woodland and swamp forests in eastern NSW (NSW Scientific Committee 2004a). The species mainly roost in spout hollows of large mature trees and sometimes under bark or in man-made structures. It is also known to forage in gaps in upper-slope vegetation and over larger waterways (OEH 2012o). The East-coast Freetail-bat was recorded from three locations in Coachwood Crabapple rainforest and Spotted Gum – Grey Ironbark forest within the Extraction Area and three locations in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road Offset area. Previous studies have recorded this species in the Extraction Area (ERM 2003) and there are 28 records of the species in the locality. Records for the Wyong LGA (OEH 2012a) indicate that this species mostly occurs on the eastern side of the F3 Freeway, distributed from Ourimbah up to Chain Valley Bay.

iii. Eastern False Pipistrelle (Falsistrellus tasmaniensis)

The Eastern False Pipistrelle is a relatively large microbat with a head-body length of about 65 mm. The fur on the dorsal surface is dark to reddish-brown and pale grey on the underside. The long, slender ears are set well back on the head and there is some sparse hair on the nose (OEH 2012n). This species prefers moist habitats, with trees taller than 20 m. It usually roosts in eucalypt hollows, but can also be found under loose bark on trees or in buildings (OEH 2012n). The Eastern False Pipistrelle was recorded at 15 locations within the Study Area – 4 at the Tooheys Road Site, 3 at the Hue Hue Road Offset site and 8 within the Extraction Area. Individuals in the Tooheys Road Site were found in Scribbly Gum – Red Bloodwood woodland or Blackbutt – Turpentine Forest, in Spotted Gum – Broadleaved Ironbark forest in the Hue Hue Road offset while those in the Extraction Area were found either in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine Forest. Previous studies have also recorded this species in the Extraction Area (BHP 2002). There are 16 records of the species in the locality and 49 within the Wyong LGA (OEH 2012a), with most occurring along the F3 Freeway but with some sightings in Olney SF.

iv. Golden-tipped Bat (Kerivoula papuensis)

The Golden-tipped Bat is a large bat with a wingspan of about 25 cm. It has dark brown, curly fur with bright golden tips which extends along the wings, legs and tail. It has a short, pointed, over-hanging muzzle and pointy, funnel-shaped ears (OEH 2012v). This species is found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. It has also been recorded in tall open forest, Casuarina dominated riparian forest and coastal Melaleuca forests. It mainly roosts in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests but is also found in tree hollows, dense foliage and epiphytes; located in rainforest gullies on small first- and second-order streams (OEH 2012v). The Golden-tipped bat was recorded from 1 location in Smooth-barked Apple – Red Bloodwood open forest within the Hue Hue Road Offset. There are 24 records in the locality and 48 records in the Wyong LGA, distributed among Jilliby SCA, Olney SF and Ourimbah SF (OEH 2012a).

v. Little Bentwing Bat (Miniopterus australis)

The Little Bentwing Bat is a small insectivorous bat with a body length of about 45 mm. It has long, thick fur, especially around the neck and crown, which is dark chocolate brown on the back and lighter on the belly. The muzzles are short and the ears are rounded and roughly triangular in shape. The tip of the wing is formed by a particularly long joint of the third finger, folded back and bent under the wing while the bat is at rest (OEH 2012□). The species inhabits a variety of habitats ranging from moist eucalypt forest, rainforest, wet and dry sclerophyll forests and vine thickets to *Melaleuca* swamps, dense coastal forests and Banksia scrub. It is generally found foraging in densely vegetated habitats and roosts in a variety of places such as caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings (OEH 2012□). The Little Bentwing Bat was recorded at 17 locations in the Study Area – 13 in the Extraction Area and 4 in the Hue Hue Road Offset. Individuals in the Extraction Area were found either in Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine forest while those in the Hue Hue Road Offset were found either in Spotted Gum – Broadleaved Ironbark forest or Smooth-barked Apple – Red Bloodwood open forest . Previous studies have also recorded this species in the vicinity of the Tooheys Road and Hue Hue road offset areas (ERM 1998a, 1998b, 1999). There are 17 records of the species in the locality and 47 within the Wyong LGA (OEH 2012a), with most occurring on the eastern side of the F3 Freeway, distributed from the Ourimbah up to Chain Valley Bay and some scattered records within Jilliby SCA and Ourimbah SF.

