Newcastle Inner City Bypass – Rankin Park to Jesmond

Environmental impact statement

Technical Paper 1 – Biodiversity Assessment Report

November 2016

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GHD

Aurecon Australasia Pty Ltd

Newcastle Inner City Bypass - Rankin Park to Jesmond
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November 2016

Executive summary

Introduction

Roads and Maritime Services (Roads and Maritime) is seeking approval to construct the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the project).

The Newcastle Inner City Bypass is part of Roads and Maritimes' long-term strategy to provide an orbital road within Newcastle's road network to connect the Pacific Highway at Bennetts Green and the Pacific Highway at Sandgate.

An environmental impact statement (EIS) is required to assess the potential environmental impacts of the project. This Biodiversity Assessment Report (BAR) has been prepared to assess the potential impacts on the project on biodiversity to support the preparation of the EIS.

On 15 October 2015, the Commonwealth determined that the project will impact on matters of national environmental significance (MNES), protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Accordingly, the project has been declared a 'controlled action' and will require assessment and approval under the EPBC Act before it can proceed.

Secretary's Environmental Assessment Requirements (SEARs) for the project were issued 3 March 2015. Supplementary SEARs were provided for the project on 19 November 2015 to address the EPBC Act requirements in accordance with the 'controlled action' determination. This BAR uses the NSW Framework for Biodiversity Assessment (FBA) to quantify the project's impacts and the BioBanking Assessment Methodology (BBAM) to determine suitable offsets in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014e).

Methods

The main components of the methodology for the BAR were:

- Desktop assessment to describe the existing environment and landscape features of the study area and to identify the suite of threatened biota potentially affected by the project, carried out by Parsons Brinckerhoff (Parsons Brinckerhoff, 2015a).
- Field surveys to describe the biodiversity values of the construction footprint and surrounding study area and determine the likelihood of threatened biota and their habitats occurring in the construction footprint or being affected by the project, carried out by Parsons Brinckerhoff (Parsons Brinckerhoff, 2015a).
- Impact assessment to determine the potential impacts on threatened biota, migratory species and Ramsar wetlands listed as MNES under the EPBC Act.
- Provision of recommendations to avoid and/or mitigate the impacts of the project on threatened biota, migratory species and Ramsar wetlands listed as MNES under the EPBC Act.
- FBA calculations using the major projects credit calculator v.4.1 (linear module) to quantify the biodiversity impacts of the project and to determine the biodiversity credits required to offset these.

The ecological survey, preparation of this BAR and biodiversity credit calculations were performed by a team of accredited BioBanking assessors and ecologists in accordance with the FBA.

Biological value

The study area is located within a large patch of remnant native vegetation within a mostly developed urban landscape. The study area contains potential habitat for numerous threatened biota including a known endangered ecological community (EEC) and known habitat for threatened biota including Black-eyed Susan (*Tetratheca juncea*), Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*), Magenta Lilly Pilly (*Syzygium paniculatum*), the Squirrel Glider (*Petaurus norfolcensis)*, Powerful Owl (*Ninox strenua*) and Grey-headed Flying-fox (*Pteropus poliocephalus)*.

One EEC, three threatened flora species and five threatened fauna species were recorded within the study area during field surveys for this assessment. An additional four threatened fauna species have been previously identified within the study area during prior field surveys. Likelihood of occurrence assessments were also carried out and identified an additional 33 threatened species not recorded during surveys, but likely to occur within habitats contained in the study area.

About 16.4 hectares of Lower Hunter Spotted Gum Ironbark Forest EEC listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) was identified within the study area, which has been identified as the eastern-most record of this EEC to date (Eastcoast Flora Survey, 2015). One intermittent groundwater dependant ecosystem (GDE) occurs within the construction footprint, Sydney Blue Gum – White Mahogany shrubby tall open forest (comprising both the *Syncarpia glomulifera* and atypical variants).

A large population of Black-eyed Susan (*Tetratheca juncea*) comprising five sub-populations totalling 10,381 plant clumps was recorded within the threatened flora study area during targeted searches for the species. This population meets several of the criteria for an important population as set out by the *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable Black-eyed Susan, Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011 and Parsons Brinkerhoff, 2015).

Grey-headed Flying-foxes *(Pteropus poliocephalus)* were observed flying over the construction footprint and blossom producing trees within the study area provide foraging resources for this species. A known camp is located about 230 metres from the southern extent of the construction footprint within Blackbutt Reserve. This is a locally important population, known to support breeding females, is the only known camp in the Newcastle local government area and is the only continuously occupied camp in the Lower Hunter region (Geolink, 2013). The Grey-headed Flying-fox is likely to forage in the study area and construction footprint on a regular basis when food trees are in flower. Habitat contained within the study area also constitutes critical habitat for this locally important population as it contains winter flowering resources foraged by the Grey-headed Flying-fox.

One threatened arboreal mammal, the Squirrel Glider (*Petaurus norfolcensis*), was recorded within the study area. This species is found to be widely, yet sparsely, distributed through dry woodlands and forests in the Lower Hunter. Woodland within the study area was highly suited to a range of arboreal mammals, including Squirrel Gliders, due to the relatively high-density of hollow-bearing trees.

Powerful Owls (*Ninox strenua*) were recorded within the study area on numerous occasions during surveys by Parsons Brinckerhoff (2015a). The high abundance of hollow-bearing trees at the site provide a nesting resource for Powerful Owl and the presence of small arboreal mammals provide a good source of prey. A breeding pair of Powerful Owls was observed within the study area during targeted surveys in July 2014 (Parsons Brinckerhoff, 2015b).

There are no wetlands within the study area, however the study area occurs within the Ironbark Creek catchment which drains into extensive areas of wetlands associated with the Hunter River floodplain. The nationally significant and Ramsar listed site, Hunter Estuary Wetlands is located about six kilometres downstream of the project. These wetland areas are protected by various legislation, agreements and planning instruments that in some cases include multiple listings for the same area:

- Hunter Estuary Wetlands Ramsar site (listed under the EPBC Act) – this comprises the Kooragang Nature Reserve (located on the north arm of the Hunter River) and Shortland Wetlands which is located about six kilometres downstream of the study area.
- Hunter Wetlands National Park (listed under the *NSW National Parks and Wildlife Act 1974*) – this site comprises a number of areas on the south and north arms of the Hunter River, the nearest of which is about six kilometres downstream of the study area. This area is also mapped as a nationally important wetland.
- There are a number of areas mapped under *State Environmental Planning Policy no. 14 – Coastal Wetlands* (SEPP 14) on the south and north arms of the Hunter River, the nearest of which is about three kilometres downstream of the study area.

Project impacts

The project would result in the following direct impacts within the construction footprint:

- Disturbance of an overall construction footprint of about 50.1 hectares.
- Removal of about 39.2 hectares of native vegetation (worst case estimate) and associated habitat resources for threatened fauna and flora species and other native biota. Within the 39.2 hectares of native vegetation:
  - Removal of about 4.1 hectares (worst case estimate) of Lower Hunter Spotted Gum Ironbark Forest EEC listed under the TSC Act.
  - Removal of about 4.4 hectares of Sydney Blue Gum – White Mahogany shrubby tall open forest intermittent GDE (comprising both the *Syncarpia glomulifera* and atypical variants).
- Removal of about 846 clumps of Black-eyed Susan (*Tetratheca juncea*).
- Removal of five known and about 17 potential Powerful Owl roost trees.
- Removal of about 320 identified hollow-bearing trees within known Squirrel Glider (*Petaurus norfolcensis*) habitat.

It is anticipated that the project would result in indirect impacts such as noise, lighting and vibration to habitats within 20 metres of the project construction footprint, likely reducing the suitability of this habitat for flora and fauna species. The inclusion of a 10 metre disturbance buffer (assuming total clearing) to account for indirect impacts associated with the project has resulted in an additional seven hectares of native vegetation being included in the BioBanking impact calculations.

About 4.1 hectares of the Lower Hunter Spotted Gum Ironbark Forest EEC which occurs within the construction footprint will be removed by the project. The project would also result in minor further fragmentation of this community as result of the project's alignment. The fragmentation and direct clearing of the EEC however, has been reduced through the route selection and concept design phase to avoid and reduce impacts to this community. The project is also likely to result in indirect impacts to this EEC such as weed invasion. Appropriate mitigation and management measures will be implemented during the project to reduce these impacts, including the implementation of the Biodiversity Offset Strategy.

The project would require clearing of about 846 clumps of an important population of Black-eyed Susan (*Tetratheca juncea*) as defined under the *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable black-eyed susan, Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011). The project impacts were assessed and determined likely to result in a significant impact on the Black-eyed Susan important population. Appropriate mitigation and management measures will be implemented during the project to reduce these impacts, including the implementation of the Biodiversity Offset Strategy.

The project would result in the removal of about 320 identified hollow-bearing trees which provide potential sheltering and breeding habitat for the Squirrel Glider (*Petaurus norfolcensis*). Furthermore, the project would result in the clearing of 39.2 hectares of known foraging habitat for the Squirrel Glider.

The project would require clearing about 39.2 hectares of critical foraging habitat for the Grey-headed Flying-fox *(Pteropus poliocephalus)* which would result in a reduction of about 10 per cent of native vegetation cover within the locality. A known camp and regionally important population is located about 230 metres from the southern extent of the construction footprint within Blackbutt Reserve. The Grey-headed Flying-fox is likely to forage in the study area and construction footprint as part of its larger home range. The removal of about 39.2 hectares of identified critical foraging habitat for this species is likely to result in a significant impact on the local population of this species as it provides a reliable foraging resource during seasonal bottlenecks for the population. Appropriate mitigation and management measures will be implemented during the project to reduce these impacts, including the implementation of the Biodiversity Offset Strategy.

The project would remove a section of an identified local area biodiversity corridor and has the potential to impede fauna movement through the locality. A project-specific fauna connectivity strategy, including installation of terrestrial and arboreal fauna crossing infrastructure, will be implemented to maintain terrestrial and arboreal fauna connectivity across the alignment.

The internationally significant wetland and Ramsar listed site, Hunter Estuary Wetlands is located about six kilometres downstream of the project. The project would alter existing hydrology as a result of the removal of about 39.2 hectares of native vegetation and replacement with an impermeable surface upstream of the Ramsar site. A water quality and watercourse assessment prepared for the project by GHD (2016a) determined that the project is unlikely to result in significant impacts to groundwater, surface water, groundwater dependent ecosystems or sensitive downstream receivers, including the Ramsar site listed wetlands.

About 4.4 hectares of Sydney Blue Gum – White Mahogany shrubby tall open forest intermittent GDE would be cleared for the project, however this is unlikely to result in any disruption to any other GDEs in the study area. A groundwater assessment has been prepared for the project (GHD, 2016) which discusses and assesses the potential impacts of the project on identified GDEs in the study area. The project would involve the construction of new fill and cuts that may result in a minor change to where perched groundwater seeps in some areas, however it is not expected to change the drainage line to which this seepage reports. The project is not expected to impact on any GDEs occurring outside of the construction footprint. Furthermore, the project is not predicted to result in any variation in the water table within 40 metres of any high priority GDEs (GHD, 2016).

Impact mitigation and avoidance

In 2007, a strategic design for the project was displayed for community comment, with the finalised preferred route corridor reserved in Newcastle City Council's local environmental plan.

Roads and Maritime has carried out a comprehensive review of the 2007 strategic design and as a result the preferred route corridor for the project has been substantially realigned and the design further refined during the concept design phase in order to avoid sensitive ecological constraints such as threatened ecological communities and threatened species as far as possible. Impact avoidance through design has included the following:

- The project was realigned to:
  - Minimise the loss of key Powerful Owl breeding trees and identified roost trees.
  - Reduce impacts on identified populations of Black-eyed Susan, the 2007 strategic design impacted an additional 112 clumps.
  - Avoid impacts on identified threatened flora species Small Flower Grevillea *(Grevillea parviflora* subsp*. Parviflora*).
  - Reduce impacts on Lower Hunter Spotted Gum Ironbark Forest EEC.
  - Retain a wider vegetation corridor west of the alignment to improve connectivity.
- The realignment of the project to the east of the 2007 strategic design allows for retention of a wider vegetated corridor on the western side of the alignment, which improves connectivity of vegetation and associated habitat and increases the viability of segregated populations.
- The overall construction footprint has been minimised wherever possible to minimise disturbance to existing vegetation and maximise retention of remnant vegetation.
- A bridge has been included instead of fill to span the northern Dark Creek tributary and provide connectivity across the alignment.
- The southern interchange was modified and realigned to retain a large sub-population of Black-eyed Susan *(Tetratheca juncea*).
- Construction access tracks and construction compounds have been located as close as possible to the final road formation and have used existing or future fire trails where possible to minimise disturbance.

Mitigation measures have been developed to minimise the impact of the project on native flora, fauna and ecological processes within the study area. Key measures to mitigate impacts on biodiversity include:

- Development and implementation of a fauna connectivity strategy including installation of fauna crossing infrastructure.
- Development of a construction environmental management plan and sub plans which would include detailed measures to minimise impacts associated with the project.
- Implementation of a Biodiversity Offset Strategy (BOS).

Conclusions

Despite measures to avoid and mitigate impacts of the project on biodiversity, there will be some unavoidable residual impacts on biodiversity values which will be offset. The project would require the removal of about 50.1 hectares of vegetation, including about 39.2 hectares of native vegetation, and an additional seven hectares of native vegetation that would be indirectly impacted within a 10 metre buffer of the construction footprint. The project is likely to result in a significant impact on an important population of Black-eyed Susan *(Tetratheca juncea*). The project would also result in the loss of about 39.2 hectares of known and potential habitat for threatened biota including the Squirrel Glider, Powerful Owl and Grey-headed Flying-fox.

These residual project impacts will be offset in accordance with the NSW Framework for Biodiversity Assessment and BioBanking Methodology which will be implemented as part of the project's Biodiversity Offset Strategy.

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Glossary and acronyms

Term	Definition
AHD	Australian height datum
Assessment Bilateral Agreement	Agreement between the Commonwealth of Australia and the State of New South Wales (NSW) relating to Environmental Assessment
Assessment buffer area	An assessment buffer was established 550 m either side of the project construction footprint, totalling about 687.7 ha in area. The percent native vegetation cover in the landscape is assessed within this buffer area, taking into account both cover and condition of vegetation.
BAR	Biodiversity Assessment Report
BBCC	BioBanking Credit Calculator
biobank site	Land that is designated by a BioBanking agreement to be a biobank site
BioBanking	The biodiversity banking and offsets scheme established under Part 7A of the TSC Act
BioBanking agreement	An agreement entered into between the landowner and the Minister under Part 7A of the TSC Act for establishing a biobank site
BioBanking Assessment Methodology (BBAM)	The rules of BioBanking established under the TSC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values
BioBanking Trust Fund	The Trust Fund established under Part 7A of the TSC Act to hold funds from the sale of credits
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the FBA or the BBAM. Includes ecosystem credits or species credits
Biodiversity credit report	Specifies the number and type of biodiversity credits: required to offset the impacts of a development to obtain a BioBanking statement; or required to offset the impacts of a major project in accordance with the FBA; or that would be generated through conservation and management of a biobank site under a BioBanking agreement
Biodiversity offsets	Specific measures that are put in place to compensate for impacts on biodiversity values
Biodiversity values	The composition, structure and function of ecosystems including threatened species, populations and ecological communities, and their habitats
Bioregion	Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. They capture the large-scale geophysical patterns across Australia.
Biota	Total collection of living organisms including flora and fauna species and ecological communities'.
BOA	Biodiversity Offsets Assessment
BOS	Biodiversity Offset Strategy; outlines how the proponent intends to offset the impacts of the project.
BVT	Biometric Vegetation Type

Term	Definition
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CEMP	Construction Environment Management Plan
CMA	Catchment Management Authority
Construction footprint	The land that would be directly impacted by construction of the project (ie the clearing footprint). The construction boundary represents the maximum footprint of the construction work for the project. It allows space to construct the road formation, fencing, ancillary facilities and temporary and permanent sedimentation basins and store cleared materials.
Cumulative impacts	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to the project SEARs for cumulative impact assessment requirements.
DECCW	NSW Department of Environment, Climate Change and Water (now the Office of Environment and Heritage (OEH))
DEWHA	Department of the Environment, Water, Heritage and the Arts (now the Commonwealth Department of the Environment and Energy)
Direct impact	Where an event or circumstance is a direct consequence of the action.
Direct impact area	Area contained within the construction footprint area which will be subject to direct impacts from the project such as clearing of vegetation.
DLWC	NSW Department of Land and Water Conservation
DotE	Department of the Environment (previously Environment, Water, Heritage and the Arts (DEWHA) and Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)) (now the Commonwealth Department of the Environment and Energy)
DPI	Department of Primary Industries
Ecosystem credit	A credit that relates to a vegetation type and the threatened species that are reliably predicted by that vegetation type (as a habitat surrogate)
Ecosystem credit species	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site. (OEH 2014)
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EOI	Expression of Interest
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*. The Act pertains to the core legislation relating to planning and development activities in NSW.

Term	Definition
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESCP	Erosion and sediment control plan
FBA	The NSW Framework for Biodiversity Assessment. The methodology to assess impacts on biodiversity that must be used by a proponent to assess all biodiversity values on the development site for a major project in accordance with The NSW Biodiversity Offsets Policy for Major Projects (OEH 2014e).
FFMP	Flora and fauna management plan
FM Act	NSW *Fisheries Management Act 1994*. This Act provides the framework for the protection of fishery resources within NSW.
GDE	Groundwater Dependent Ecosystems
GHD	GHD Pty Ltd
GIS	Geographic Information System
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH 2014).
IBRA	Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell 1995)
IBRA subregion	The project is located within the Hunter subregion of the Sydney Basin bioregion, according to the Interim Biogeographical Regionalisation for Australia (IBRA) version 7 (Thackway and Cresswell 1995; DotE 2015).
Indirect	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter.
Indirect impact area	Area occurring within a 20 m buffer of the construction footprint and is subject to indirect impacts of the project such as light spill and edge effects.
Interchanges	A northern and a southern interchange would be constructed at either end of the project, to enable connections with the existing sections of the Newcastle Inner City Bypass and key arterial roads such as Newcastle Road and Lookout Road. A half interchange would be constructed to the west of the John Hunter Hospital precinct
KTP	Key Threatening Process
LGA	Local Government Area. A spatial unit representing the geographic area that is under the responsibility of an incorporated Local Government Council.
Likelihood of occurrence assessment	An assessment of a species' or communities' likelihood of occurrence based on habitat, previous records/sightings and known distribution.
Locality	The area within a 10 kilometre radius of the project
Major Project	Major Projects include State Significant Development (SSD) and State Significant Infrastructure (SSI)
MAP	Management Actions Plan
Matters for further consideration	Impacts that are considered to be complicated or severe that will require further consideration by the consent authority (OEH 2014). The assessment is based on thresholds detailed in Section 9 of the FBA. These can also be included as part of the project SEARs.
Migratory species	Migratory species are those animals that migrate to Australia and its external territories, or pass though or over Australian waters during their annual migrations.
Mitigation measure	An action to reduce the severity of an impact.

Term	Definition
MNES	Matters of National Environmental Significance
NCC	Newcastle City Council
NOW	NSW Office of Water (now DPI Water)
NW Act	The *Noxious Weeds Act 1993*. This Act provides for the declaration of noxious weeds by the Minister for Primary Industries
OEH	Office of Environment and Heritage (previously Department of Environment and Climate Change (DECC) and Department of Environment, Climate Change and Water (DECCW))
PCT	Plant Community Type. A classification of vegetation types which is designed to be the NSW standard for community-level vegetation mapping.
PMST	Protected Matters Search Tool
Population	All the individuals that interbreed within a given area.
Proposed road corridor	The land required for all operational elements of the project. This area will become the Roads and Maritime owned road reserve and includes the road formation and ancillary activities such as permanent water quality treatment structures.
Ramsar wetland	Wetland of International Importance listed under the Ramsar convention
Roads and Maritime	NSW Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements. These requirements set out the matters to be addressed in the EIS. This may include biodiversity impacts not considered by the FBA.
SEPP	State Environmental Planning Policy
Species Credit	A credit that relates to an individual threatened species that cannot be reliably predicted based on habitat surrogates.
Species Credit Species	Threatened species that require species credits are identified in the Threatened Species Profile Database. Threatened species and populations that are assessed according to Section 6.4 of the FBA (OEH 2014).
SSD	State Significant Development
SSI	State Significant Infrastructure
Study area	The area that was subject to a site survey and assessed for indirect impacts arising from construction and operation of the project. between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital precinct, Lookout Road and both northern and southern sides of McCaffrey Drive.
Target Species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.
TECs	Threatened Ecological Communities
the project	Construction of the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond
Threatened biota	Threatened species, populations or ecological communities listed under the TSC Act and/or the EPBC Act
Threatened flora study area	The area assessed and surveyed for threatened flora species by Parsons Brinkerhoff (2015a).
TSC Act	NSW *Threatened Species Conservation Act 1995*. This Act provides the statutory framework for biota of conservation significance in NSW
TSPD	Threatened Species Profile Database

Term	Definition
VIS	Vegetation Management System
VMP	Vegetation Management Plan
WIRES	Wildlife Information Rescue and Education Service

1. Introduction

1.1 Project overview

Roads and Maritime Services (Roads and Maritime) is seeking approval to construct the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the project). The approval is sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Newcastle Inner City Bypass is part of Roads and Maritimes' long-term strategy to provide an orbital road within Newcastle's road network to connect the Pacific Highway at Bennetts Green with the Pacific Highway at Sandgate (Figure 1-1).

Construction of the project would form part of the Newcastle Inner City Bypass. This would provide improved traffic flows across the western suburbs of Newcastle and connect key regional destinations such as Bennetts Green, Charlestown and Jesmond shopping centres, John Hunter Hospital precinct, The University of Newcastle and the Pacific Highway.

The north-south road corridor was first planned in the 1950s and incorporated into the Northumberland County Planning Scheme in 1957.

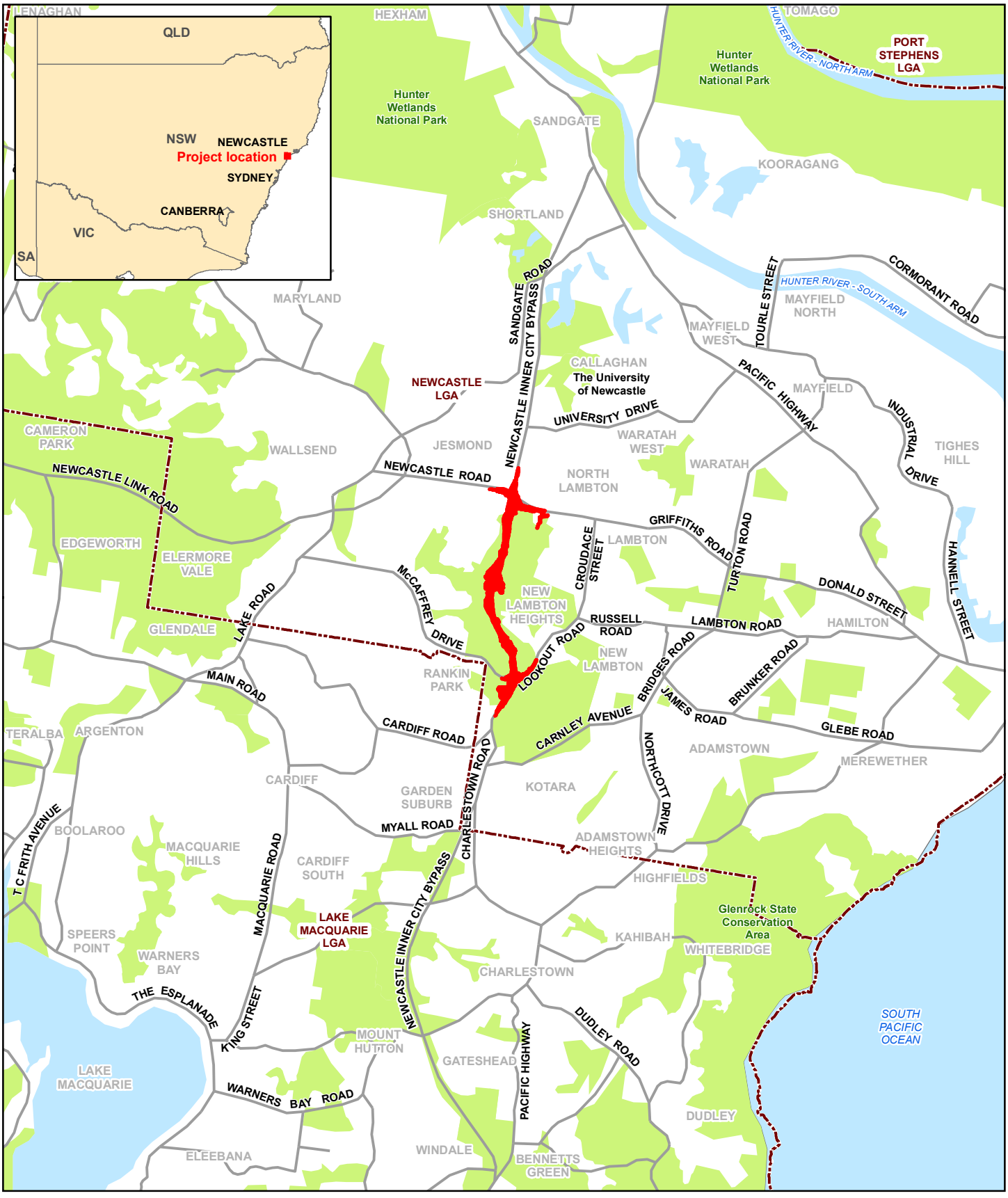
Sections of the Newcastle Inner City Bypass have opened progressively since the early 1980s as outlined in Table 1-1.

Table 1-1 Newcastle Inner City Bypass sections status

Section	Route	Length	Status
A	West Charlestown Bypass	6 km	Completed in 2003
B	Kotara to Rankin Park	2.4 km	Completed in 1983
C	Rankin Park to Jesmond	3.4 km	Subject to this planning approval
D	Jesmond to Shortland	3.2 km	Completed in 1993
E	Shortland to Sandgate	2.3 km	Completed in 2014

A strategic design for the Rankin Park to Jesmond project was displayed for community comment in 2007. Community feedback was considered to finalise the preferred route corridor, which was reserved in Newcastle City Council's local environmental plan.

In June 2014 the NSW Government announced it would complete the $280 million Rankin Park to Jesmond section of the bypass, including $150 million from Restart NSW to progress the project. Roads and Maritime has since carried out a comprehensive review of the 2007 strategic design and a refined strategic design was displayed for community feedback in May and June 2016. A concept design has since been developed for the project, which forms the basis of this assessment that has been prepared to support the environmental impact statement (EIS) for the project.



LEGEND

- The Project
- Road
- Local government area
- National Parks and Wildlife Service Estate and bushland reserves
- Watercourse area

Paper Size A4

0 270 540 1,080 1,620 2,160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number 22-17656
Revision 0
Date 26 Aug 2016

Project locality

Figure 1-1

G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA001_ProjectLocality_0.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

Data source: Geoscience Australia: 250k Topographic Series 3, 2012; Aurecon: The Project, 2015; LPI: DTDB, 2006. Created by: fmackay, tmorton

1.2 The project

The project would involve the construction of about 3.4 kilometres of new four lane divided road between Lookout Road at New Lambton Heights and Newcastle Road at Jesmond. The project is located in the Newcastle local government area (LGA), about 11 kilometres west of the Newcastle central business district and about 160 kilometres north of Sydney (Figure 1-1).

Key features of the project (Figure 1-2) include:

- New road with two lanes in each direction, separated by a median.
- Three interchanges, consisting of:
  - Northern interchange providing access to Newcastle Road and the existing Jesmond to Shortland section of the Newcastle Inner City Bypass. The full interchange provides all movements to/from the bypass and Newcastle Road.
  - Hospital interchange providing access between John Hunter Hospital precinct and the bypass. The half-interchange providing access to/from the north.
  - Southern interchange providing access to Lookout Road and the existing Kotara to Rankin Park section of the Newcastle Inner City Bypass. The bypass would travel under McCaffrey Drive. The half interchange provides connection in both directions on Lookout Road.
- Structures along the road to allow for drainage, animal and bushwalker access.
- Tie in and upgrades to connecting roads, including Lookout Road, McCaffrey Drive and Newcastle Road.
- Large cut and fill embankments due to steep and undulating terrain.
- Pedestrian and cycling facilities, including a shared path bridge over Newcastle Road.
- Noise barriers and/or architectural treatment, as required.
- Permanent operational water quality measures.

Ancillary work to facilitate construction of the project (Figure 1-3), including:

- Adjustment, relocation and/or protection of public utilities and services.
- Mine subsidence treatment, as required.
- Temporary construction facilities, including sedimentation basins, compounds and stockpile sites.
- Temporary and permanent access tracks.
- Concrete/asphalt batching plant, as required.

1.2.1 Project objectives

The key objectives of the project are to:

- Provide continuity of the Newcastle Inner City Bypass between Bennetts Green and Sandgate.
- Reduce travel times and congestion on the Newcastle Inner City Bypass.
- Provide traffic relief on key parts of the surrounding road network.

In so doing, it is intended to:

- Improve road safety.
- Minimise impacts on the natural and built environment.
- Provide value for money.

To support the project objectives, the concept design and EIS has been developed by:

- Designing the project to consider the environmental constraints and avoid or minimise impacts to the environment.
- Satisfying the technical requirements for the design of the project.
- Optimising the concept design to ensure the project can be constructed and maintained both practically and efficiently.
- Applying appropriate urban design, landscape and visual principles in the concept design of the project elements.
- Carrying out appropriate community and stakeholder consultation.
- Designing all connections, modifications and improvements necessary to link the project to the existing road network.
- Planning temporary arrangements which minimise disruption to local and through traffic and maintain access to adjacent properties during construction.

The overall project goal is to achieve the best possible result for each of these tasks, both in isolation and when considered together.

1.2.2 Study area

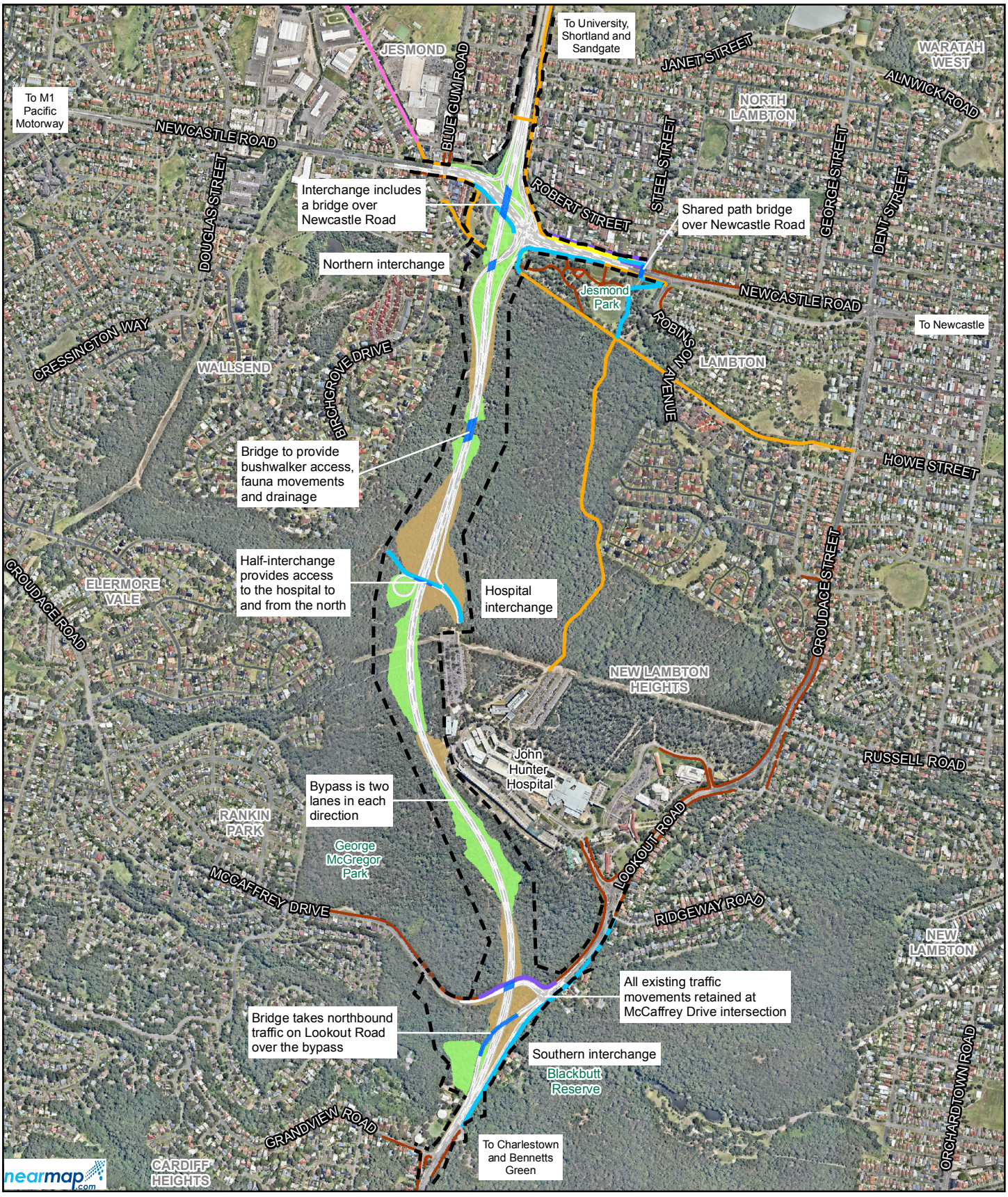
The study area subject to this assessment comprises the area between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital precinct, Lookout Road and both the northern and southern sides of McCaffrey Drive. The study area consists of the operational and construction footprints, including areas which could be indirectly impacted by the project (Figure 1-4).

1.2.3 Definitions

For the purpose of this assessment, the following definitions have been used:

- The ‘project’ refers to the proposed work which are shown on Figure 1-2.
- The ‘proposed road corridor’ refers to the land required for all operational elements of the project. This area will become the Roads and Maritime owned road reserve and includes the road formation and ancillary activities such as operational water quality treatment structures (Figure 1-4).
- The ‘construction footprint’ refers to the land that would be directly impacted by construction of the project (ie clearing footprint). The construction footprint represents the maximum footprint of the construction work for the project. It allows space to construct the road formation, fencing, ancillary facilities and temporary sedimentation basins and store cleared materials (Figure 1-2, Figure 1-3 and Figure 1-4).

- The ‘study area’ refers to the area that was subject to field surveys for the project completed by Parsons Brinckerhoff and assessed for direct and indirect impacts arising from construction and operation of the project. This comprised the area of bushland between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital precinct, Lookout Road and both northern and southern sides of McCaffrey Drive (Figure 1-4).
- The ‘threatened flora study area’ refers to the area assessed for threatened flora species. The location of the threatened flora study area is shown on Figure 1-4.
- The ‘locality’ refers to the area within a 10 kilometre radius of the project.
- IBRA subregion – the project is located within the Hunter subregion of the Sydney Basin bioregion, according to the Interim Biogeographical Regionalisation for Australia (IBRA) version 7 (Thackway and Cresswell 1995; DotE 2015).



LEGEND

- Design
- Pavement
- Bridge
- Earthworks cut
- Earthworks fill
- Proposed road corridor
- Existing on-road cycleway
- Existing shared path
- Proposed shared path
- Proposed on-road cycleway
- Existing footpath
- Proposed footpath

Paper Size A4

0 62.5 125 250 375 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number	22-17656
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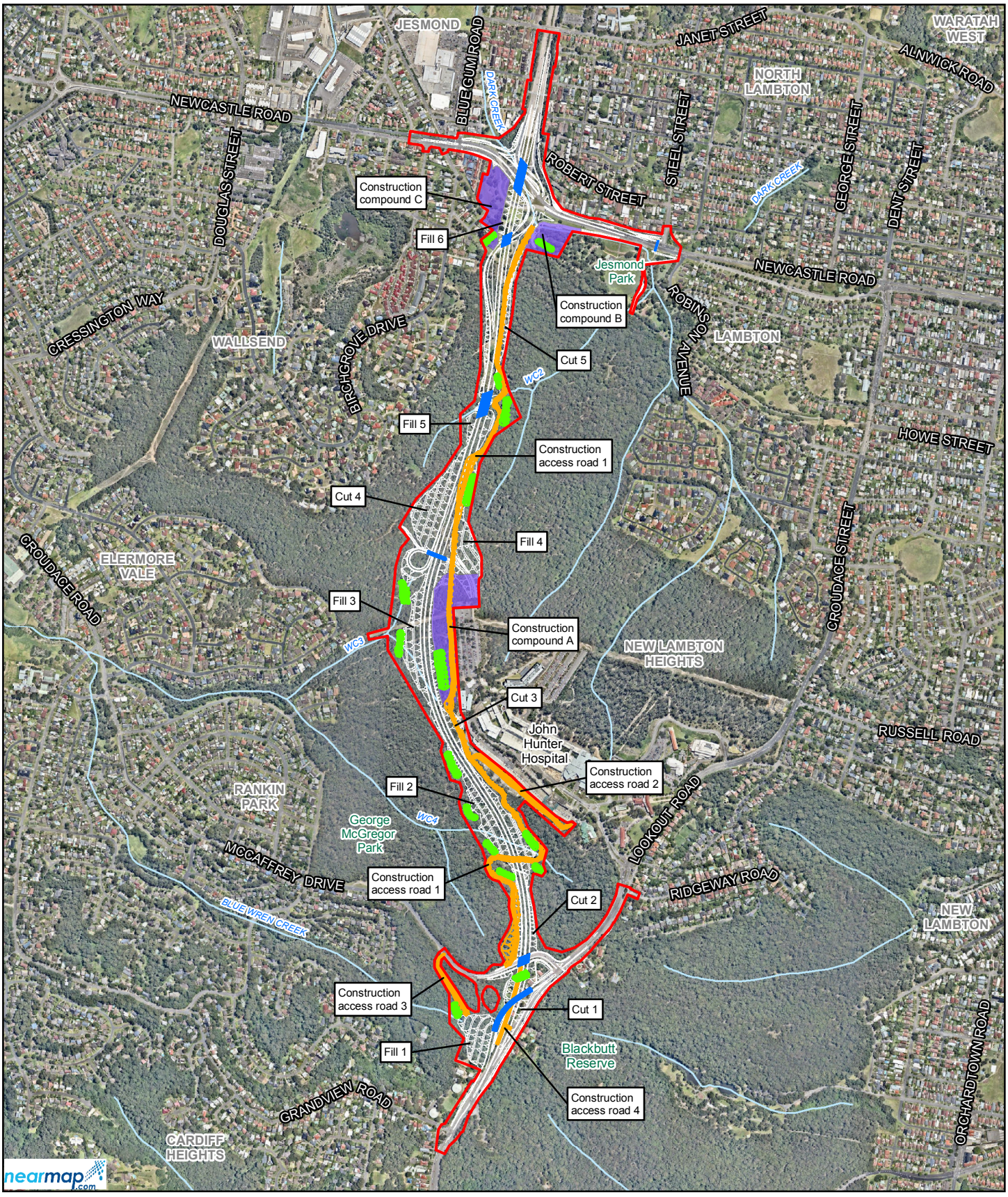
Project overview

Figure 1-2

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA002_ProjectOverview_0.mxd

Data source: RMS: Project corridor, 2016; Aurecon: Design / cycleways, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: fmackay



LEGEND

- Construction footprint
- Construction compound
- Construction access tracks
- Construction sedimentation basin
- Design
- Bridge
- Watercourse

Paper Size A4

0 62.5 125 250 375 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

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Date	26 Aug 2016

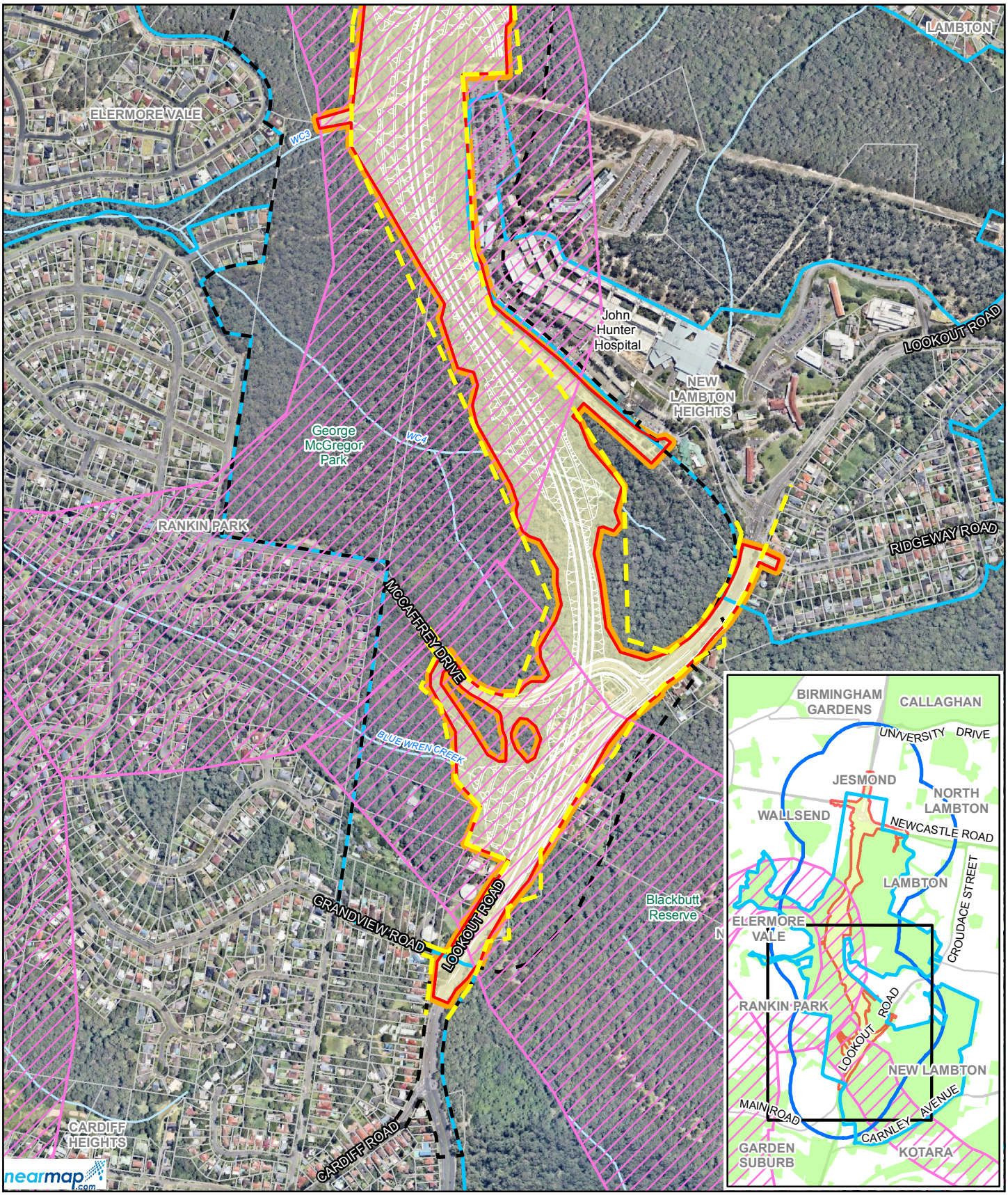
Construction ancillary facilities

Figure 1-3

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA015_ConstructionFacilities_0.mxd

Data source: Nearmap: Aerial Imagery, 20160331; Aurecon: Construction footprint/ Design / Water quality structures, 2016; LPI: DTDB, 2012. Created by: tmorton, fmackay