vi. Eastern Bentwing Bat (Miniopterus orianae oceanensis)

The Eastern Bentwing Bat has a head and body length of about 6 cm and a wingspan of 30 - 35 cm. The fur on the back varies from chocolate to reddish-brown with slightly lighter coloured fur on its belly. It has a short snout and a high, domed head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the species its characteristic 'bentwing' appearance (OEH 2012m). This species is insectivorous and almost exclusively roosts in caves and artificial constructions such as mines along the east coast of Australia (Churchill 2008). In south eastern Australia the species hibernates in underground sites, usually large caves with a constant microclimate, during winter. It requires very specific conditions in terms of temperature and humidity for maternity sites. The species changes roosts in response to seasonal needs, and in turn long-distance movements occur (OEH 2012m). The Eastern Bentwing Bat was recorded at five locations in the Extraction area, predominantly in Mountain Blue Gum Turpentine forest with one recording near Honeysuckle Park. Previous studies have also recorded this species in the vicinity of the Tooheys Road area (ERM 1998b). There are 52 records of the species in the locality and a total of 118 within the Wyong LGA (OEH 2012a), distributed among Jilliby SCA, Olney SF, Ourimbah SF and areas east of the F3 Freeway up to Tuggerah and Budgewoi Lakes.

vii. Southern Myotis (Myotis macropus)

The Southern Myotis (formerly Large-footed Myotis) is a cave-dwelling, fishing bat with a wingspan of about 28 cm. It has disproportionately large feet; more than 8 mm long, which

are distinctly hairy with widely-spaced toes and long, curved claws. The fur on the back varies from dark-grey to reddish brown and becomes paler on the belly (OEH 2012Š). This species has a primarily coastal distribution along the east coast to the Kimberley, and along major rivers in south eastern Australia (Churchill 2008). They generally roost in groups of 10 - 15 in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Roosting sites are often close to water as the species forages over streams and pools catching insects, prawns and small fish by raking their feet across the water surface (NSW Scientific Committee 2004d). The Southern Myotis was recorded at eight locations within the Study Area – one at Tooheys Road, four at Hue Hue Road Offset and three in the Extraction Area. The recording at Tooheys Road occurred in Scribbly Gum – Red Bloodwood woodland, in Spotted Gum – Broadleaved Ironbark forest or Smooth-barked Apple – Red Bloodwood open forest at Hue Hue Road and either in Mountain Blue Gum Turpentine forest or Spotted Gum – Grey Ironbark forest in the Extraction Area. Previous studies have also recorded this species in the vicinity of the Tooheys Road (ERM 1998b 1999) and the Extraction Area (ERM 2003). There are 26 records of the species in the locality and 48 within the Wyong LGA (OEH 2012a), mostly in areas east of the F3 Freeway but with scattered records within Jilliby SCA and near Wyong SF and Ourimbah SF.

viii. Greater Broad-nosed Bat (Scoteanax rueppellii)

The Greater Broad-nosed Bat is a large, insectivorous bat, up to 95 mm long, with a broad head and a short square muzzle. The fur on the dorsal surface varies from dark reddish-brown to mid-brown and becomes slightly paler on the under parts (OEH 2012w). The species is found in a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest. It mainly roosts in tree hollows and cracks or fissures in trunks and branches (NSW Scientific Committee 2004c). It is also known to prey on other microbat species (Churchill 2008). The Greater Broad-nosed Bat was recorded at seven locations within the Study Area – three in Spotted Gum Broadleaved Ironbark forest in the Hue Hue road offset site and four in Spotted Gum – Grey Ironbark forest in the Extraction Area. Previous studies have also recorded this species within the Tooheys Road and Hue Hue road areas (ERM 1999, 2002). There are 34 records of the species in the locality and 72 within the Wyong LGA (OEH 2012a), mostly concentrated in areas along and to the east of the F3 freeway but with some scattered records to the north-west within Olney SF.

ix. Large-eared Pied Bat (Chalinolobus dwyeri)

The Large-eared Pied Bat is a small to medium-sized bat with long, prominent ears and glossy black fur. This species is a wattled bat, having small lobes of skin between the ears and corner of the mouth. The lower body has broad white fringes running under the wings and tail-membrane, meeting in a V-shape in the pubic area (OEH 2012}). This species roosts in caves entrances, crevices in cliffs, gullies, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*) in dry open forest and woodland. Maternity roosts are generally found in roof domes in sandstone caves and overhangs (OEH 2012}). There are 3 records in the locality and 4 records in the Wyong LGA, with one occurring near the F3 Freeway and others distributed among Olney SF and Jilliby SCA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to

occur based on the availability of suitable habitat in the Study Area and the proximity of the historic records to the Project Boundary.