LEGEND

- Proposed road corridor
- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area
- Design
- Cadastre
- DECCW biodiversity corridor (290)
- Watercourse
- Native Vegetation Assessment Buffer (550 meters)
- Native vegetation
- Indirect Impact Assessment Buffer (10 meters)

Sheet layout

Paper Size A4

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Location map sheet 1 of 2

Figure 1-4a

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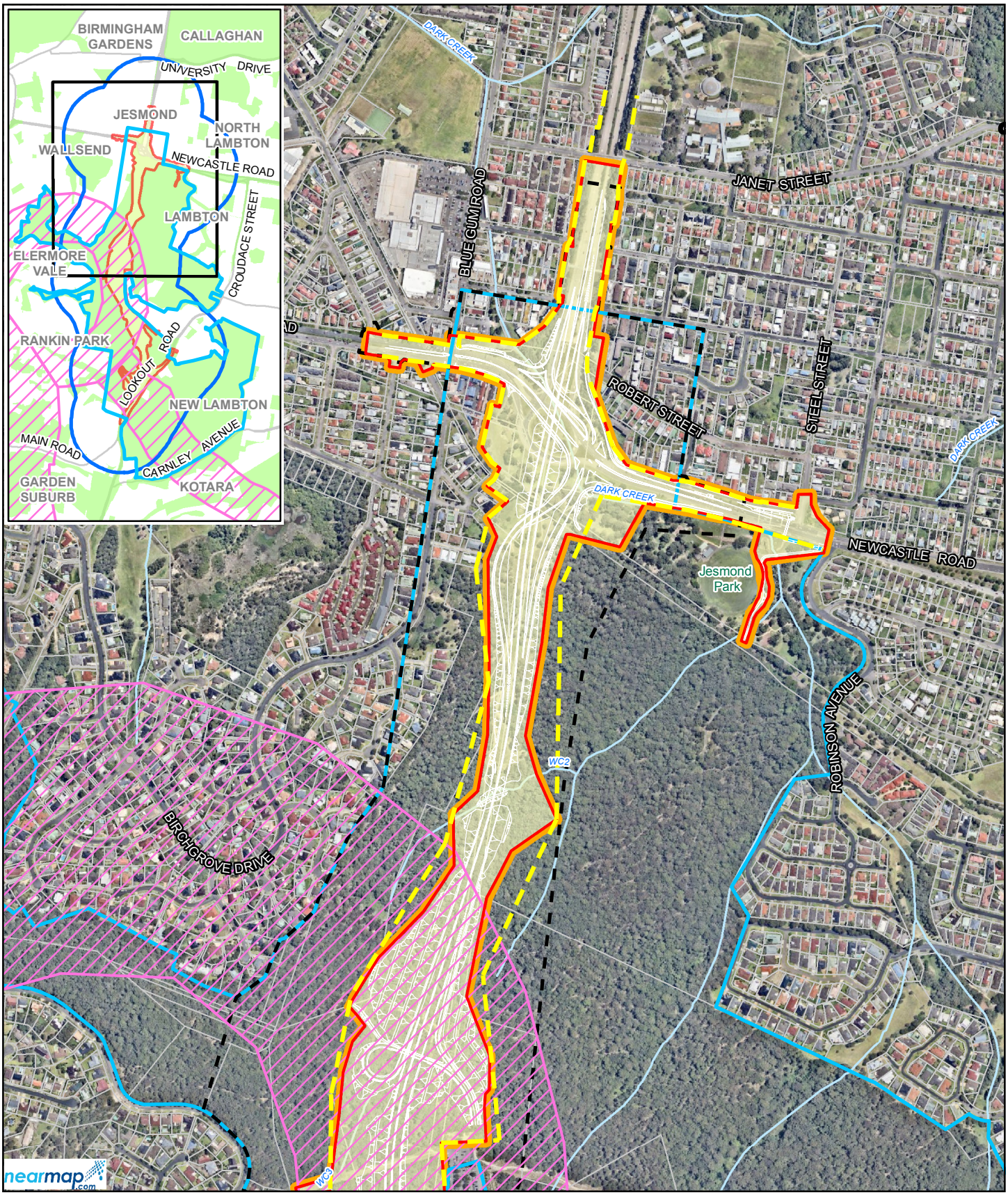
G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA009_BiodiversityStudyArea_Sht1_0.mxd

Data source: LHCCREMS: Native vegetation, 2008; DECCW: Biodiversity Corridor 2008; Aurecon: Corridors, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012; PB: Study area, 2015. Created by: tmorton, fmackay



LEGEND

- Proposed road corridor
- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area
- Design
- Cadastre
- DECCW biodiversity corridor (290)
- Watercourse
- Native Vegetation Assessment Buffer (550 meters)
- Native vegetation
- Indirect Impact Assessment Buffer (10 meters)

Sheet layout

Paper Size A4

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Revision 0
Date 26 Aug 2016

Location map
sheet 2 of 2

Figure 1-4b

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA009_BiodiversityStudyArea_Sht2_0.mxd

Data source: LHCCREMS: Native vegetation, 2008; DECCW: Biodiversity Corridor 2008; Aurecon: Corridors, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012; PB: Study area, 2015. Created by: tmorton, fmackay

1.3 Legislative context and SEARs

1.3.1 Assessment of major projects

Environmental impact statements (EIS's) are prepared to assess the impacts of major projects, including State Significant Infrastructure (SSI) projects, under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Biodiversity Assessment Report (BAR) forms part of the EIS being prepared for the Newcastle Inner City Bypass –Rankin Park to Jesmond project and assesses the biodiversity impacts of the project.

Secretary's Environmental Assessment Requirements

EIS's are subject to a range of legislative and policy requirements as set out in the Secretary's Environmental Assessment Requirements (SEARs) (issued 3 March 2015).

The SEARs require the BAR to address the following:

- The likely biodiversity impacts of the development, having regard to OEH's requirements.
- Details of the biodiversity offsets to compensate for significant residual impacts required to offset the development in accordance with the Framework for Biodiversity Assessment (FBA) (OEH 2014b).

Appendix A contains a copy of the SEARs for the project and further detail on where specific requirements have been addressed in the BAR.

In accordance with the SEARs, a BAR has been prepared to quantify the project's impacts and to determine suitable offsets in accordance with the NSW Biodiversity Offsets Policy for Major Projects and Framework for Biodiversity Assessment (Sections 6 and 10).

Matters for further consideration

On 20 January 2015, the NSW OEH provided 'project specific SEARs (Attachment B to the SEARs) which outlined 'matters for further consideration' in addition to the project SEARs. The following additional requirements were made by OEH in respect to the project:

"Impacts on the following species and ecological community will require further consideration and provision of the information specified in section 9.2 of the Framework for Biodiversity Assessment:

- *Corybas dowlingii* (Red Helmet Orchid) – This taxon has been poorly recorded within the Wyong IBRA Sub-Region (ie main population centred around Port Stephens and Bulahdelah) and as such any potential loss could significantly reduce the viability of this species (as stated in Section 9 of the FBA). OEH understands that Roads and Maritime ecological consultants have undertaken some targeted threatened orchid surveys and to date have not detected any Corybas species. However, OEH has received photographic evidence (in June 2013) from George McGregor Park (Rankin Park) within the western part of the proposed development of a Corybas species which has affinity with the threatened *C. dowlingii*. As such OEH expects appropriately targeted sampling to be undertaken during its known flowering period (June) and samples sent to the NSW Herbarium for identification. OEH will provide assistance with details of the location of recently observed Corybas to assist with the targeted sampling. *C. dowlingii* flowers from June to (early) August (Jones 2004). Specifically, *C. dowlingii* and *C. barbarae* (a more common related taxon) often occur sympatrically, with the former species typically flowering as *C. barbarae* is finishing (Jones 2004); in Stoney Ridge Reserve (Soldiers Point) in the Port Stephens region *C. dowlingii* is known to flower from mid to late-July (Okada 2006).

- 'Lower Hunter Spotted Gum Ironbark in the Sydney Basin Bioregion' endangered ecological community - This EEC has been poorly recorded within the Wyong IBRA Sub-Region and as such any potential loss could significantly reduce the viability of this community, particularly so given this may represent one it's most easterly occurrences. OEH understands that this community has been nominally determined as present within the project area (ie Biometric Vegetation Type – HU629 Spotted Gum - Broad-leaved Ironbark Grassy Open Forest). OEH recommends that further assessment is required to confirm the presence of this community within the study area. This should be undertaken by a person with relevant experience with this particular community."

Further consideration of these matters has been carried out in the BAR in accordance with the FBA (Section 8.3).

EPBC Act Assessment Requirements

The project was referred to the Commonwealth Department of the Environment (DotE) (now the Commonwealth Department of the Environment and Energy) on 25 August 2015 (referral number 2015/7550).

On 15 October 2015, the Commonwealth Government Minister for the Environment determined the project to be a 'controlled action'. Consequently, the project requires assessment and approval by the Commonwealth Minister for the Environment under the EPBC Act in addition to the approval from the NSW Minister for Planning under the EP&A Act.

The controlling provisions (MNES) identified by the EPBC Referral decision of relevance to the project are:

- Black-eyed Susan (*Tetratheca juncea*).
- Grey-headed Flying Fox (*Pteropus poliocephalus*).
- Leafless Tongue Orchid (*Cryptostylis hunteriana*).
- Newcastle Doubletail (*Diuris praecox*).
- Ecological character of the Hunter Estuary Wetlands Ramsar site.

In February 2015, the Commonwealth Government and the NSW State Government signed the *Agreement between the Commonwealth of Australia and the State of New South Wales relating to Environmental Assessment* (the Assessment Bilateral Agreement) under section 45 of the EPBC Act. The Assessment Bilateral Agreement accredits the assessment process of Part 5.1 under the EP&A Act, so that a separate assessment under Part 8 of the EPBC Act is not required.

Schedule 1 of the NSW Bilateral Agreement details the accredited assessment process for the project under the Bilateral Agreement. This entails controlled actions pursuant to Section 75 of the EPBC Act determined before the start date. Any controlled action subject to a bilateral agreement must also be subject to additional requirements: provide documentation in response to guidelines issued by the NSW Minister or Director General, and make assessment documentation available to the public and available for comment. A detailed assessment report must be prepared for the action in accordance with 3.4 of Schedule 1 of the NSW Bilateral Agreement.

Following consultation between the NSW Department of Planning and Environment (DP&E) and the Commonwealth Department for the Environment (DotE), Supplementary SEARs were issued for the project on 19 November 2015. The Supplementary SEARs are required to be addressed in conjunction with the original project SEARs issued on 3 March 2015. The project's Supplementary SEARs are provided in Appendix A.

The specific matters raised in the Supplementary SEARs relevant to biodiversity have been addressed in the BAR (Section 8.4).

1.3.2 Biodiversity assessment report

This BAR addresses the specific matters raised in the SEARs and Supplementary SEARs relevant to biodiversity. In accordance with the SEARs, the BAR uses the Framework for Biodiversity Assessment (FBA) to quantify the project's impacts and the BioBanking Assessment Methodology (BBAM) to determine suitable offsets in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014e).

The FBA underpins the offset policy, and contains the assessment methodology that is required to quantify the potential impacts on biodiversity and to determine the required offsets for a major project. Where the proponent is proposing to establish an offset for a major project, the BBAM is used to assess the biodiversity values of the offset site and to identify the number and type of biodiversity credits created.

A biodiversity offset strategy (BOS), provided in Appendix B has been prepared to outline how the proponent intends to retire the credits or provide supplementary measures to offset the impacts of the major project. Under the policy, the BAR and BOS are required to form part of the EIS for the project and must be carried out by a person accredited in accordance with section 142B(1)(c) of the NSW *Threatened Species Conservation Act 1995* (TSC Act).

This BAR has been prepared by accredited assessors (Section 3.1.4) and includes desktop assessments, site surveys and offset calculations in accordance with the FBA.

Table 1-2 identifies where the biodiversity assessment requirements under NSW and Commonwealth legislation and policy are addressed in this BAR. Appendix A contains a copy of the SEARs and Supplementary SEARs for the project and further detail on where specific requirements have been addressed in the BAR.

Table 1-2 Commonwealth and NSW Assessment requirements

Biodiversity assessment	Required by	Section addressed
Inventory		
Identification of the terrestrial biodiversity values, including NSW listed threatened species and endangered ecological communities, in the proposed construction footprint.	Framework for Biodiversity Assessment	Section 2 Section 3 Section 4
Identification of aquatic biodiversity values in the area proposed construction footprint.	Policy and guidelines for fish habitat conservation and management	Section 4.4
Identification of nationally listed threatened species, endangered ecological communities and migratory species in the proposed construction footprint.	EPBC Act Bilateral Agreement	Section 5

Biodiversity assessment	Required by	Section addressed
Further consideration of the following matters: • *Corybas dowlingii* (Red Helmet Orchid) • Lower Hunter Spotted Gum Ironbark Forest EEC	FBA SEARs (OEH requirements)	Section 8.3
Impact assessment		
Description of the full range of impacts of the project on biodiversity	Secretary's Environmental Assessment Requirements	Section 8
Description of the direct (related to vegetation clearance) impacts of the project on biodiversity	Framework for Biodiversity Assessment	Section 8
Carry out an assessment of the nominated protected matters that may be significantly impacted by the development: *Listed threatened species:* • Black-eyed Susan (*Tetratheca juncea*) – vulnerable, and • Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable, • Leafless Tongue-orchid (*Cryptostylis hunteriana*) - vulnerable, and • Newcastle Doubletail (*Diuris praecox*) - vulnerable. • Ramsar Wetlands: The Hunter Estuary Wetlands Ramsar site *Impacts resulting in:* • A substantial and measurable change in the hydrological regime of the wetland • A substantial and measurable change in the water quality of the wetland.	EPBC Act Bilateral Agreement Supplementary SEARs	Section 8.3 and 8.4
Mitigation measures		
Description of the mitigation measures to be applied	Framework for Biodiversity Assessment	Section 7

Biodiversity assessment	Required by	Section addressed
Description of the specific mitigation measures to be applied for each nationally listed species, EEC and migratory species.	EPBC Act Bilateral Agreement	Section 9
Offset requirements		
Quantification and description of biodiversity offsets required for the unavoidable direct impacts of the project on threatened species and EECs	Framework for Biodiversity Assessment	Section 10
Quantification and description of biodiversity offsets required for all direct and indirect significant residual impacts on nationally listed species, EEC and migratory species.	EPBC Act Bilateral Agreement Supplementary SEARs	Section 10
Offset proposals		
Details of how offsets provided meet expected loss	Framework for Biodiversity Assessment	Refer Appendix B - Biodiversity Offset Strategy
Demonstrate offsets for MNES are like-for-like, consistent with the EPBC Act Bilateral Agreement	EPBC Act Bilateral Agreement Supplementary SEARs	Refer Appendix B- Biodiversity Offset Strategy

2. Landscape features

2.1 Identified features

The FBA requires the assessment of landscape features to help describe the biodiversity values of the construction footprint and assess the impacts of the project. Landscape features relevant to the FBA calculations are shown on Figure 1-4, Figure 2-1, Figure 2-2 and Figure 3-1 and are summarised in Section 2.2.

The study area is within an isolated patch of good quality, reserved bushland, which includes George McGregor Park and Sygna Close Reserve (

Figure 1-1 and Figure 1-4). These areas are currently used for recreational activities such as cycling and bushwalking. The study area has been subject to historical underground mining activities.

The bushland within the study area is surrounded mostly by residential properties and some commercial areas to the north and west. To the south, Blackbutt Reserve borders the site. The John Hunter Hospital precinct is on the eastern boundary of the study area.

2.1.1 Bioregion and IBRA subregion

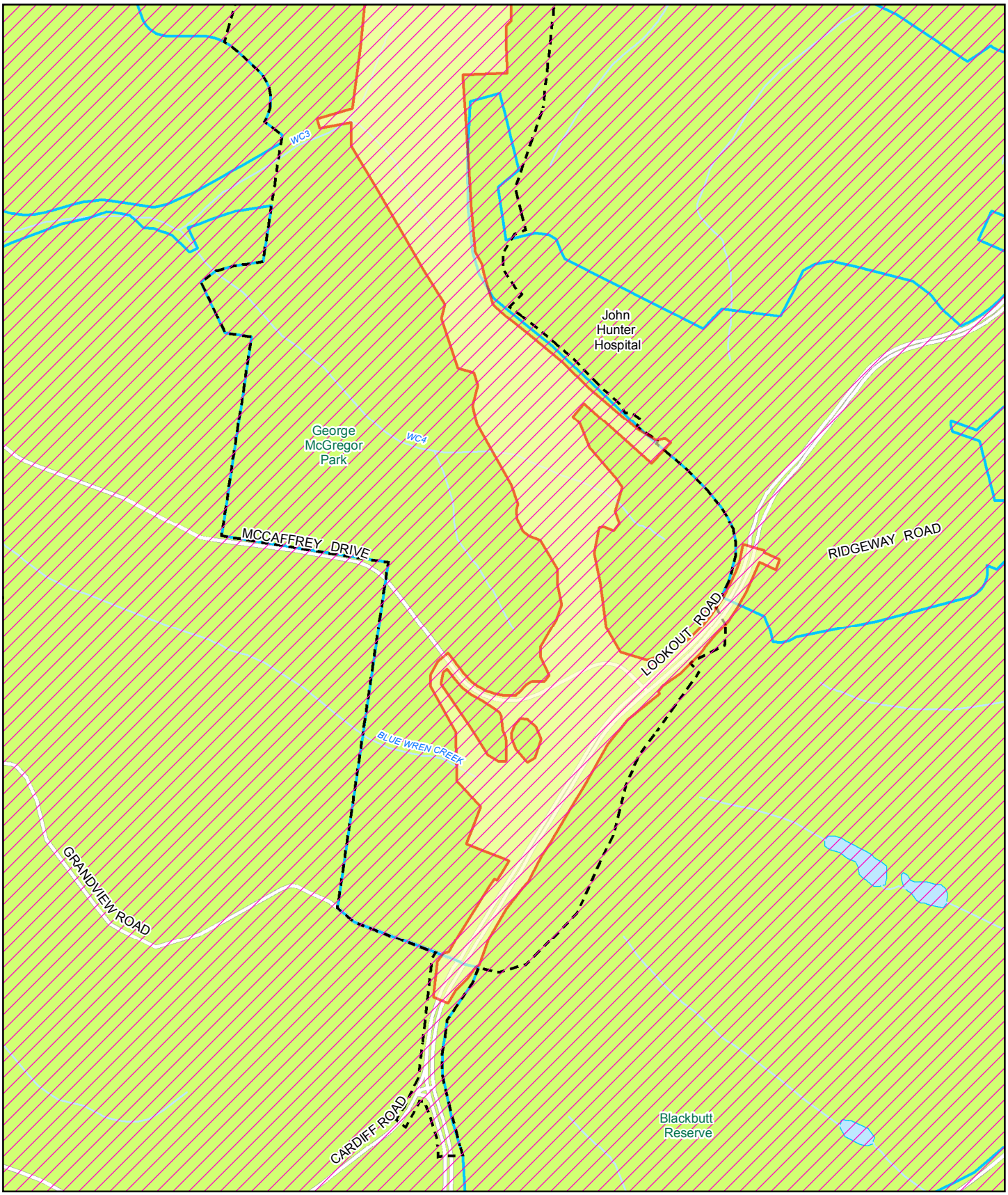
The study area occurs mainly within the Wyong IBRA (Interim Biogeographic Regionalisation for Australia) subregion of the Sydney Basin Bioregion, with a small section in the north of the study area falling within the Hunter IBRA subregion (Figure 2-1). The Sydney Basin Bioregion lies on the central east coast of NSW and covers an area of about 3,624,008 hectares which includes about 4.53 per cent of NSW. The bioregion extends from north of Batemans Bay to Nelson Bay and West to Mudgee and includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems.

2.1.2 NSW landscape regions (Mitchell landscapes)

The study area falls mostly within the Gosford-Cooranbong Coastal Slopes Mitchell landscape (Figure 2-1). This landscape occurs on hills and sandstone plateau outliers of Triassic Narrabeen sandstones, with extensive rock outcrop and low cliffs along ridge margins. Soils of this landscape consist of texture-contrast soils on lithic sandstones and shales, loamy sand alluvium along creek and organic sand and mud in lagoons and swamps.

Vegetation on hills and slopes is characterised by open forest and woodland dominated by Smooth Barked Apple (*Angophora costata*), Red Bloodwood (*Corymbia gummifera*), Brown Stringybark (*Eucalyptus capitellata*), Sydney Peppermint (*Eucalyptus piperita*), Spotted Gum (*Corymbia maculata*), Bastard Mahogany (*Eucalyptus carnea*), Northern Grey Ironbark (*Eucalyptus siderophloia*) and Grey Gum (*Eucalyptus punctata*).

In gullies, vegetation includes areas of closed forest with Turpentine (*Syncarpia glomulifera*), Lilly Pilly (*Acmena smithii*), Mountain Cedar Wattle (*Acacia elata*), Coachwood (*Ceratopetalum apetalum*), Sassafras (*Doryphora sassafras*) and Water Gum (*Tristaniopsis laurina*). On swampy creek flats, common species include Prickly-leaved Tea-Tree (*Melaleuca styphelioides*), Swamp Mahogany (*Eucalyptus robusta*), Swamp Oak (*Casuarina glauca*), Common Reed (*Phragmites australis*) as well as a variety of sedges (DECC 2008b).



LEGEND

- Construction footprint
- Threatened flora study area
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse
- Waterbody

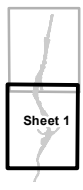
IBRA Subregions

- Hunter - Sydney Basin
- Wyong - Sydney Basin

Mitchell Landscapes

- Gosford - Cooranbong Coastal Slopes

Sheet layout



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Rankin Park to Jesmond
Biodiversity Assessment Report

Site context and landscapes sheet 1 of 2

Job Number	22-17656
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Figure 2-1a

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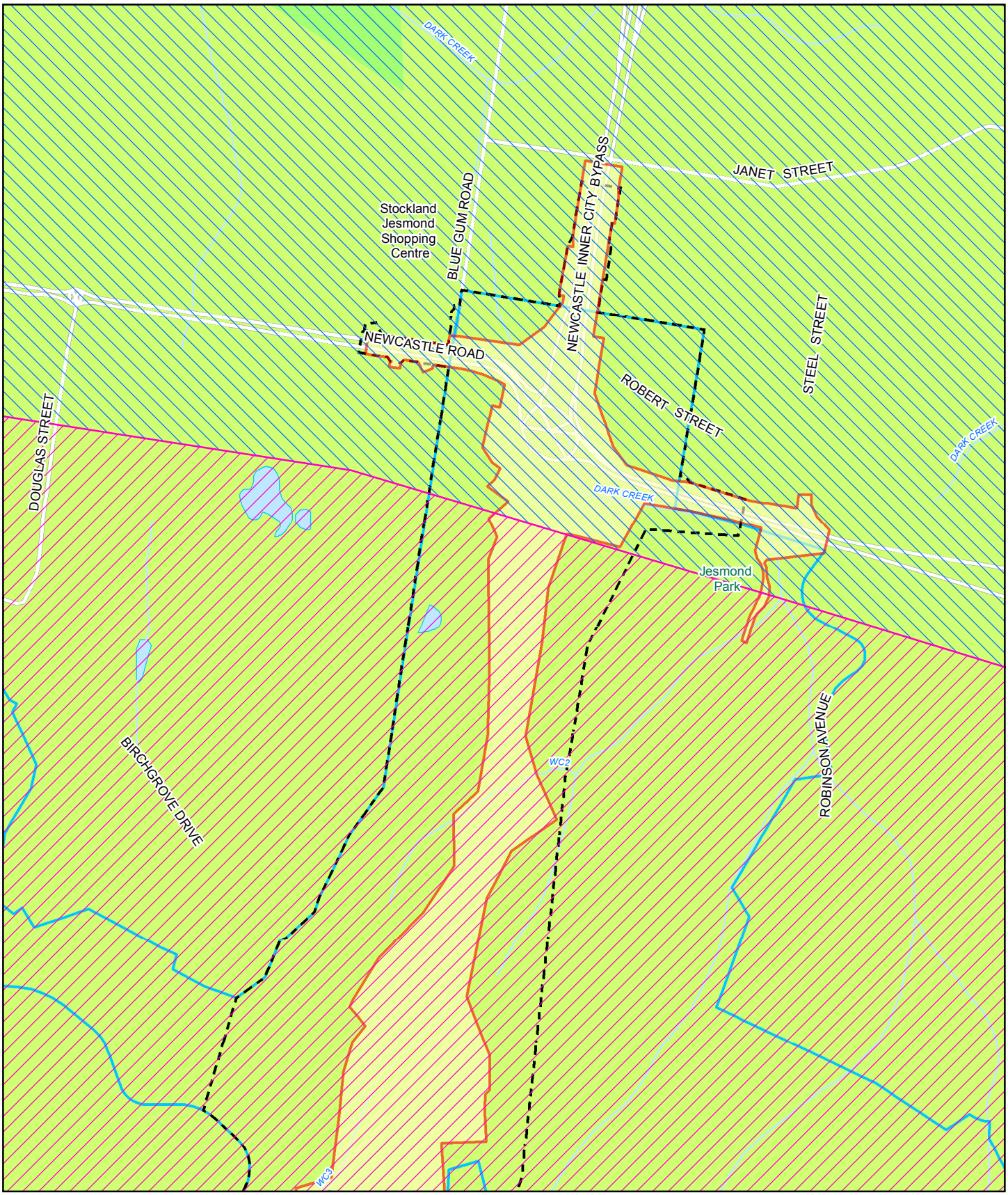
G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA003_SiteMap_Landscapes_DDP_0.mxd

Data source: DSEWPaC: Bioregions, Subregions, 2013; DECCW: Mitchell landscapes, 2008; Geoscience Australia: 250k Topographic Series 3, 2012; Aurecon: Construction footprint, 2016; LPI: DTDB, 2006; PB: Study area, 2015.

Created by: tmorton



LEGEND

- Construction footprint
- Threatened flora study area
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse
- Waterbody

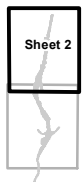
IBRA Subregions

- Hunter - Sydney Basin
- Wyong - Sydney Basin

Mitchell Landscapes

- Gosford - Cooranbong Coastal Slopes
- Lower Hunter Channels and Floodplains

Sheet layout



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

Site context and landscapes
sheet 2 of 2

Job Number	22-17656
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Figure 2-1b

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Data source: DSEWPaC: Bioregions, Subregions, 2013; DECCW: Mitchell landscapes, 2008; Geoscience Australia: 250k Topographic Series 3, 2012; Aurecon: Construction footprint, 2016; LPI: DTDB, 2006; PB: Study area, 2015.

Created by: tmorton

2.1.3 Climate

The Newcastle region is considered to be on the borderline of oceanic/humid subtropical climate with warm summers and mild winters. The Bureau of Meteorology website provides climatic information for the study area, taken from the Newcastle Nobbys Signal Station (site number 061055, closest station to the study area with detailed long-term climate statistics). The mean annual rainfall for this area is 1132 millimetres. Rainfall is typically highest in autumn and lowest in late winter and early spring. Mean daily maximum temperatures range from 25.6 degrees in summer to 16.8 degrees in winter. Mean minimum temperatures ranging from 19.4 degrees in summer down to 8.5 degrees in winter (BOM 2015).

2.1.4 Geology and soils

Reference to the *1:100,000 Soil Landscape Sheet of the Newcastle Region*, produced by the NSW Department of Land and Water Conservation (DLWC, 1995), indicates that the study area is characterised mostly by the Killingworth (ki) soil landscape, with the Beresfield, Gateshead, and Cedar Hills landscapes also evident in the northern (Beresfield), and southern ends (Gateshead and Cedar Hill) of the study area. The landscape is undulating to rolling hills and low hills on the Newcastle Coal Measures of the Awaba Hills region. Dominant soil materials include brownish black pedal loam (topsoil), bleached hard setting loamy sand to sandy clay loam (topsoil) and pedal yellowish brown clay (subsoil).

The Killingworth, Beresfield, and Gateshead soil landscapes are all limited by water erosion hazard, seasonal waterlogging on lower slopes and localised high run-on, mine subsidence, foundation hazard, shallow soils, very strongly acidic soils of low fertility, and rock outcrops. The Cedar Hill soil landscape is limited by high mass movement and foundation hazard, steep slopes, mine subsidence, and acid soils.

Elevation ranges between 50 to 160 metres. Local relief is about 30 to 100 metres, with slopes about three to 20 per cent. Soils are generally shallow (less than 60 centimetres) to moderately deep (less than 150 centimetres) with imperfectly drained Yellow Podzolic Soils, Yellow Soloths, Gleyed Podzolic Soils and Gleyed Soloths on crests and hillslopes with shallow (less than 60 centimetres), well drained Structured Loams, Bleached Loams and Lithosols on some crests.

2.1.5 Topography

The topography of the study area ranges from undulating hills with broad and rounded crests and ridges in the northern portion of the study area to steep gullies and grades in the southern portion of the study area.

The topography of the site is dominated by a ridgeline that runs with a general north-south orientation through most of the study area. This ridgeline reaches a peak of about 142 metres Australian Height Datum (AHD) near the southern extent of the study area. From the southern end, this ridgeline follows Lookout Road as it gradually dips to an elevation of about 108 metres AHD just outside the study area to the east of John Hunter Hospital precinct. From the hospital precinct, elevations generally decrease towards a valley near Newcastle Road, although there is another peak in the ridgeline of about 90 metres AHD to the north-west of the hospital precinct. To the east and west of this ridgeline elevations decrease to flatter areas that occur along creek and drainage lines surrounding the study area.

2.1.6 Rivers and streams

The study area is located within the Lower Hunter River catchment and is primarily located within the Ironbark Creek catchment and a small portion of the study area extends into the Styx Creek catchment. The study area intersects five watercourses and one small dam as shown on Figure 2-2 and described in Table 2-1. Most of these watercourses are first order streams as per the Strahler stream order system. Dark Creek is a third order stream system and occurs as a concrete stormwater channel in the study area. Creeks occurring within the study area drain to Ironbark Creek, which drain to the Hunter River at Hexham through extensive areas of SEPP 14 Wetlands and Ramsar Wetlands, about six kilometres downstream of the project (Figure 2-2).

North of the John Hunter Hospital precinct the study area drains to Dark Creek which then flows into Ironbark Creek. To the west of Lookout Road and south of McCaffrey Drive, the study area drains into Blue Wren Creek and an unnamed creek that both flow into Ironbark Creek (Figure 2-2). Areas east of Lookout Road drain towards a number of unnamed tributaries that flow towards Styx Creek and then into the Hunter River.

Table 2-1 Stream classes within the study area (Strahler)

Watercourse/creek number and name	Strahler classification	Riparian corridor width (both side of the waterway)
WC1 – Dark Creek	Class 2	20 m
WC2 – Unnamed Dark Creek Tributary – Northern branch	Class 1	10 m
WC2 – Unnamed Dark Creek Tributary – Southern branch	Class 1	10 m
WC2 – Unnamed Dark Creek Tributary – Main channel	Class 2	20 m
WC3 – Unnamed Ironbark Creek Tributary – Northern branch	Class 1	10 m
WC3 – Unnamed Ironbark Creek Tributary – Southern branch	Class 1	10 m
WC3 - Unnamed Ironbark Creek Tributary – Main channel	Class 2	20 m
WC4 – Unnamed Ironbark Creek Tributary – Northern branch	Class 1	10 m
WC4 – Unnamed Ironbark Creek Tributary – Southern branch	Class 1	10 m
WC4 – Unnamed Ironbark Creek Tributary – Main channel	Class 2	20 m
WC5 - Blue Wren Creek (Ironbark Creek Tributary)	Class 1	10 m

Catchment description

Ironbark Creek

The study area is located in the upper reaches of the Ironbark Creek catchment. Near the project, the upper reaches of the Ironbark Creek catchment are densely vegetated. Within the study area Ironbark Creek is fed by WC1, WC3, WC4 and Blue Wren Creek (WC5). Along flatter elevations to the west and north-western areas of the study area, the catchment of Ironbark Creek is mostly residential.

Areas north of the John Hunter Hospital precinct drain to Dark Creek (WC1), an ephemeral creek that is formed by a concrete stormwater channel from near Newcastle Road to Sandgate Road via WC2. Dark Creek flows into Ironbark Creek just downstream of Sandgate Road.

Flow within much of Ironbark Creek is intermittent with flow only occurring following periods of rainfall. However, flow is perennial in the downstream, undeveloped reach of the catchment. There are commercial and industrial centres within the Ironbark Creek catchment, including Jesmond, Wallsend, Hexham and Sandgate. These industrial areas are generally characterised by local service, automotive, engineering, transport and storage activities (Newcastle City Council 2004).

From its confluence with Dark Creek, Ironbark Creek drains to the north to Hexham Swamp and then into the south arm of the Hunter River.

Styx Creek

The study area forms the western boundary of the Styx Creek catchment. Near the study area, the upper reaches of the Styx Creek catchment are characterised by heavily vegetated slopes. The remainder of the catchment is characterised by developed areas along the flatter areas of the floodplain. Land use within the Styx Creek catchment is a mixture of residential, commercial and industrial development. The major areas of commercial and industrial developments are located at Kotara, Broadmeadow and Hamilton.

Styx Creek drains into Throsby Creek at Islington. Throsby Creek flows into the Hunter River at Newcastle.

2.1.7 Wetlands

Although there are no wetlands within the study area, there is one small dam that has been constructed to collect runoff from the surrounding urban development. Vegetation within the dam is not consistent with a native vegetation community, although it contains native emergent aquatic species such as *Persicaria decipiens, Paspalum distichum* and *Juncus usitatus* which may provide habitat for commonly occurring waterbirds and herpetofauna (Parsons Brinckerhoff 2015a).

There are no wetlands within the study area. The lower reaches of the Ironbark Creek catchment contains extensive areas of wetlands associated with the Hunter River floodplain (Figure 2-2). These wetland areas are protected by various legislation, agreements and planning instruments that in some cases include multiple listings for the same area:

- Hunter Estuary Wetlands Ramsar site (listed under the EPBC Act) – this comprises the Kooragang Nature Reserve (located on the north arm of the Hunter River) and Shortland Wetlands which is located about six kilometres downstream of the study area.
- Hunter Wetlands National Park (listed under the NSW *National Parks and Wildlife Act 1974*) – this site comprises a number of areas on the south and north arms of the Hunter River, the nearest of which is about six kilometres downstream of the study area. This area is also mapped as a nationally important wetland.

  There are a number of areas mapped under *State Environmental Planning Policy no. 14 – Coastal Wetlands* (SEPP 14) on the south and north arms of the Hunter River, the nearest of which is about three kilometres downstream of the study area. No other significant wetlands are located within the study area or construction footprint.

2.1.8 State, regionally and locally significant biodiversity links

Vegetation within the study area has limited connectivity to large expanses of native vegetation in the wider locality. Directly to the east is Blackbutt Reserve, which is separated from the study area by Lookout Road, a major road that would constitute a hostile gap for many fauna species. To the west is a network of patchy vegetated areas interspersed around the urban environment that provides some connectivity to Blue Gum Hills Regional Park located about five kilometres from the study area.

Although there are no state, regional or biodiversity links as defined by the FBA mapped within the study area, a sub-regional fauna corridor occurs through the construction footprint (DECCW 2012) which is detailed on Figure 1-4. Parsons Brinckerhoff (2015a) has also mapped a local corridor link running north-south through the study area. It is likely that a range of fauna species would use this corridor to move through the study area. The DECCW sub-regional fauna corridor and local biodiversity corridor link mapped by Parsons Brinckerhoff are shown on Figure 1-4.

Habitat in the construction footprint forms part of a large isolated patch of remnant bushland surrounded by urban development, including the John Hunter Hospital precinct. This bushland patch includes Blackbutt Reserve which adjoins the study area's eastern boundary. Lookout Road currently forms a barrier between George McGregor Park and Blackbutt Reserve (

Figure 1-1 and Figure 1-4).

2.1.9 National Park estates

There are no National Parks estates within or immediately next to the project construction footprint. The nearest national park is the Hunter Wetlands National Park (previously Hexham Swamp Nature Reserve, and Kooragang Nature Reserve) which is also forms part of a Ramsar listed site of international importance. These sites are located about six kilometres downstream of the project (Figure 2-2).

The potential impacts of the project on OEH estates reserved under the *National Parks and Wildlife Act 1974*, including the downstream OEH estates listed previously, have been assessed in accordance with the matters to be considered outlined in the *Guidelines for developments adjoining land and water managed by DECCW* (DECCW 2010) in Section 8.3.1.

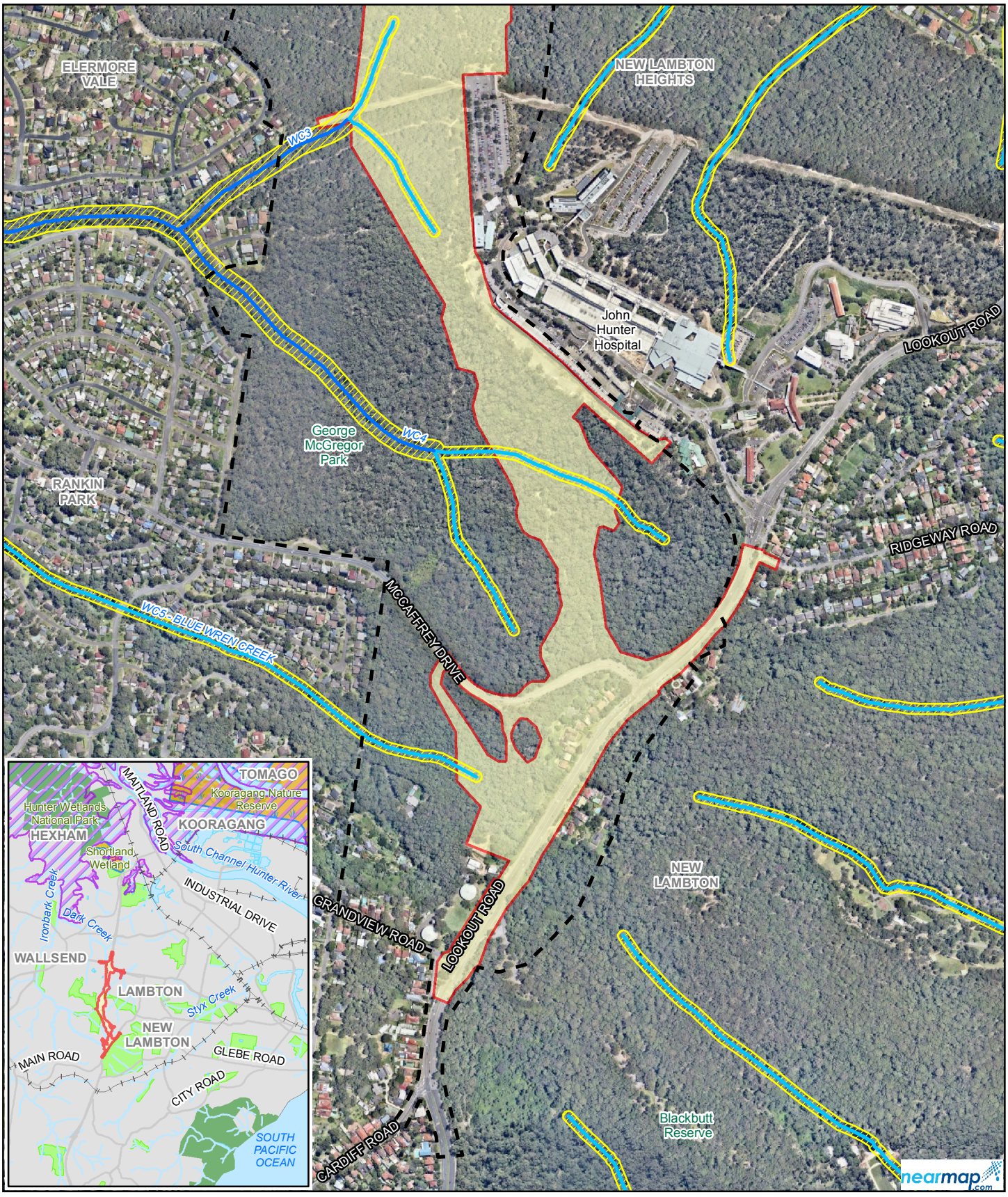
The locally significant Newcastle City Council managed Blackbutt Reserve is located close to the project, occurring immediately east of the project construction footprint (refer Figure 1-4).

2.1.10 Noxious and environmental weeds

Seven flora species declared as noxious under the *Noxious Weeds Act 1993* (NW Act) for the Newcastle City Council control area occur within the study area mostly along creek lines, next to roads and tracks and in close proximity to residential properties. Most of these are also listed as weeds of national significance, with the exception of Crofton Weed and Pampas Grass. Lantana was identified at the site which is not considered a noxious weed within the Newcastle LGA but is listed as a weed of national significance and is also considered a significant environmental weed in the area. Table 2-2 identifies the noxious weeds present in the study area and their control category under the NW Act. Other highly invasive species that occur within the study area particularly along road verges and water bodies, include *Hyparrhenia hirta* (Coolatai Grass), *Chloris gayana* (Rhodes Grass), *Bidens pilosa* (Cobblers Pegs), *Sida rhombifolia* (Paddy's Lucerne), *Ligustrum* sp. (Privet) and *Setaria palmifolia* (Pigeon Grass) (Parsons Brinckerhoff 2015a).