Assessment of Significance

(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 known and potential forage and breeding habitat for these microchiropteran bat species. However this is a very small area and only approximately 50.4 ha of native vegetation will be removed. These species are highly mobile and have the capacity to access resources from a wide area. Large areas of similar habitat will remain in the Study Area and the locality and 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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of the TSC Act.

(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

Approximately 50.4 ha of native vegetation that provides potential foraging habitat for these species wil be removed. A further 2240.9 ha may be affected by subsidence, however this is not expected to impact on habitat for these species as woodland vegetation will remain.

No areas of habitat will become isolated as part of the proposal. These are highly mobile animals that will be able to fly over disturbed areas to access other areas of habitat.

(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 microchiropteran bat 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 is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 208 ha of native vegetation.

(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 following KTP are relevant to raptors:

- **Clearing of native vegetation** as this reduces the area of forage and roosting habitat available for these species;
- **Loss of hollow-bearing trees** as this reduces the abundance of breeding and roosting habitat;
- **Removal of dead wood and dead trees** as this reduces the abundance of roosting habitat; and
- **Competition from feral honey bees (*Apis mellifera*)** as they compete with hollow-dependent bats for tree hollows

Conclusion

The Project is expected to impact on approximately 50.4 ha of known and potential habitat for these species through the removal of woodland and forest vegetation for the surface infrastructure areas. Further areas of habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to these bats.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 208 ha of native vegetation 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 to microchiropteran bats as a result of the Project.

H.14 Stephens' Banded Snake (Hoplocephalus stephensii)

Stephens' Banded Snake is a medium-sized partly tree-dwelling snake up to one metre long. It is brown or yellow-brown above, with a series of irregular, broad, dark crossbands (OEH 2012□).

It is a partly tree-dwelling snake that inhabits rainforest and eucalypt forests and rocky areas up to 950 m in altitude. It is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day (OEH 2012□).

There are 2 records of this species in the locality and a total of 8 records for the Wyong LGA (OEH 2012a). It has not been recorded within the Study Area but is considered to have potential to occur based on the availability of suitable habitat.

Assessment of Significance

(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 potential foraging habitat for Stephens' Banded Snake. The area of vegetation to be removed is a very small area and only approximately 53 ha of native vegetation will be removed. Large areas of similar habitat will remain in the Study Area and the locality and the removal of this small area is not considered likely to place a viable local population of Stephens' Banded Snake 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

No endangered populations of Stephens' Banded Snake occur in NSW.

(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

Approximately 53 ha of native vegetation that provides potential foraging habitat for Stephens' Banded Snake will be removed. A further 2615 ha may be affected by subsidence, however this is not expected to impact on habitat for this species as woodland vegetation will remain.

No areas of habitat will become isolated as part of the proposal. Native vegetation will remain contiguous around the disturbance areas.

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

No critical habitat for this 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

A recovery plan or a threat abatement plan has not been prepared for Stephens' Banded Snake. Priority Actions have been identified for this species, which have the overall aim of preventing it from declining further and promoting its recovery. The Project is considered to be consistent with these actions as the majority of the native vegetation present in the Study Area will remain, and the Project will result in the protection for conservation of approximately 200 ha of native vegetation.

(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 following KTP have potential to operate as a result of the Project:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for this species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

Conclusion

The Project is expected to impact on approximately 53 ha of potential foraging habitat for Stephens' Banded Snake through the removal of woodland and forest vegetation for the surface infrastructure areas. Further areas of habitat will be subject to subsidence, however modelling indicates that this will not affect the survival of woodland and forest communities that are important to this species. No breeding habitat occurs and no camps are located within the Study Area.

Over 2,500 ha of woodland and forest habitat will remain in the Study Area and surrounding locality and a total of approximately 200 ha of native vegetation will be conserved within the offset areas. It is expected that the Stephens' Banded Snake will remain viable in the locality and no significant impact is predicted to occur as a result of the Project.