Table 2-2 Noxious weeds and weeds of national significance

Scientific name	Common name	Noxious weed category	Weed of national significance
Asparagus aethiopicus	Asparagus Fern	4 – Locally controlled weed *The plant must not be sold, propagated or knowingly distributed*	Yes
Ageratina adenophora	Crofton Weed	4 – Locally controlled weed *The plant must not be sold, propagated or knowingly distributed*	No
Asparagus officinalis	Asparagus	4 – Locally controlled weed *The plant must not be sold, propagated or knowingly distributed*	No
Rubus fruiticosus	Blackberry	4 – Locally controlled weed *The plant must not be sold, propagated or knowingly distributed*	Yes
Senecio madagascariensis	Fireweed	4 – Locally controlled weed *The plant must not be sold, propagated or knowingly distributed*	Yes
Chrysanthemoides monilifera subsp. *rotundata*	Bitou Bush	4 – Locally controlled weed *The plant must not be sold, propagated or knowingly distributed*	Yes
Cortaderia selloana	Pampas Grass	3 – Regionally controlled Weed *The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed*	No
Lantana camara	Lantana	-	Yes



LEGEND

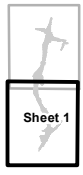
- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)

Strahler stream classification

- Class 1
- Class 2
- Watercourse buffer zone

- SEPP14 - wetland
- Hunter Estuary Wetlands (Ramsar)
- Waterbody
- NPWS Reserve

Sheet layout



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Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

Hydrology
sheet 1 of 2

Job Number	22-17656
Revision	0
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Figure 2-2a

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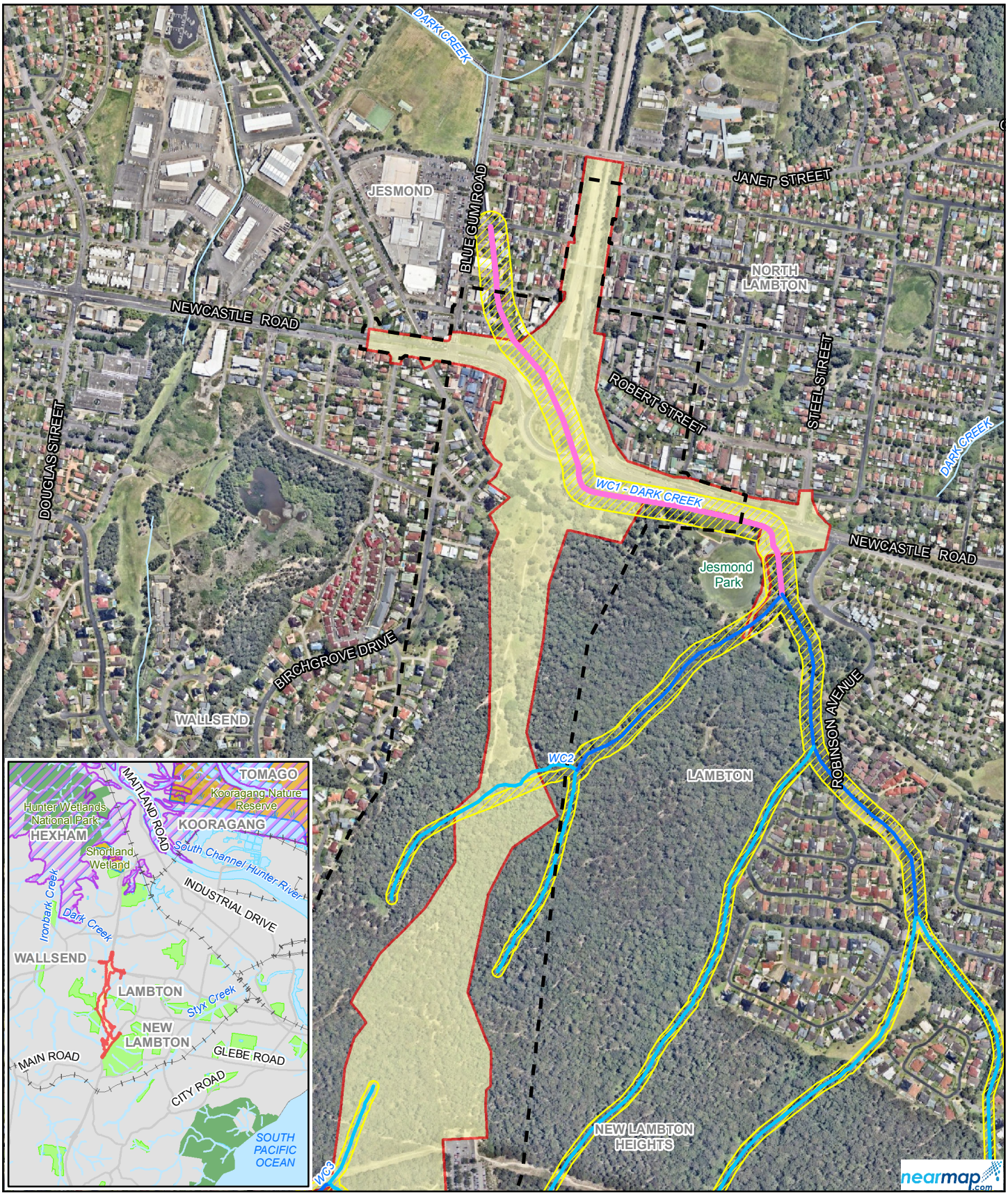
Data source: DSEWPaC: Ramsar Wetland, 2008, CANRI: SEPP14, 2008; Aurecon: Construction footprint, 2016: PB: Study Area, 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: fmackay



LEGEND

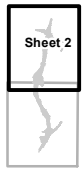
- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)

Strahler stream classification

- Class 1
- Class 2
- Class 3
- Watercourse buffer zone

- SEPP14 - wetland
- Hunter Estuary Wetlands (Ramsar)
- Waterbody
- NPWS Reserve

Sheet layout



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Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

Hydrology
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Figure 2-2b

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Data source: DSEWPaC: Ramsar Wetland, 2008, CANRI: SEPP14, 2008; Aurecon: Construction footprint, 2016: PB: Study Area, 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: fmackay

2.2 Landscape values

The landscape assessment for the site is summarised in Table 2-3. The landscape assessment was carried out in accordance with the FBA methodology for linear infrastructure detailed in Appendix 5 of the FBA (OEH 2014b).

Patch size and connectivity were assessed using GIS (regional vegetation mapping - LHCCREMS 2003) and air photo interpretation of vegetation cover within the buffer area and nearby areas of vegetation. Impacts on connectivity are calculated by identifying any connecting links for the project and determining if the project would affect any connecting links in accordance with Table 17 of the FBA (OEH, 2014b). A connecting link is when native vegetation on the site adjoins native vegetation surrounding the site. A local area biodiversity link was identified within the construction footprint resulting in a connectivity value class of 2.5. This score is the minimum score awarded for impacts to corridors under the FBA (other than no impact).

For linear developments the assessor is also required to assess the patch size for each Mitchell Landscape in which the project occurs. This score is calculated based on the percentage of cleared vegetation within the Mitchell landscape and patch size in accordance with Table 18 of the FBA (OEH, 2014b). The project occurs within the Gosford-Cooranbong Coastal Slopes Mitchell Landscape in an estimated patch size of 569 hectares with a resulting patch size score of 12.5, the highest patch size score under FBA.

Furthermore, linear projects are also required to assess the change in perimeter area ratio of patch size areas that are impacted by the project. This is determined by calculating the current and future perimeter to area ratios of each patch impacted by the project and within the buffer area surrounding the project. The proportional change in area to perimeter ratio is determined by dividing current area to perimeter ratio by the future area to perimeter ratio, a score is then awarded based on this ratio and Table 19 of the FBA (OEH 2014b). An area/perimeter ratio changed from 100 to 74 as a result of the project and a score of zero was calculated for the project. This is the default score in the credit calculator when the area/perimeter ratio reduces.

Table 2-3 Landscape assessment values summary

Landscape feature	Construction footprint	Before development	After development
Interim Biogeographic regionalisation of Australia (IBRA) bioregion and IBRA subregions	The construction footprint occurs mainly within the Wyong IBRA subregion of the Sydney Basin IBRA region with a small section in the south of the study area falling within the Hunter IBRA subregion. The construction footprint has a landscape value score of 16.5.		
Mitchell landscapes	The construction footprint falls within the Gosford-Cooranbong Coastal Slopes Mitchell landscape (DECC 2008a) in an estimated patch size of 569 ha with a resulting patch size score of 12.5.		
Rivers, streams and estuaries	The construction footprint contains five first order streams and two second order streams, according to the Strahler ordering system.		

Landscape feature	Construction footprint	Before development	After development
Wetlands	The construction footprint does not contain any important or local wetlands as defined in the FBA		
% Native vegetation cover	An assessment buffer was established 550 m either side of the project construction footprint, totalling about 687.7 ha in area. The score for percent native vegetation cover is 1.5.	The current per cent native vegetation cover in the buffer assessment area is 51-55%, equating to about 352.8 ha of native vegetation cover of the total 687.7 ha buffer assessment area. Note that this figure includes planted and/or non-indigenous vegetation cover and is different to the definition of 'native vegetation' as it relates to offset calculations.	The future percent native vegetation cover in the buffer assessment area is 41-45%, equating to about 298.1 ha of native vegetation cover within the total 687.7 ha buffer assessment area. Given the removal of about 46.2 ha of remnant, regrowth or planted native vegetation for the project assessed under the BBCC (direct and indirect impact.
Connectivity value - class	The project would affect only a local area biodiversity link, because it affects vegetation in a link that is less than 1000 ha in area.		The local area biodiversity link connectivity value score is 2.5.
Connectivity value - class	The project would affect only a local area biodiversity link, because it affects vegetation in a link that is less than 1000 ha in area.	The local area biodiversity link connectivity value score is 2.5.	
Edge to perimeter ratios	There is no proportional change in area to perimeter ratios for the project.	100	74

Landscape feature	Construction footprint	Before development	After development
Area to perimeter ratio	Area perimeter ratio score is 0. Proportional change in area to perimeter ratio is 0%.	-	
Landscape value score	16.5	-	-

3. Native vegetation

This section of the BAR provides the methods and results of the vegetation surveys within the study area. This BAR has been prepared based on targeted field surveys and reporting completed for the project by Parsons Brinckerhoff. Biodiversity surveys completed by Parsons Brinckerhoff for the project include:

- Parsons Brinckerhoff 2014, Newcastle Inner City Bypass: Rankin Park to Jesmond, Preliminary Environmental Investigation.
- Parsons Brinckerhoff 2015a, Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report (Appendix C).

The following additional biodiversity reports relating to the study area were also reviewed as part of the desktop assessment:

- GHD 2015, EPBC Referral for the Newcastle Inner City Bypass – Rankin Park to Jesmond.
- Eastcoast Flora Survey 2015, Lower Hunter Spotted Gum-Ironbark Forest: Verification Survey, Proposed Newcastle Inner City Bypass (Rankin Park to Jesmond), Newcastle LGA (Appendix K).
- Umwelt Environmental Consultants 2006, Ecological Constraints Analysis for a Proposed New Route for State Highway 23 between Rankin Park and Jesmond.
- Umwelt Environmental Consultants 2004, Ecological Inspection of Proposed Geotechnical Sites and Access Tracks within the Proposed New Route for State Highway 23 between Rankin Park and Jesmond.
- Ecotone Ecological Consultants Pty Ltd 2002, Flora and Fauna survey and threatened species assessment for a proposal to construct a new access road to John Hunter Hospital, an extension to the hospital building including a new car park and a relocated helipad.
- T. J. Fatchen & Associates 1984, Rankin Park Highway Development Vegetation Description and Assessment.
- Anne Clements & Associates 1994, Flora survey of remnant bushland patches in Newcastle Local Government Area – part of the 'Save the Bush' Program.

3.1 Method

3.1.1 Background research

A desktop database review was carried out by Parsons Brinckerhoff in July 2014 to identify threatened populations and ecological communities listed under the TSC Act and FM Act, and MNES listed under the EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. These were also used to obtain the necessary site data to perform FBA calculations. Biodiversity resources pertaining to the locality (ie within a 10 kilometre radius of the site) that were reviewed before conducting field investigations in addition to aerial photographs and satellite imagery of the study area are detailed in Table 3-1.

Table 3-1 Database searches completed

Database	Searches	Area searched	Reference
Atlas of NSW Wildlife (BioNet)	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	10 km buffer around project [1]	Office of Environment and Heritage (2014b)
NSW Department of Primary Industries (Fishing and Aquaculture) threatened Aquatic Fauna Database	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	Hunter/Central Rivers and Catchment Management Authority area	NSW Department of Primary Industries (2014)
PlantNet	25 July 2014 7 October 2014	10 km buffer around project [1]	Royal Botanical Gardens Sydney (2014)
Protected Matters Search Tool	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	10 km buffer around project [1]	Department of Environment (2014b)
Noxious Weeds Database	29 October 2014	Newcastle City Council	Department of Trade and Investment Regional Infrastructure and Services (2014)
DotE online species profiles and threats database	25 July 2014	Study area	Department of Environment (2014b)
Threatened biota profiles outlining distribution and habitat requirements of threatened biota	25 July 2014	Study area	Office of Environment and Heritage (2014b)
Nationally Important Wetland search	25 July 2014	Study area	Department of Environment (2015b)
BioBanking Credit Calculator	12 April 2016	Study area	Office of Environment and Heritage (2014b)
SPRAT database for EPBC listed threatened species and communities	25 July 2014	Study area	Department of Environment (2015c)
OEH vegetation information systems (VIS) database	25 July 2014	Study area	OEH, 2015c
NSW OEH Vegetation types database	25 July 2014	Study area	OEH, 2015c
Australian Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems	25 July 2014	Study area	BOM, 2015

Note: 1 - Coordinates used -32.86, 151.64, -32.96, 151.74

3.1.2 Vegetation surveys

Survey effort that has directly contributed to this BAR is summarised in Table 3-2 and is described in further detail in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Section 2.5) (Parsons Brinckerhoff 2015a) (Appendix C). Additional surveys were also carried out in the study area by Eastcoast Flora Survey 2015 (Appendix K).

Table 3-2 Vegetation survey effort

Survey technique	Ideal survey detection period	Date carried out
Field verification of existing vegetation mapping	N/A	September-October 2014
Collection of plot data in accordance with the FBA. This included a total of 30 quadrat/transect surveys	N/A	July-October 2014
Vegetation mapping (Bell, 2015)	N/A	February 2015

Site stratification

Vegetation type boundaries were initially stratified using aerial photo interpretation. This provided an initial split of vegetation types into simple structural and disturbance classifications.

Pre-existing vegetation mapping (LHCCREMS 2003 and Umwelt 2006) was ground-truthed in the field to determine the site specific classification of vegetation structure, dominant canopy species, native diversity and condition (Parsons Brinckerhoff 2015a).

The site was divided into relatively homogenous or discrete zones for assessment based on observed vegetation structure, species composition, soil type, landscape position and condition.

Plot/transect surveys

Plot and transect surveys were conducted by Parsons Brinckerhoff (2015a) in accordance with the FBA to confirm vegetation types, assess site condition and where required to calculate biodiversity credits. The site value was determined by assessing ten site condition attributes against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Cover abundance data was also collected for each species within the 20 by 20 metre portion of each plot/transect.

Plots were used to sample potential vegetation zones (ie PCTs and broad condition classes) based on the initial site stratification. The minimum number of plots and transects for each zone were determined and carried out in accordance with Table 3 of the FBA (OEH, 2014b).

Thirty plot/transects were sampled within the construction footprint as shown on Figure 3-1. A summary of survey effort for the vegetation plots in each PCT is summarised in Table 3-3.

Table 3-3 Vegetation plot/transect survey effort

Plant community type (PCT)	Minimum number of plots required	Number of plots surveyed
HU631 Spotted Gum – Grey Ironbark Open Forest – atypical variant (HU803)	3	3
HU631 Spotted Gum – Grey Ironbark Open Forest – *Eucalyptus fergusonii* variant (HU803)	3	6
HU629 Spotted Gum –Broad-leaved Ironbark grassy open woodland (HU806)	3	4
HU621 Smooth-barked Apple – Red Bloodwood open forest (HU833)	3	7
HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest (HU841)	2	3
HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant (HU782)	3	3
HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant (HU782)	3	3
Planted and parkland vegetation	0	1
Total	**20**	**30**

Additional vegetation surveys

Additional vegetation survey effort was used to supplement the plot/transect surveys and help describe the vegetation of the study area. Area searches were conducted within all vegetation types to compile a more exhaustive species list for the study area (Parsons Brinckerhoff 2015a).

Vegetation condition assessment

The overall condition of vegetation was assessed through general observation and comparison against the BioBanking benchmark data (Office of Environment and Heritage 2014c) and the vegetation condition definition as set out in the BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014a). The moderate to good condition classes as outlined in the BBAM methodology have been separated as the parts of the native vegetation within the study area retains the native canopy floristic characteristics with the shrub and ground layer being disturbed from maintenance such as mowing or weed incursions. Three criteria were used to describe the condition of the vegetation communities and are set out in Table 3-4.

Table 3-4 Vegetation condition assessment criteria

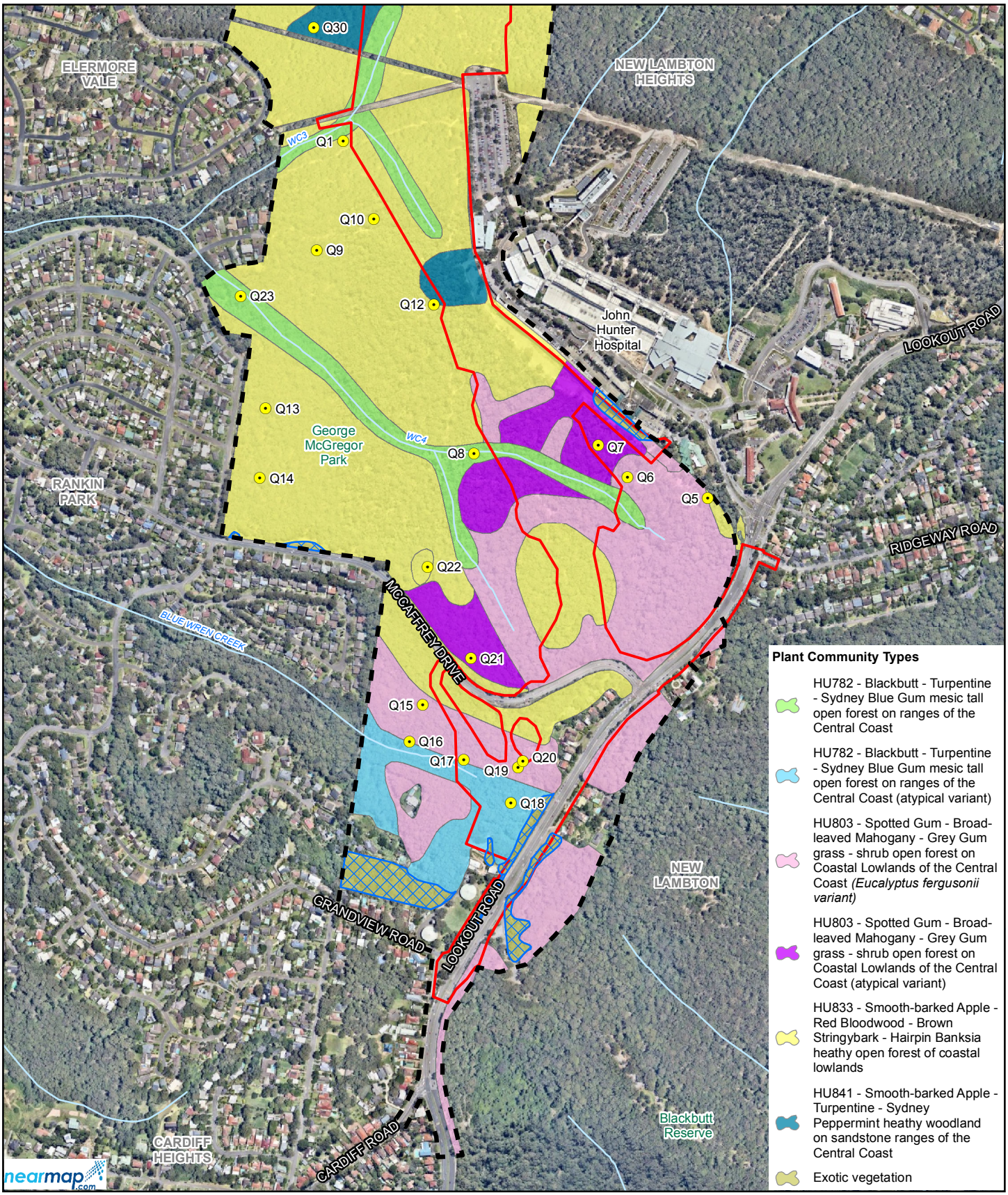
Good condition	Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers. This vegetation will be at or above the BioBanking benchmarks (Office of Environment and Heritage 2014c). This condition equates to BBAM Moderate to Good condition (Office of Environment and Heritage 2014a).
Moderate condition	Vegetation has retained a native canopy and has a native understorey of greater than 50%. This condition class can include derived native grasslands and can have minor weed incursions with some patches being subject to grazing. This condition equates to BBAM moderate to good condition (Office of Environment and Heritage 2014a).
Low condition	Vegetation has a native canopy less than 50% of the lower benchmark. The understorey is generally dominated by exotic species being greater than 50% exotic cover. The shrub layer was generally absent from this condition class. Weed invasion can be significant in such remnants. This condition class equates to BBAM low condition (Office of Environment and Heritage 2014a).

3.1.3 Assumptions and limitations

It is possible that some species were not detected during the survey due to activity (permanently, seasonally or transiently). These species may include flora species such as annual, ephemeral or cryptic species.

Site conditions (including the presence of threatened species of flora) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

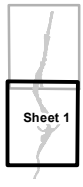
This report has been prepared based on information provided in reports and spatial data provided by Parsons Brinckerhoff (2015a, 2015b, 2015c, 2015d, 2016). These data have in turn been relied upon in the FBA calculations and the determination of key thresholds such as whether the project would have a direct impact on a EEC, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated project design and/or spatial data.



LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse
- Biobanking Plot
- Below benchmark condition vegetation (site value score <17)

Sheet layout



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Rankin Park to Jesmond
Biodiversity Assessment Report

Vegetation Plot and Survey Effort - sheet 1 of 2

Job Number	22-17656
Revision	0
Date	26 Aug 2016

Figure 3-1a

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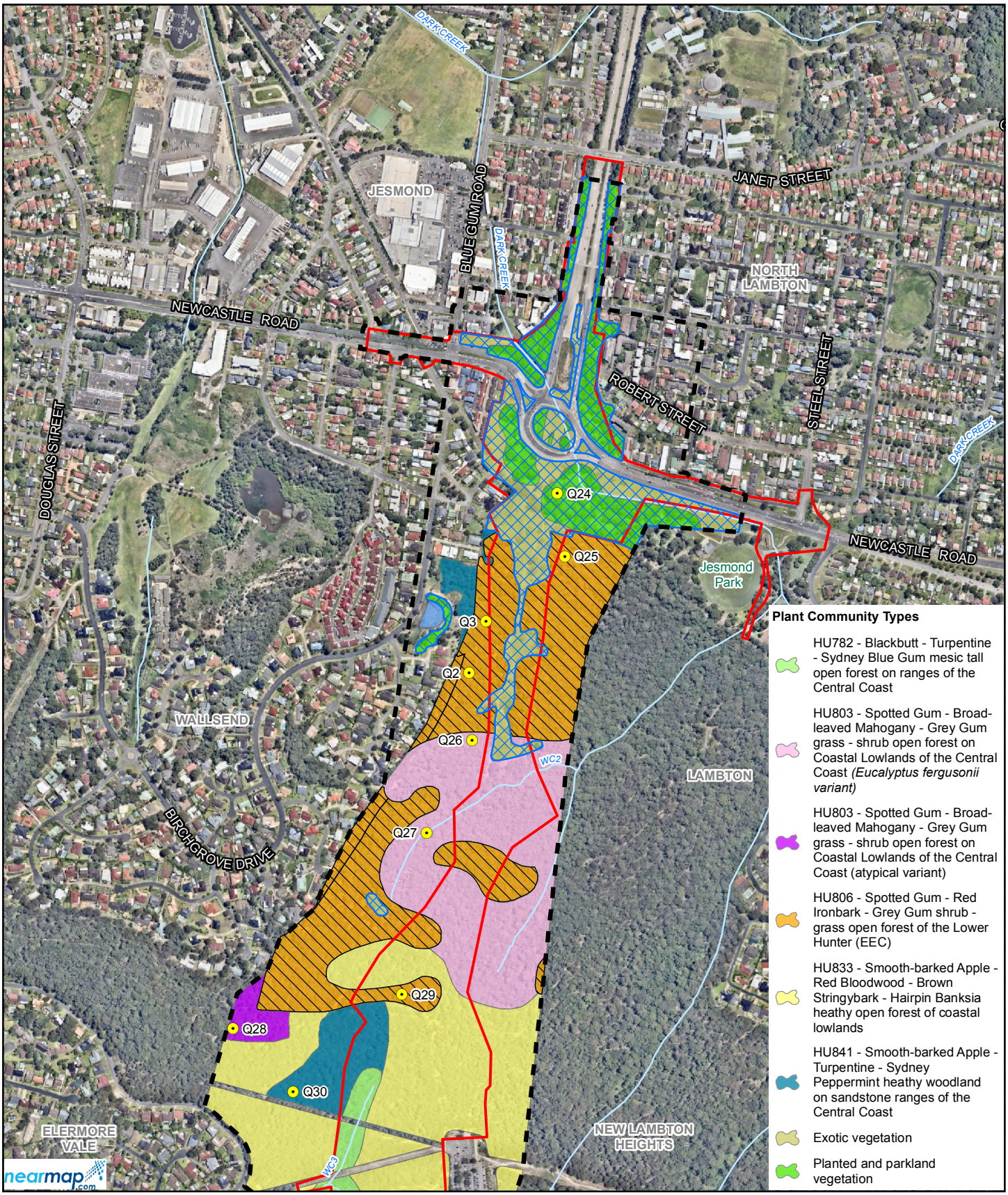
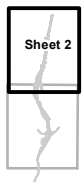
Data source: Aurecon: Construction footprint, 2016: PB: Vegetation Mapping / study area, 2015; BELL: EEC 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton, fmackay



LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse
- Biobanking Plot
- Endangered Ecological Community (NSW TSC Act) (Lower Hunter Spotted Gum Ironbark Forest)
- Below benchmark condition vegetation (site value score <17)
- Dam

Sheet layout



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Biodiversity Assessment Report

Vegetation Plot and Survey Effort - sheet 2 of 2

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Figure 3-1b

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Data source: Aurecon: Construction footprint, 2016: PB: Vegetation Mapping / study area, 2015; BELL: EEC 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton, fmackay

3.1.4 Native vegetation assessment

The FBA credit calculations were performed by Dan Williams (assessor accreditation number 0082) and Arien Quinn (assessor accreditation number 0120) using credit calculator Version 4.1 (linear module). The credit calculations will be submitted to OEH and the biodiversity credit report is included in Appendix E. The data and assumptions used to perform the FBA credit calculations are summarised below according to the structure and information requirements outlined in Appendix 7 of the FBA (OEH, 2014b).

The project impacts that have been included in the credit calculations include the 39.2 hectares of native vegetation that meets a PCT criteria and that would be removed for construction of the project. It also includes the seven hectares of native vegetation that may be indirectly impacted by the project (assumed 10 metre total cleared buffer area around the construction footprint to compensate for an estimated 20 metre indirect impact disturbance area around the project construction footprint).

The total area of impacted native vegetation assessed in the credit calculations is therefore 46.2 hectares.

A 550 metre buffer area either side of the project construction footprint was used to estimate the extent and connectivity of native vegetation and habitat surrounding the construction footprint. The total remnant vegetation area of the buffer utilised for the assessment was about 687.7 hectares (refer Table 3-5 and Figure 1-4).

Vegetation cover and connectivity were estimated based on the current and post-development vegetation cover within the assessment buffer using GIS measurement of foliage projective cover within the buffer area. The percentage change in vegetation cover was estimated by subtracting the area of vegetation that would be impacted as a result of the project from the existing area of vegetation within the buffer area. A combination of aerial photography and regional vegetation mapping (LHCCREMS 2003) was used for the vegetation cover and connectivity assessment in the buffer area. There is currently about 352.8 hectares of vegetation within the assessment buffer which will be reduced to about 298.1 hectares post-project (refer Table 3-5). This accounts for the removal of about 54.7 hectares of vegetation which includes remnant, regrowth or planted vegetation. A score of 1.5 for ‘percent native vegetation cover’ in the landscape was determined for the project by the credit calculator.

Table 3-5 Remnant vegetation cover

Assessment area – 550 m either side of project construction footprint (ha)	Before development		After development	
	Remnant vegetation cover (ha)	Cover class	Remnant vegetation cover (ha)	Cover class
687.7	352.8	51-55%	298.1	41-45%

3.2 Plant community type descriptions

One vegetation zone was created for each plant community type (PCT) and broad condition state in the construction footprint. The area of each zone was calculated using GIS. Native vegetation zones within the construction footprint assessed in the credit calculator are summarised in Table 3-6.

All native vegetation zones within the construction footprint are in moderate/good condition and are connected to vegetation extending to the south-east and west of the site. The extent of vegetation within the project buffer area was calculated using GIS (refer Figure 1-4) and determined to be currently about 687.7 hectares in total.

Site value data was collected using the BioBanking plot/transect methodology and was entered for each plot/transect field in each vegetation zone. This plot/transect data is provided in Appendix F.

Most of the study area contains native vegetation. Vegetation within the study area that has been mapped by Parsons Brinckerhoff (2015a) corresponds with five PCTs (as per OEH 2014d) and two non-native vegetation types as summarised in Table 3-6, shown on Figure 3-1 and described in detail in the following sections.

Table 3-6 Plant community types within the study area

Vegetation types	Plant Community Type ID	Plant Community Type [1]	Condition	Area within study area (ha)	Conservation significance	Patch size (ha)	Extent cleared in the CMA sub region (percent)	Total Impact area (ha) assessed in credit calculator	Area (ha) – direct impacts	Area (ha) – indirect impacts [2]	Site value score
Spotted Gum – Grey Ironbark open forest – atypical variant	HU803	Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	Moderate/good	7.2	Not listed	300	71	15	12.0	3.0	88.54
Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	HU803	Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	Moderate/good	34.4	Not listed	300	71	15	12.0	3.0	88.54
Spotted Gum – Broad-leaved Ironbark grassy open forest	HU806	Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	Moderate/good	16.4	Listed as an EEC under the TSC Act (Lower Hunter Spotted Gum Ironbark Forest EEC)	300	44	5.1	4.1	1.0	68.23
Smooth-barked Apple – Red Bloodwood open forest	HU833	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Moderate/good	55.1	Not listed	300	45	19.1	16.8	2.3	76.04
Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	HU841	Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Moderate/good	4.4	Not listed	300	9	2.2	1.9	0.3	73.44
Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant	HU782	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Moderate/good	7.1	Not listed	300	40	4.8	4.4	0.4	86.98
Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	HU782	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Moderate/good	4.6	Not listed	300	40	4.8	4.4	0.4	86.98
Planted and parkland vegetation	N/A	N/A	Cleared/non-native	5.9	Not listed	N/A	N/A	N/A	N/A	N/A	N/A
Exotic vegetation	N/A	N/A	Cleared/non-native	7.9	Not listed	N/A	N/A	N/A	N/A	N/A	N/A
Total				**142.9**							

Note: 1 OEH Biometric types database, (OEH, 2011).

2 Assessed as total clearing in a 10 m buffer around construction footprint to compensate for estimated 20 m indirect impact buffer area

The following descriptions of vegetation and PCTs in the study area have been prepared based on data provided in Parsons Brinckerhoff (2015a).

3.2.1 HU806 - Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter

HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest	
Vegetation formation	KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests
PCT	1592
BVT	HU806 - Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter
Conservation status	High: This community consisted of native species characteristic with the HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest native vegetation community. This community is consistent with Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion, which is listed as an endangered ecological community under the TSC Act. This community is not consistent with any threatened ecological community listed under the EPBC Act.
Estimate of percent cleared	44%
Condition	This vegetation community occurred as two variants within the study area and as such has two condition classes, as follows: • Good – The type variant of this community is in good condition with high diversity of native species recorded, with little weed incursions. This condition class generally occurred as the dominant vegetation community within the northern section of the Study Area where no vegetation clearing has occurred. This community had grassy patches dominated by *Joycea pallida* and shrubby areas dominated by prickly shrub species such as *Bursaria spinosa*. This condition class occupies an area of 15.6 ha. • Moderate – This condition class occurred immediately behind housing east of Minimbah Close, Wallsend. This variant contained an intact canopy of tree species characteristic of this community however, was almost entirely void of shrub and groundcover species as a result of vegetation clearance and recreational use. This condition class occupies an area of 0.80 ha.
Extent in the study area	About 16.4 ha, equivalent to 12% of the study area.

Plots completed in vegetation zone

Structure	Average height and height range	Average cover and cover range	Typical Species
Trees	10-18	0-40	*Eucalyptus fibrosa, Corymbia maculata, Eucalyptus umbra*
Small trees	3-8	0-30	*Syncarpia glomulifera*
Shrubs	0.4-3	0-50	*Daviesia ulicifolia, Breynia oblongifolia, Bursaria spinosa, Acacia ulicifolia, Pultenaea villosa, Acacia falcata, Notelaea longifolia, Maytenus silvestris,* and the occasional *Dodonaea triquetra*

HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest				
	Ground covers	0.1-1	0-90	*Joycea pallida, Entolasia stricta, Imperata cylindrica, Lomandra multiflora, Macrozamia producta, Lepidosperma laterale, Hardenbergia violacea, Pratia purpurascens, Digitaria parviflora, Phyllanthus hirtellus, Dianella revoluta* and *Pandorea pandorana*
	Vines & climbers	N/A	N/A	N/A
Description	The broad scale vegetation mapping of the study area did not identify the presence of HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest within the study area. This community was previously mapped as Coastal Foothills Spotted Gum – Ironbark Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). Within the study area this community covered 16.4 ha equivalent to 12% of the study area occurring in the north of the study area between Dangerfield Drive Reserve and Newcastle Road within the study area. The Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter community contains two condition classes good (15.6 ha) and moderate (0.80 ha). Most of the community was in good condition occurring generally within the northern section of the study area in areas of minimal disturbance. The moderate condition vegetation occurred as a narrow linear patch immediately behind houses on Minimbah Close, Wallsend. The moderate condition patch contained canopy trees only with minimal shrub or groundcover species as a result of vegetation clearance. Both the good and moderate conditions contained native canopy shrub and groundcover species representative of this community. The community differed from the other two spotted gum communities within the study area having a canopy dominated by *Eucalyptus fibrosa* (Broad-leaved Ironbark) and an understorey dominated by shrubs and grasses that prefer drier environments. This community occurred on the tops of ridges and on the drier north facing slopes.			
Photograph	 Photo 3.1 – Good condition HU629 Spotted Gum – Broad-leaved – Ironbark grassy open woodland with grassy understorey of *Joycea pallida.*			

HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest

Photo 3.2 - Good condition HU629 Spotted Gum – Broad-leaved – Ironbark grassy open woodland with shrubby mid storey of prickly shrubs such as *Bursaria spinosa.*

Photo 3.3 - Moderate condition HU629 Spotted Gum – Broad-leaved – Ironbark grassy open woodland (canopy only).

3.2.2 HU803 - Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast

<table>
<tr><th colspan="2">HU631 Spotted Gum – Grey Ironbark open forest – atypical variant</th></tr>
<tr><td>Vegetation formation</td><td>KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)</td></tr>
<tr><td>Vegetation class</td><td>Hunter-Macleay Dry Sclerophyll Forests</td></tr>
<tr><td>PCT</td><td>1589</td></tr>
<tr><td>BVT</td><td>HU803 - Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast</td></tr>
<tr><td>Conservation status</td><td>High: While this community is not consistent with any threatened ecological community, it does contain a high diversity of native species providing habitat for a number of threatened flora and fauna species.</td></tr>
<tr><td>Estimate of percent cleared</td><td>71%</td></tr>
<tr><td>Condition</td><td>Good – This community occurred mostly within the south of the study area which has been subjected to moderate weed infestations, particularly near existing infrastructure such as roads, paths and John Hunter Hospital precinct. This community had a sparse to dense canopy, shrub and ground cover with a high diversity of native species.</td></tr>
<tr><td>Extent in the study area</td><td>About 7.22 ha, equivalent to 5% of the study area.</td></tr>
<tr><td>Plots completed in vegetation zone</td><td>
<table>
<tr><th>Structure</th><th>Average height and height range</th><th>Average cover and cover range</th><th>Typical Species</th></tr>
<tr><td>Trees</td><td>14-25</td><td>0-40</td><td>Eucalyptus paniculata, Corymbia maculata, Angophora costata, Eucalyptus fergusonii subsp. dorsiventralis X paniculata, Eucalyptus punctata, Eucalyptus acmenoides, Eucalyptus umbra</td></tr>
<tr><td>Small trees</td><td>1-6</td><td>0-20</td><td>Juvenile Eucalyptus sp. and Allocasuarina torulosa</td></tr>
<tr><td>Shrubs</td><td>0.4-2</td><td>0-10</td><td>Daviesia ulicifolia, Pultenaea villosa, Acacia ulicifolia, Dodonaea triquetra, Epacris pulchella, juvenile Allocasuarina torulosa and the occasional Banksia spinulosa</td></tr>
<tr><td>Ground covers</td><td>0.1-1</td><td>0-70</td><td>Entolasia stricta, Imperata cylindrica, Lomandra longifolia, Billardiera scandens, Lepidosperma laterale, Macrozamia communis, Microlaena stipoides, Glycine tabacina, Lomandra multiflora subsp. multiflora, Eustrephus latifolius, Pseuderanthemum variable</td></tr>
<tr><td>Vines & climbers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Description</td><td>The broad scale vegetation mapping of the study area mapped this community as Coastal Foothills Spotted Gum – Ironbark Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. This was confirmed during field surveys which identified 7.22 ha of this community, equivalent to 5% of the study area.
This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of the community.</td></tr>
</table>

HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	
	This community differed from the other two spotted gum communities in the study area as it was dominated by *Eucalyptus paniculata* (Grey Ironbark), occurred on more sheltered slopes.
Photograph	 Photo 3.4 – HU631 Spotted Gum – Grey Ironbark open forest – atypical variant

3.2.3 HU631 - Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin Bioregion

HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant				
Vegetation formation	KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)			
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests			
PCT	1589			
BVT	HU631 - Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin Bioregion			
Conservation status	High: While this community is not consistent with any threatened ecological community listed under the TSC Act or the EPBC Act, it does contain a high diversity of native species providing habitat for a number of threatened flora and fauna species.			
Estimate of percent cleared	71%			
Condition	Good – This community occurred mostly within gullies to the south and north of the study area, which have been subjected to moderate weed infestations, particularly within the creeks, as a result of run off from Lookout Road. This community had a dense canopy, shrub and ground cover with a high density of native species with areas.			
Extent in the study area	About 34.40 ha, equivalent to 24% of the study area.			
Plots completed in vegetation zone	Structure	Average height and height range	Average cover and cover range	Typical Species
	Trees	12-24	0-40	*Eucalyptus fergusonii subsp. dorsiventralis, Eucalyptus punctata, Corymbia maculata, Eucalyptus acmenoides, Eucalyptus umbra* and the occasional *Angophora costata*
	Small trees	3-10	0-40	*Syncarpia glomulifera, Glochidion ferdinandi* and *Allocasuarina torulosa*
	Shrubs	0.4-3	0-80	*Acacia linearis, Persoonia linearis, Pomaderris aspera, Notelaea longifolia, Dodonaea triquetra, Pultenaea euchila* and the occasional *Leucopogon lanceolatus, Breynia oblongifolia*, *Podolobium ilicifolium, Bursaria spinosa* and *Acacia ulicifolia*
	Ground covers	0.-1	0-40	*Calochlaena dubia, Pteridium esculentum, Microlaena stipoides, Poa affinis, Lepidosperma laterale Entolasia stricta, Imperata cylindrica, Lomandra longifolia, Smilax australis, Blechnum cartilagineum, Doodia aspera, Hibbertia dentata, Desmodium rhytidophyllum, Cheilanthes sieberi subsp. sieberi, Dichondra repens, Eustrephus latifolius, Billardiera scandens, Polyscias sambucifolia*
	Vines & climbers	N/A	N/A	N/A

HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	
Description	The broad scale vegetation mapping of the study area mapped this community as Hunter Valley Moist Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. This was confirmed during field surveys which identified 34.40 ha of the community, equivalent to 24% of the study area. This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of this community. This community differs from the HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant and other spotted gum communities as it is dominated by *Eucalyptus fergusonii* subsp*. dorsiventralis* instead of *Eucalyptus paniculata*. In addition, this community occurred generally on sheltered slopes and gullies and contained a ferny understorey with species that grow in moist environments such as sedges, ferns.
Photograph	 Photo 3.5 – HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant within the study area.

3.2.4 HU833 - Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands

HU621 Smooth-barked Apple – Red Bloodwood open forest	
Vegetation formation	KF_CH5B Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation class	Sydney Coastal Dry Sclerophyll Forests
PCT	1619
BVT	HU833 - Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands
Conservation status	High: While this community is not consistent with any threatened ecological community listed under the TSC Act or the EPBC Act, it does contain a high diversity of native species providing habitat for a number of threatened flora and fauna species, including a large population of *Tetratheca juncea.*
Estimate of percent cleared	45%
Condition	Good – HU621 Smooth-barked Apple – Red Bloodwood open forest was the most abundant vegetation community recorded within the study area. In some areas, the community occurred next to previously disturbed areas that have been subjected to land clearance and weed invasion. This community had a sparse to dense canopy, shrub and ground cover with a high density of native species representative of this community
Extent in the study area	About 55.06 ha, equivalent to 38% of the study area.
Plots completed in vegetation zone	

Structure	Average height and height range	Average cover and cover range	Typical Species
Trees	10-23	0-40	*Angophora costata, Corymbia gummifera, Eucalyptus capitellata* and the occasional *Eucalyptus punctata* and *Eucalyptus globoidea*
Small trees	1-6	0-20	*Allocasuarina torulosa, Syncarpia glomulifera, Persoonia linearis* and juvenile *Eucalyptus* spp.
Shrubs	0.5-3	0-60	*Leptospermum trinervium, Banksia spinulosa, Persoonia levis, Acacia ulicifolia, Acacia terminalis, Pittosporum undulatum, Lomatia salicifolia, Pultenaea euchila* and *Tetratheca juncea*
Ground covers	0.1-1.5	0-80	*Pteridium esculentum, Imperata cylindrica, Lomandra oblique, Themeda australis, Entolasia stricta, Cassytha pubescens, Ptilothrix deusta, Xanthorrhoea latifolia* and *Lindsaea linearis*
Vines & climbers	N/A	N/A	N/A

HU621 Smooth-barked Apple – Red Bloodwood open forest	
Description	The broad scale vegetation mapping of the study area mapped this community as Coastal Plains Smooth-barked Apple Woodland (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. This was confirmed during field surveys which identified 55.06 ha of this community, equivalent to 38% of the study area. This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of this community. This community contained a *Gahnia clarkei* variant that occurred within a potential groundwater seep or potentially as a result of a culvert associated with McCaffrey Drive (Parsons Brinckerhoff, 2015a). This variant occurred within George McGregor Park to the north of McCaffrey Drive and is located outside of the proposal area. The groundwater seep appeared to have heavily influenced the vegetation composition which was dominated by *Pteridium esculentum, Gahnia clarkei, Leptospermum polygalifolium, Calochlaena dubia, Glochidion ferdinandi, Lantana camara** and dead stags. The stags observed appeared to have been *Eucalyptus acmenoides* and *Angophora costata* representative of HU621 Smooth-barked Apple – Red Bloodwood open forest and has therefore been included in this community.
Photograph	 Photo 3.6 – HU621 Smooth-barked Apple – Red Bloodwood open forest within the study area.  Photo 3.7 - HU621 Smooth-barked Apple – Red Bloodwood open forest groundwater seep.

3.2.5 HU841 - Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast

<table>
<tr><th colspan="5">HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest</th></tr>
<tr><td>Vegetation formation</td><td colspan="4">KF_CH5B Dry Sclerophyll Forests (Shrubby sub-formation)</td></tr>
<tr><td>Vegetation class</td><td colspan="4">Sydney Coastal Dry Sclerophyll Forests</td></tr>
<tr><td>PCT</td><td colspan="4">1627</td></tr>
<tr><td>BVT</td><td colspan="4">HU841 - Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast</td></tr>
<tr><td>Conservation status</td><td colspan="4">High: While this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of native species providing habitat for a number of threatened flora and fauna species.</td></tr>
<tr><td>Estimate of percent cleared</td><td colspan="4">9%</td></tr>
<tr><td>Condition</td><td colspan="4">Good – This community occurred as two small isolated patches which have been subjected to low to moderate weed infestations, particularly within areas close to vegetation clearing, paths, roads and private residences. This community had a dense canopy, shrub and ground cover with a high density of native species.</td></tr>
<tr><td>Extent in the study area</td><td colspan="4">About 4.4 ha, equivalent to 3% of the study area.</td></tr>
<tr><td>Plots completed in vegetation zone</td><td colspan="4"><table>
<tr><th>Structure</th><th>Average height and height range</th><th>Average cover and cover range</th><th>Typical Species</th></tr>
<tr><td>Trees</td><td>10-20</td><td>0-40</td><td>Eucalyptus piperita, Eucalyptus globoidea, Angophora costata, Corymbia gummifera and Syncarpia glomulifera</td></tr>
<tr><td>Small trees</td><td>4-10</td><td>0-30</td><td>Allocasuarina torulosa and juvenile Eucalyptus spp.</td></tr>
<tr><td>Shrubs</td><td>1-4</td><td>20-80</td><td>Breynia oblongifolia, Banksia spinulosa, Leptospermum polygalifolium, Acacia myrtifolia, Dodonaea triquetra, Daviesia ulicifolia, Zieria smithii subsp smithii and Leucopogon lanceolatus</td></tr>
<tr><td>Ground covers</td><td>0.1-1</td><td>0-90</td><td>Entolasia stricta, Imperata cylindrica, Pteridium esculatum, Gonocarpus spp., Xanthorrhoea latifolia, Pratia purpurascens, Dichondra repens, Cassytha pubescens, Viola hederacea, Microlaena stipoides and Dianella caerulea var. producta</td></tr>
<tr><td>Vines & climbers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Description</td><td colspan="4">The broad scale vegetation mapping of the study area has not mapped this community within the study area (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). The field surveys identified this community as being equivalent to the vegetation description of Coastal Sheltered Apple – Peppermint Forest as described by LCCREMS (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). This community encompasses 4.4 ha, equivalent to 3% of the study area.
This community occurred in good condition with a high density of representative native canopy, shrub and groundcover species. The northern patch of this community has been subjected to moderate weed infestation by exotic species such as Lantana camara* which was observed to be currently under management by bush regeneration efforts.</td></tr>
</table>

HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	
Photograph	

Photo 3.8 – HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest within the study area.

3.2.6 HU782 - Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast

HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant	
Vegetation formation	KF_CH2B Wet Sclerophyll Forests (Shrubby sub-formation)
Vegetation class	North Coast Wet Sclerophyll Forests
PCT	1568
BVT	HU782 - Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast
Conservation status	High: While this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of native species providing habitat for a number of threatened flora and fauna species. The threatened flora species *Syzygium paniculatum* was recorded within this community. A Powerful Owl was recorded roosting in dense vegetation in the south-east of the study area in this community.
Estimate of percent cleared	40%
Condition	Good – This community occurred within the centre of the study area (behind John Hunter Hospital precinct and Lookout Road through to Sygna Close Reserve). This community has been subjected to moderate weed infestations, particularly within the creeks, as a result of run off from Lookout Road. This community had a dense canopy, shrub and ground cover with a high density of native species.
Extent in the study area	About 7.05 ha, equivalent to 5% of the study area.
Plots completed in vegetation zone	

Structure	Average height and height range	Average cover and cover range	Typical Species
Trees	14-24	0-40	*Eucalyptus acmenoides, Syncarpia glomulifera, Eucalyptus paniculata, Eucalyptus siderophloia, Eucalyptus resinifera* and *Eucalyptus piperita* with the occasional *Angophora costata*
Small trees	3-6	10-40	*Syncarpia glomulifera, Melaleuca linariifolia, Glochidion ferdinandi* and *Allocasuarina torulosa*
Shrubs	0.4-3	0-40	*Dodonaea triquetra, Zieria smithii* subsp. *smithii, Leucopogon lanceolatus, Notelaea ovata, Acmena smithii* and *Syzygium paniculatum*
Ground covers	0.-1	0-90	*Juncus usitatus, Carex appressa, Oplismenus aemulus, Entolasia marginata, Smilax australis, Gahnia erythrocarpa, Adiantum aethiopicum, Calochlaena dubia* and *Morinda jasminoides*
Vines & climbers	N/A	N/A	N/A

HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant	
Description	The broad scale vegetation mapping of the study area mapped this community as a variety of native vegetation communities, including Coastal Foothills Spotted Gum – Ironbark Forest, Coastal Wet Gully Forest, Hunter Valley Moist Forest, Coastal Plains Smooth-barked Apple Woodland, Coastal Narrabeen Forest and Alluvial Tall Moist Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). This community is equivalent to Alluvial Tall Moist Forest as described by the broad scale vegetation mapping for the study area (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). The field surveys identified areas of HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant along the creek lines within the study area covering 7.05 ha equivalent to 5% of the study area. This community occurred in good condition with a high density of representative native canopy, shrub and ground cover species. Some areas within this community, mostly along the creeks, did contain moderate weed infestations such as *Lantana camara**. This community differs from the HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant as *Eucalyptus saligna* was absent from the canopy layer. and had a higher density of *Syncarpia glomulifera.*
Photograph	 Photo 3.9 – HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant within the study area.

3.2.7 HU782 - Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast

<table>
<tr><th colspan="5">HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant</th></tr>
<tr><td>Vegetation formation</td><td colspan="4">KF_CH2B Wet Sclerophyll Forests (Shrubby sub-formation)</td></tr>
<tr><td>Vegetation class</td><td colspan="4">North Coast Wet Sclerophyll Forests</td></tr>
<tr><td>PCT</td><td colspan="4">1568</td></tr>
<tr><td>BVT</td><td colspan="4">HU782 - Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast</td></tr>
<tr><td>Conservation status</td><td colspan="4">High: While this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of native species providing habitat for a number of threatened flora and fauna species</td></tr>
<tr><td>Estimate of percent cleared</td><td colspan="4">40%</td></tr>
<tr><td>Condition</td><td colspan="4">Moderate – This community occurred as remnant vegetation surrounded by residential development and urban infrastructure (such as roads). Previous and current land uses have resulted in this community being moderately to highly disturbed from weed invasion. Some areas within this community have received bush regeneration efforts to remove areas of woody weeds. This community had a dense canopy and shrub cover however in areas contained a sparse or completely void ground cover.</td></tr>
<tr><td>Extent in the study area</td><td colspan="4">About 4.61 ha, equivalent to 3% of the study area.</td></tr>
<tr><td>Plots completed in vegetation zone</td><td colspan="4"><table>
<tr><th>Structure</th><th>Average height and height range</th><th>Average cover and cover range</th><th>Typical Species</th></tr>
<tr><td>Trees</td><td>18-26</td><td>0-40</td><td>Eucalyptus saligna, Eucalyptus acmenoides, Eucalyptus paniculata, Syncarpia glomulifera, Eucalyptus siderophloia and Corymbia maculata</td></tr>
<tr><td>Small trees</td><td>3-6</td><td>0-30</td><td>Allocasuarina torulosa and Glochidion ferdinandi</td></tr>
<tr><td>Shrubs</td><td>0.4-3</td><td>30-60</td><td>Dominated by Lantana camara*, Ligustrum sinense*, Pittosporum undulatum, Breynia oblongifolia, Eupomatia laurina, Ochna serrulata*</td></tr>
<tr><td>Ground covers</td><td>0.1-1</td><td>0-50</td><td>Cynodon dactylon, Entolasia marginata, Dichondra repens, Sarcopetalum harveyanum, Lomandra sp., Gahnia melanocarpa, Smilax australis and Cissus antarctica</td></tr>
<tr><td>Vines & climbers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Description</td><td colspan="4">The broad scale vegetation mapping of the study area mapped this community as Coastal Foothills Spotted Gum – Ironbark Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. The field surveys identified this community as HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant covering 4.61 ha equivalent to 3% of the study area.
This community occurred in moderate condition with a high density of representative native canopy species and moderate density of native shrub and ground cover species. Along the creek line, vegetation was dominated by exotic species such as Lantana camara*.</td></tr>
</table>

HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	
Photograph	 Photo 3.10 – HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant within the study area.

3.2.8 Planted and parkland vegetation

<table>
<tr><th colspan="2">Planted and parkland vegetation</th></tr>
<tr><td>Vegetation formation</td><td>N/A</td></tr>
<tr><td>Vegetation class</td><td>N/A</td></tr>
<tr><td>PCT</td><td>N/A</td></tr>
<tr><td>BVT</td><td>N/A</td></tr>
<tr><td>Conservation status</td><td>Moderate: This community consisted of planted and the occasional remnant native tree species.
This community was not consistent with any native vegetation community or any threatened ecological Community listed under the TSC Act or EPBC Act.</td></tr>
<tr><td>Estimate of percent cleared</td><td>N/A</td></tr>
<tr><td>Condition</td><td>Moderate – This community generally occurred next to previously disturbed areas that have been subjected to land clearance and weed invasion. This community had a sparse to dense remnant and/or planted canopy and ground cover, and lacked a native species shrub layer. Within Jesmond Park, numerous planted exotic and native species occurred, whereas to the north of the roundabout, dense stands of Casuarina glauca have been planted along the road verges.</td></tr>
<tr><td>Extent in the study area</td><td>About 5.9 ha, equivalent to 4% of the study area.</td></tr>
<tr><td>Plots completed in vegetation zone</td><td>
<table>
<tr><th>Structure</th><th>Average height and height range</th><th>Average cover and cover range</th><th>Typical Species</th></tr>
<tr><td>Trees</td><td>8-30</td><td>0-40</td><td>Eucalyptus punctata, Corymbia maculata, Eucalyptus acmenoides, Eucalyptus fergusonii, Syncarpia glomulifera, Brachychiton acerifolius, and Casuarina glauca</td></tr>
<tr><td>Small trees</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Shrubs</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Ground covers</td><td>0.1-1</td><td>0-90</td><td>Cynodon dactylon, Dichondra repens, Ehrharta erecta*, Trifolium repens*, Sporobolus africanus*, Avena fatua*, Poa annua*, Sonchus oleraceus*, Conyza sp.*, Hypochaeris spp.</td></tr>
<tr><td>Vines & climbers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Description</td><td>The planted and parkland vegetation was a highly disturbed vegetation community that occurred within Jesmond Park and along Newcastle Road to the north of the study area. The community was generally associated with areas that had been subjected to land clearance and weed invasion as a result of parkland and infrastructure (such as walking tracks and roads). The community covered 5.9 ha, equivalent to 4% of the study area. Due to previous and current land uses this community no longer resembles any local native remnant vegetation communities.</td></tr>
</table>

Planted and parkland vegetation	
Photograph	 Photo 3.11 – Planted and parkland vegetation to the north of the study area

3.2.9 Exotic vegetation

<table>
<tr><th colspan="2">Exotic vegetation</th></tr>
<tr><td>Vegetation formation</td><td>N/A</td></tr>
<tr><td>Vegetation class</td><td>N/A</td></tr>
<tr><td>PCT</td><td>N/A</td></tr>
<tr><td>BVT</td><td>N/A</td></tr>
<tr><td>Conservation status</td><td>Low: This community is not consistent with any native vegetation community or any threatened ecological community listed under the TSC Act or EPBC Act.</td></tr>
<tr><td>Estimate of percent cleared</td><td>N/A</td></tr>
<tr><td>Condition</td><td>Low – This community generally occurred next to previously disturbed areas that have been subjected to land clearance and weed invasion. This community generally lacked a canopy layer and had a high density of ground layer exotic species and in some of the gullies a high density of Lantana camara* was recorded.</td></tr>
<tr><td>Extent in the study area</td><td>About 7.85 ha, equivalent to 5% of the study area.</td></tr>
<tr><td>Plots completed in vegetation zone</td><td>
<table>
<tr><th>Structure</th><th>Average height and height range</th><th>Average cover and cover range</th><th>Typical Species</th></tr>
<tr><td>Trees</td><td>6-20</td><td>0-20</td><td>Occasional isolated Eucalyptus sp.</td></tr>
<tr><td>Small trees</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Shrubs</td><td>1-2.5</td><td>0-100</td><td>Lantana camara*</td></tr>
<tr><td>Ground covers</td><td>0.1-2</td><td>0-100</td><td>Hyparrhenia hirta*, Chloris gayana*, Ehrharta erecta*, Trifolium repens*, Sporobolus africanus*, Avena fatua*, Poa annua*, Sonchus oleraceus*, Conyza sp*, Hypochaeris spp. and the occasional native species such as Imperata cylindrica and Pteridium esculentum</td></tr>
<tr><td>Vines & climbers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Description</td><td>The exotic vegetation was a highly disturbed vegetation community that occurred mostly to the north and south of the study area. The community covered 7.85 ha equivalent to 5% of the study area. The community was generally associated with areas that had been subjected to land clearance and weed invasion as a result of residential development, recreation (parks) and infrastructure (such as walking tracks, roads and power easements). Due to previous and current land uses this community no longer resembles any local native remnant vegetation communities.</td></tr>
</table>

Exotic vegetation	
Photograph	

Photo 3.12 – Exotic vegetation to the north of the study area.

3.2.10 Aquatic vegetation –dam

<table>
<tr><th colspan="2">Dam</th></tr>
<tr><td>Vegetation formation</td><td>N/A</td></tr>
<tr><td>Vegetation class</td><td>N/A</td></tr>
<tr><td>PCT</td><td>N/A</td></tr>
<tr><td>BVT</td><td>N/A</td></tr>
<tr><td>Conservation status</td><td>Low: Persistent aquatic habitat in the study area occurred in the form of a dam in the north-western boundary of the study area. The dam has been constructed to collect runoff from the surrounding urban development. It provides habitat for commonly occurring fauna species such as waterfowl and herpetofauna.</td></tr>
<tr><td>Estimate of percent cleared</td><td>N/A</td></tr>
<tr><td>Condition</td><td>Low – The general condition of the dams is low due to high sediment build up and the poor quality of the water. The vegetation would provide habitat for commonly occurring fauna species.</td></tr>
<tr><td>Extent in the study area</td><td>About 0.17 ha, equivalent to 0.11% of the study area.</td></tr>
<tr><td>Plots completed in vegetation zone</td><td>
<table>
<tr><th>Structure</th><th>Average height and height range</th><th>Average cover and cover range</th><th>Typical Species</th></tr>
<tr><td>Floating Aquatic</td><td>-</td><td>-</td><td>Spirodela punctata and Nymphaea sp.</td></tr>
<tr><td>Emergent Aquatic</td><td>0.9-2</td><td>0-20</td><td>Persicaria decipiens, Paspalum distichum and Juncus usitatus</td></tr>
<tr><td>Terrestrial ground layer</td><td>0.1-0.8</td><td>0-40</td><td>Rumex crispus*, Pennisetum clandestinum* and Cynodon dactylon</td></tr>
</table>
</td></tr>
<tr><td>Description</td><td>There is the only dam within the study area and has been constructed to collect runoff from the surrounding urban development (Figure 3.2 and Photo 3.13). The identified aquatic vegetation encompasses 0.17 ha, equivalent to 0.11% of the study area. The vegetation associated with the dam is not consistent with a native vegetation community, although it does contain native emergent aquatic flora species which would provide habitat for commonly occurring waterfowl and herpetofauna (Photo 3.12). The vegetation characteristics of this community are summarised in Table 3.12.</td></tr>
<tr><td>Photograph</td><td> 
Photo 3.13 – Dam</td></tr>
</table>

3.3 Threatened ecological communities

Eighteen EECs listed under the TSC Act are predicted to occur within the Hunter Central Rivers Hunter Sub-catchment (Parsons Brinckerhoff 2015a). In addition, one EEC listed under the EPBC Act is predicted to occur in the locality (DotE 2014a) (Parsons Brinckerhoff 2015a).

One EEC listed under the TSC Act; Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion, was recorded within the study area by Parsons Brinckerhoff (2015a). The extent of this EEC within the study area is shown on Figure 3-1.

The occurrence of Lower Hunter Spotted Gum-Ironbark Forest within the study area coincides with the PCT Spotted Gum – Broad-leaved Ironbark grassy open forest (HU803). This PCT occurs in the north of the study area.

This community was mapped by Parsons Brinckerhoff (2015a) as being mainly in good condition (15.6 hectares), with a small area of moderate condition (0.8 hectares). The moderate condition patch consists of a narrow linear patch of vegetation located immediately behind residences on Minimbah Close, Wallsend. The moderate condition patch comprises a canopy only with minimal native shrub or groundcover species as a result of vegetation clearance. Both the good and moderate condition areas contained native canopy shrub and groundcover species representative of this vegetation type (Parsons Brinckerhoff 2015a).

The community differed from the other two spotted gum communities within the study area as the canopy was dominated by Broad-leaved Ironbark (*Eucalyptus fibrosa*) and the understorey was dominated by shrubs and grasses that prefer drier environments (Parsons Brinckerhoff 2015a).

No other threatened ecological communities occur within the study area.

Lower Hunter Spotted Gum Ironbark Forest

Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is the name given to the ecological community that occurs principally on Permian geology in the central to lower Hunter Valley. The community is restricted to a range of about 65 by 35 kilometres centred on the Cessnock – Beresfield area in the Central and Lower Hunter Valley (NPWS 2000, NSW Scientific Committee 2010).

The OEH final determination (NSW Scientific Committee 2010) defines the EEC as follows:

"Lower Hunter Spotted Gum – Ironbark Forest 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* (NPWS 2000, Hill 2003, Bell 2004). In an undisturbed condition, the structure of the community is typically open forest. If thinning has occurred, it may take the form of woodland or a dense thicket of saplings, depending on post-disturbance regeneration."

To confirm the occurrence of this community within the study area, two independent investigations were carried out by GHD (2015) and Stephen Bell (2015). Both independent studies confirmed the presence and extent of this EEC within the study area. GHD carried out a desktop review of the findings by Parsons Brinckerhoff, detailed in Parsons Brinckerhoff (2015a) (Appendix C) and conferred with the findings.

Bell (2015) was engaged by Roads and Maritime as an independent assessor and carried out field investigations, data collection and numerical data analysis to confirm the presence of this EEC within the study area.

This determination (Bell 2015) was based upon the following key considerations:

- The study area lies within the Sydney Basin and on Permian-aged geology, satisfying two of the three principal determining features of Lower Hunter Spotted Gum – Ironbark Forest EEC (NSW Scientific Committee 2010).
- In the areas inspected as part of this study, the community is also dominated by *Corymbia maculata* and *Eucalyptus fibrosa* (satisfying the third determiner), with *Eucalyptus umbra* also commonly present. In moister areas, other canopy species include *Eucalyptus propinqua* and *Eucalyptus acmenioides*, with *Eucalyptus fergusonii* also occasionally evident from nearby sheltered slopes.

Based on these characteristics, the community was deemed to be Lower Hunter Spotted Gum – Ironbark Forest EEC as defined in the current Final Determination (Bell 2015). To further verify this conclusion, additional analysis was carried out, involving:

- An assessment of species presence within two sample plots against diagnostic lists which showed there to be 64 per cent and 72 per cent 'hit' for Hinterland Spotted Gum – Ironbark Forest.
- A floristic dichotomous key developed as part of this revision lead directly to the Hinterland Spotted Gum – Ironbark Forest form.

Both analyses suggested that the community in the study area was more closely related to LHSGIF (as identified elsewhere in the region) than to other more general Spotted Gum-Ironbark communities, including Coastal Foothills Spotted Gum-Ironbark Forest (Bell 2015).

Consequently, Bell (2015) determined that the study area supports Hinterland Spotted Gum – Ironbark Forest, which constitutes a form of the Lower Hunter Spotted Gum – Ironbark Forest EEC listed under the TSC Act.

The occurrence of the Lower Hunter Spotted Gum-Ironbark Forest EEC within the study area is considered the eastern-most record of this community to date (LHCCREMS 2003; Bell 2015, Parsons Brinckerhoff 2015a).

3.4 Groundwater dependent ecosystems

The *NSW State Groundwater Dependent Ecosystems Policy* defines groundwater dependent ecosystems (GDEs) as ecosystems, which have their species composition, and their natural ecological processes determined by groundwater (DLWC 2002).

The policy defines groundwater as the water beneath the earth's surface that has filtered down to the zone where the earth or rocks are fully saturated (DLWC 2002). Ecosystems vary dramatically in the degree of dependency of groundwater, from having no apparent dependence through to being entirely dependent on it (DLWC 2002). With the exception of the Great Artesian Basin's mound springs, the level of scientific understanding of the role that groundwater plays in maintaining ecosystems in Australia is generally low (DLWC 2002).

Currently the approach for assessment of terrestrial groundwater dependent ecosystems is not well documented or understood.

Dependence (or interaction) of the vegetation communities identified within the study area on groundwater was determined by aligning them with the GDE types identified by the *Groundwater Dependant Ecosystem Assessment* (DLWC 2002).

The *Risk Assessment Guidelines for Groundwater Dependent Ecosystems – The Conceptual Framework* (Serov et. al. 2012) has recently been developed by the NSW Office of Water (NOW) (now known as DPI Water) and the OEH. This presents an approach to GDE identification, classification, ecological valuation, and ecological risk assessment for a given activity or potential impact on a groundwater source. This also details a series of steps to identify and infer the level of groundwater dependency and provides a summary of risk assessment guidelines for GDEs. This risk assessment has assigned probabilities of vegetation types in the Hunter Central Rivers CMA being a GDE and has been used to assess the likelihood of vegetation within the study area being a GDE (Kuginis et al 2012).

The upper groundwater source within the study area is considered to be low yielding perched groundwater (GHD 2016). The deeper regional groundwater table is reported to be at about sea level (Coffey 1983). There is no known alluvial groundwater within the study area. Dependence (or interaction) of the vegetation communities identified in the study area on groundwater was determined by Parsons Brinckerhoff (2015a) by aligning them with the groundwater dependent ecosystem types identified by the *Groundwater Dependent Ecosystems Assessment, Registration and Scheduling of High Priority Manual* (DNR 2006).

Two vegetation types that are considered to be intermittently dependent on groundwater and one that is considered dependent have been identified within the study area as part of biodiversity surveys conducted by Parsons Brinckerhoff (2015a). Details regarding these GDEs are shown in Table 3-7 and Figure 3-2.

Vegetation within the study area identified as GDEs include the two variants of the Sydney Blue Gum – White Mahogany shrubby tall open forest (HU782). These PCTs are both riparian communities and are likely to rely on surface water runoff and accessing groundwater when groundwater levels are high and were therefore classified as being intermittently dependent on groundwater (Parsons Brinkerhoff 2015a). This community (HU782) is the only identified riparian vegetation community in the study area.

The *Gahnia clarkei* variant of the Smooth-barked Apple Red Bloodwood open forest was considered by Parsons Brinckerhoff (2015a) as likely to occur as a result of groundwater seep and to be dependent on groundwater.

Table 3-7 Identified groundwater dependent ecosystems (Parsons Brinckerhoff 2015a)

Vegetation type [1]	Plant community type	GDE type	Class	Habitat	Dependency on groundwater [2]
HU782 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Riparian and terrestrial vegetation	T1 – Riparian vegetation community	Terrestrial	Intermittently
HU782 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Riparian and terrestrial vegetation	T1 – Riparian vegetation community	Terrestrial	Intermittently
HU833 Smooth-barked Apple – Red Bloodwood open forest – *Gahnia clarkei* variant	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Wetlands	W10 – Sedge Swamp	Epigean	Known

Note: 1 PCTs as per Parsons Brinckerhoff (2015a)

2 Known groundwater dependency as per (Eamus et al. 2006).

LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area

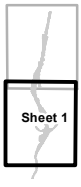
Known groundwater dependent ecosystems

- Smooth-barked Apple - Red Bloodwood open forest - *Gahnia clarkei variant* (HU833)

Intermittent groundwater dependent ecosystems

- Sydney Blue Gum - White Mahogany shrubby tall open forest - atypical variant (HU782)
- Sydney Blue Gum - White Mahogany tall open forest - *Syncarpia glomulifera variant* (HU782)

Sheet layout



Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number	22-17656
Revision	0
Date	26 Aug 2016

Groundwater dependent ecosystems
sheet 1 of 2

Figure 3-2a

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G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA010_GDE_Vegetation_DDP_0.mxd

Data source: Aurecon: Construction footprint, 2016; LPI: Aerial imagery, 2015. LPI: DCDB\DTDB, 2012, Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012; PB: Vegetation Mapping, 2016. Created by: fmackay, tmorton

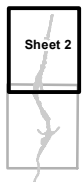
LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area

Intermittent groundwater dependent ecosystems

- Sydney Blue Gum - White Mahogany tall open forest - *Syncarpia glomulifera variant* (HU782)

Sheet layout



Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number	22-17656
Revision	0
Date	26 Aug 2016

Groundwater dependent ecosystems
sheet 2 of 2

Figure 3-2b

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G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA010_GDE_Vegetation_DDP_0.mxd

Data source: Aurecon: Construction footprint, 2016; LPI: Aerial imagery, 2015. LPI: DCDB\DTDB, 2012, Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012; PB: Vegetation Mapping, 2016. Created by: fmackay, tmorton

4. Threatened species

This section of the BAR provides the methods and results of threatened biota surveys within the study area. This BAR has been prepared based on targeted field surveys and reporting completed for the project by Parsons Brinckerhoff. Biodiversity surveys completed by Parsons Brinckerhoff for the project include:

- Parsons Brinckerhoff 2014, Newcastle Inner City Bypass: Rankin Park to Jesmond, Preliminary Environmental Investigation.
- Parsons Brinckerhoff 2015a, Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report (Appendix C).
- Parsons Brinckerhoff 2015b, Newcastle Inner City Bypass: Rankin Park to Jesmond, Additional Powerful Owl and Hollow-bearing Tree Surveys (Appendix G).
- Parsons Brinckerhoff 2015c, Newcastle Inner City Bypass: Rankin Park to Jesmond, Nest Box Inspections (Appendix H).
- Parsons Brinckerhoff 2015d, Newcastle Inner City Bypass: Additional Diuris praecox and Corybas dowlingii targeted surveys (Appendix I).
- Parsons Brinckerhoff 2016b, Newcastle Inner City Bypass: Rankin Park to Jesmond, Additional Cryptostylis hunteriana and Threatened Frogs targeted surveys (Appendix J).

The following additional biodiversity reports relating to the study area were also reviewed as part of the desktop assessment:

- GHD 2015, *EPBC Referral for the Newcastle Inner City Bypass – Rankin Park to Jesmond* Umwelt Environmental Consultants 2006, *Ecological Constraints Analysis for a Proposed New Route for State Highway 23 between Rankin Park and Jesmond.*
- Umwelt Environmental Consultants 2004, *Ecological Inspection of Proposed Geotechnical Sites and Access Tracks within the Proposed New Route for State Highway 23 between Rankin Park and Jesmond.*
- Ecotone Ecological Consultants Pty Ltd 2002, *Flora and Fauna survey and threatened species assessment for a proposal to construct a new access road to John Hunter Hospital, an extension to the Hospital building, including a new car park and a relocated helipad.*
- Winning 2000 *Survey of Tetratheca juncea Sm. in Blackbutt Reserve and Rankin Park Bushland.*
- Mount King Ecological Surveys, 1984, *Fauna Survey of Rankin Park Area for Proposed Route of State Highway 23.*
- T. J. Fatchen & Associates 1984, *Rankin Park Highway Development Vegetation Description and Assessment.*
- Anne Clements & Associates 1994, *Flora survey of remnant bushland patches in Newcastle Local Government Area – part of the 'Save the Bush' Program.*

4.1 Candidate species

All species credit species with a moderate to high likelihood of occurrence, that have been identified as requiring survey in the BioBanking Credit Calculator (BBCC), or that have been recorded during the surveys are considered candidate species. Species credit candidate species have formed the basis for targeted surveys for this assessment. Ecosystem credit

species with a high multiplier number such as the Powerful Owl (*Ninox strenua*), have also been surveyed to inform the credit calculations.

A total of 45 candidate species have been identified for this assessment and are identified in Table 4-3.

4.1.1 Desktop assessment

A desktop database review was carried out by Parsons Brinckerhoff in July 2014 to identify threatened flora and fauna species, populations and ecological communities (biota) listed under the TSC Act and FM Act, and MNES listed under the EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. Biodiversity resources pertaining to the locality (ie within a 10 kilometre radius of the site) that were reviewed before conducting field investigations are detailed in Table 4-1.

Table 4-1 Database searches completed

Database	Searches	Area searched	Reference
Atlas of NSW Wildlife (BioNet)	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	10 km buffer around project [1]	Office of Environment and Heritage (2014b)
NSW Department of Primary Industries (Fishing and Aquaculture) threatened Aquatic Fauna Database	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	Hunter/Central Rivers and Catchment Management Authority area	NSW Department of Primary Industries (2014)
PlantNet	25 July 2014 7 October 2014	10 km buffer around project [1]	Royal Botanical Gardens Sydney (2014)
Protected Matters Search Tool	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	10 km buffer around project [1]	Department of Environment (2014b)
Noxious Weeds Database	29 October 2014	Newcastle City Council	Department of Trade and Investment Regional Infrastructure and Services (2014)
DotE online species profiles and threats database	25 July 2014	Study area	Department of Environment (2014b)
Threatened biota profiles outlining distribution and habitat requirements of threatened biota	25 July 2014	Study area	Office of Environment and Heritage (2014b)
Nationally Important Wetland search	25 July 2014	Study area	Department of Environment (2015b)
BioBanking Credit Calculator	12 April 2016	Study area	Office of Environment and Heritage (2014b)
SPRAT database for EPBC listed threatened species and communities	25 July 2014	Study area	Department of Environment (2015c)

Note: 1 Coordinates used -32.86, 151.64, -32.96, 151.74

A search of the OEH Atlas of Wildlife database and DotE protected matters search tool indicates that 27 threatened flora species listed under the TSC Act and 22 threatened flora species listed under the EPBC Act have been recorded or are predicted to occur within 10 kilometres of the study area. A total of 55 threatened fauna species listed under the TSC Act and 18 threatened fauna species listed under the EPBC Act have been recorded or are predicted to occur within the locality (note that exclusively marine species have been excluded from this list).

No threatened populations are predicted or known to occur within the study area (*Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* - Appendices C and D of Parsons Brinckerhoff 2015a provided in Appendix C).

The protected matters search (Appendix D) identifies 44 migratory species listed under the EPBC Act as potentially occurring in the locality (not including marine and pelagic species) (Appendix D). Three EPBC Act listed migratory bird species were recorded and a further four species were considered to have moderate likelihood of occurrence within the study area (refer Table 4-3).

One threatened species listed under the FM Act has been previously recorded in the locality; Black Cod (*Epinephelus daemelii)* (Appendix D of Parsons Brinckerhoff 2015a provided in Appendix C). The study area does not contain habitat for this species and it therefore has a 'nil' likelihood of occurrence.

The threatened and migratory species identified in the desktop assessment are presented in Table 4-3.

4.1.2 Species credit species

A total of 12 species-credit species have been identified by the BBCC during FBA credit calculations as potentially occurring within the study area. The suite of species-credit species for the project are identified in Table 4-3 along with the corresponding threatened species multiplier value, which PCTs contain habitat components for these threatened species and their likelihood of occurrence within the study area.

4.1.3 Ecosystem credit species

The credit calculator reports the suite of threatened fauna species that are predicted to be associated with ecosystem credits generated for the project. That is, the threatened fauna species that are predicted to use habitat within the vegetation types within the construction footprint. Each of these species has a 'threatened species multiplier' that feeds into the ecosystem credit calculations. If that fauna species or specific habitat resources for that species are not present at the site, then the threatened species multiplier may be adjusted. All identified ecosystem credit species were found to have habitat components within the study area.

A total of 19 ecosystem-credit species have been identified by the BBCC during FBA credit calculations as potentially occurring within the study area. The suite of ecosystem credit species for the project are shown in Table 4-3 along with the corresponding threatened species multiplier value, which PCTs contain habitat components for these threatened species and their likelihood of occurrence within the study area.

The Powerful Owl and Barking Owl have the highest threatened species multiplier (3.0) of the threatened species predicted to occur within ecosystem credits for all five vegetation types being impacted by the project. The Powerful Owl was recorded within the study area during surveys completed by Parsons Brinckerhoff (2015a and 2015b), and is consequently the species which is driving the ecosystem credit calculations for the impacts on all the five PCTs. Further targeted surveys to determine the potential presence or otherwise for all other threatened species that have been predicted to occur within the ecosystem credits will have no impact on the ecosystem credit requirement for the project as they all have a lower threatened species multiplier.

4.1.4 Likelihood of occurrence

Following collation of database records and threatened species and community profiles, a 'likelihood of occurrence' assessment was prepared for threatened and migratory species with reference to the broad vegetation types and habitats contained within the study area. This was further refined following field surveys and verification of vegetation types and identification and assessment of habitat present within the study area.

A likelihood of occurrence ranking was attributed to these biota based on this information by Parsons Brinckerhoff (2015a) (Appendix C).

Likelihood of occurrence of threatened species within the study area for species recorded or predicted to occur in the locality is defined in Table 4-2.

Table 4-2 Likelihood of occurrence methodology

Likelihood	Description
Low	Species considered to have a low likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: • Have not been recorded previously in the study area and surrounds and for which the study • Area is beyond the current distribution range • Rely on specific habitat types or resources that are not present in the study area • Are considered locally extinct • Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded
Moderate	Species considered to have a moderate likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: • Have infrequently been recorded previously in the study area and surrounds • Use habitat types or resources that are present in the study area, although generally in a poor or modified condition • Are unlikely to maintain sedentary populations, however, may seasonally use resources • Within the study area opportunistically during variable seasons or migration • Are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded
High	Species considered to have a high likelihood of occurrence include species not recorded that fit one or more of the following criteria: • Have frequently been recorded previously in the study area and surrounds • Use habitat types or resources that are present in the study area, that are abundant and/or in good condition within the study area

Likelihood	Description
	• Are known or likely to maintain resident populations surrounding the study area • Are known or likely to visit the site during regular seasonal movements or migration.
Recorded	Any threatened species recorded during field surveys.

Table 4-3 Candidate species

Scientific name	Common name	TSC Act status	EPBC Act status	Source of identification	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification	Threatened species multiplier	Corresponding PCT
Flora									
Caladenia tessellata	Thick Lip Spider Orchid	E	V	PlantNet	-	Moderate [1]	Potential habitat recorded within the study area [1]	N/A [3]	HU803 [3], HU806 [3], HU841 [3]
Callistemon linearifolius	Netted Bottle Brush	-	V	BBCC, Atlas of NSW, PlantNet	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]	1.4	HU803 [4], HU806 [3], HU833 [3], HU841 [4]
Corybas dowlingii	Red Helmet Orchid	E	-	BBCC, Atlas of NSW, SEARs	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]	1.3	HU782 [4]
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	BBCC, PMST	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]	4.0	HU803 [3], HU806 [3], HU833 [3], HU841 [4]
Diuris praecox	Rough Doubletail	V	V	BBCC, Atlas of NSW, PMST, PlantNet	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]	1.3	HU782 [3], HU803 [3], HU806 [3], HU833 [3], HU841 [3]
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	BBCC, Atlas of NSW, PMST, PlantNet, SEARs	Species credit species	Recorded [1]	Two small populations recorded within the study area.	1.4	HU803 [4], HU806 [3]
Rutidosis heterogama	Heath Wrinklewort	V	V	BBCC, PMST	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]	1.5	HU803 [3], HU806 [4]
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Atlas of NSW, PMST, PlantNet, SEARs	-	Recorded [1]	Recorded within the study area however occurred outside the construction footprint	N/A [3]	N/A, assumed planted
Tetratheca juncea	Black-eyed Susan	V	V	BBCC, PMST, Atlas of NSW, PlantNet, SEARs	Species credit species	Recorded [1]	Large population recorded within study area	1.5	HU782 [3], HU803 [3], HU806 [3], HU833 [3], HU841 [3]
Fauna									
Anthochaera phrygia	Regent Honeyeater	CE	CE	BBCC, Atlas of NSW, PMST	Species credit species	Moderate	Potential habitat recorded within the study area [1]	7.7	HU806 [4], HU803 [3]
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded within the study area [1]	2.0	HU782, HU803, HU806, HU833, HU841
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	V	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded within the study area [1]	1.8	HU782, HU803, HU806, HU833, HU841
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	PMST	-	Moderate [1]	Potential habitat recorded [1]	N/A [3]	HU782 [3], HU806 [4], HU803 [3]
Chthonicola sagittata	Speckled Warbler	V	-	BBCC	Ecosystem credit species	Moderate [2]	Potential habitat recorded in study area [2]	2.6	HU803, HU806, HU833, HU841
Daphoenositta chrysoptera	Varied Sittella	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded [1]	1.3	HU782, HU803, HU806, HU833, HU841
Dasyurus maculatus	Spotted-tailed Quoll	V	E	BBCC, PMST	Ecosystem credit species	Moderate [1]	Potential habitat recorded in study area [1]	2.6	HU782, HU803, HU806, HU833, HU841
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded within the study area [1]	2.2	HU782, HU803, HU806, HU833, HU841
Glossopsitta pusilla	Little Lorikeet	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Recorded [1]	-	1.8	HU782, HU803, HU806, HU833, HU841
Hieraaetus morphnoides	Little Eagle	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded within the study area [1]	1.4	HU803, HU806, HU833, HU841
Lathamus discolor	Swift Parrot	E	E	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded [1]	1.3	HU782, HU803, HU806, HU833, HU841

Scientific name	Common name	TSC Act status	EPBC Act status	Source of identification	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification	Threatened species multiplier	Corresponding PCT
Litoria aurea	Green and Golden Bell Frog	V	E	BBCC	Species credit species	Low [2]	No preferred habitat recorded [2]	2.6	HU782
Litoria brevipalmata	Green-thighed Frog	V	-	BBCC	Species credit species	Low [2]	No preferred habitat recorded [2]	1.3	HU782
Lophoictinia isura	Square-tailed Kite	V	-	BBCC	Ecosystem credit species	Moderate [2]	Potential habitat recorded [2]	1.4	HU782, HU803, HU806, HU833, HU841
Miniopterus australis	Little Bent-wing Bat	V	-	Atlas of NSW	-	Recorded [1]	-	N/A [3]	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Atlas of NSW	-	High [1]	Previously recorded in study area (Umwelt, 2006) [1]	N/A [3]	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	BBCC	Ecosystem credit species	High [1]	Previously recorded in study area (Umwelt, 2006) [1]	2.2	HU782, HU803, HU806, HU833, HU841
Myotis macropus	Southern Myotis	V	-	Atlas of NSW	-	Moderate [1]	Potential habitat recorded [1]	N/A [3]	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]
Ninox strenua	Powerful Owl	V	-	BBCC, SEARs, Atlas of NSW	Ecosystem credit species	Recorded [1]	-	3.0	HU782, HU803, HU806, HU833, HU841
Petaurus australis	Yellow-bellied Glider	V	-	BBCC	Ecosystem credit species	Moderate [2]	Potential habitat recorded [2]	2.3	HU782, HU803, HU806, HU833, HU841
Petaurus norfolcensis	Squirrel Glider	V	-	BBCC, SEARs, Atlas of NSW	Ecosystem credit species	Recorded [1]	-	2.2	HU782, HU803, HU806, HU833, HU841
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	SEARs, Atlas of NSW, PMST	-	Recorded [1]	-	N/A [3]	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]
Petroica boodang	Scarlet Robin	V	-	BBCC	Ecosystem credit species	Moderate [2]	Potential habitat recorded [2]	1.3	HU803, HU806, HU833, HU841
Phascolarctos cinereus	Koala	V	V	BBCC, Atlas of NSW, PMST	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]	2.6	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]
Pseudophryne australis	Red-crowned Toadlet	V	-	BBCC	Species credit species	Moderate [2]	Potential habitat recorded [2]	1.3	HU841 [4]
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	BBCC	Ecosystem credit species	High [1]	Previously recorded in study area (Umwelt, 2006) [1]	2.2	HU782, HU803, HU806, HU833, HU841
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	BBCC, Atlas of NSW	Ecosystem credit species	High [1]	Previously recorded in study area (Umwelt, 2006) [1]	2.2	HU782, HU803, HU806, HU833, HU841
Tyto novaehollandiae	Masked Owl	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded in study area [1]	3.0	HU782, HU803, HU806, HU833, HU841
Tyto tenebricosa	Sooty Owl	V	-	BBCC, Atlas of NSW	Ecosystem credit species	Moderate [1]	Potential habitat recorded [1]	3.0	HU841
Migratory species									
Apus pacificus	Fork-tailed Swift	-	M	PMST	-	Moderate [1]	Potential habitat identified in study area [1]	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation
Ardea ibis	Cattle Egret	-	M	PMST	-	Recorded [1]	Recorded in study area	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation

Scientific name	Common name	TSC Act status	EPBC Act status	Source of identification	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification	Threatened species multiplier	Corresponding PCT
Hirundapus caudacutus	White-throated Needletail	-	M	PMST, Atlas of NSW	-	Moderate [1]	Potential habitat identified in study area [1]	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation
Merops ornatus	Rainbow Bee-eater	-	M	PMST	-	Moderate [1]	Potential habitat identified in study area [1]	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation
Monarcha melanopsis	Black-faced Monarch	-	M	PMST	-	Recorded [1]	Recorded in study area	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation
Myiagra cyanoleuca	Satin Flycatcher	-	M	PMST	-	Moderate [1]	Potential habitat identified in study area [1]	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation
Rhipidura rufifrons	Rufous Fantail	-	M	PMST	-	Recorded [1]	Recorded in study area	N/A [3]	HU782, HU803, HU806, HU833, HU841, Remnant Native Vegetation

Key V = vulnerable E= endangered, CE= critically endangered

Notes:
1 Parsons Brinckerhoff, 2015a
2 Assessment prepared as desktop assessment using existing information sources.
3 Not listed in BioBanking credit calculator as ecosystem or species credit, therefore does not have threatened species multiplier or corresponding PCT value.
4 Species credit matters are not assigned a corresponding PCT as they do not have habitat surrogates. Hence the requirement to complete targeted surveys for these species.

4.1.5 Fauna habitat

The main fauna habitats that occur within the study area are dry open forest, wet sclerophyll forest, aquatic habitat and cleared land with scattered trees. These habitat types are described in detail in the following sections and shown on Figure 4-1.

Dry open forest

Several types of dry open forest occur in the study area:

- Spotted Gum – Grey Ironbark open forest – atypical variant (HU806) and Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant (HU806) occurs on sheltered mid to lower slopes.
- Spotted Gum – Broad-leaved Ironbark grassy open forest (HU803) occurs on upper west facing slopes.
- Smooth-barked Apple – Red Bloodwood open forest (HU833) occurs on dry ridges.
- Smooth-barked Apple – Sydney Peppermint – Turpentine open forest (HU841) occurs on the south-facing upper ridges.

Canopy species in dry open forest contain a range of hollow sizes. Large hollows in this habitat provide breeding habitat for birds and arboreal mammals, including forest owls. This vegetation contains a known roost site for the Powerful Owl (*Ninox strenua*). Spotted Gum *(Corymbia maculata)* and Fergusons Ironbark (*Eucalyptus fergusonii* are both winter flowering species which provide foraging resources for the Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Anthochaera phrygia*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Squirrel Glider (*Petaurus norfolcensis*) (Parsons Brinckerhoff 2015a). Red Bloodwood (*Corymbia gummifera*) is also an important feed tree for nectarivorous fauna during the autumn period. Furthermore, a variety of canopy species in the Myrtaceae family and understorey plants including a high abundance of proteaceous shrubs that produce nectar and pollen for gliders were identified within the study area.

A range of other fauna microhabitats are present within dry open forests, including fallen timber, leaf litter, loose rocks, and shrubby ground cover. These habitat attributes have the potential to support a diverse range of ground dwelling fauna, including reptiles and small mammals. It is likely that arboreal mammals utilising these areas of habitat would provide a source of prey for the Powerful Owl (*Ninox strenua*).

Wet sclerophyll forest

Wet forest is present within deep gullies of the study area. Wet forest consists of both variants of Sydney Blue Gum – White Mahogany shrubby tall open forest (*Syncarpia glomulifera* variant and atypical variant (HU782). Many of the trees contain large hollow cavities, which would provide important roosting habitat for arboreal mammals and forest owls. Mesic broad-leaf tree species form a mid-understorey, which provides cover and foraging habitats for wet forest birds and other small mammals as well as roosting sites for arboreal mammals and forest owls. This habitat type had dense understorey vegetation in patches, which is dominated by ferns and vines (Parsons Brinckerhoff 2015a).

Aquatic habitat

Aquatic habitats identified within the study area include Dark Creek, Ironbark Creek, unnamed drainage lines, Blue Wren Creek and a small dam located in the north-west corner of the study area (Figure 4-1) (Parsons Brinckerhoff 2014 and 2015a). All aquatic habitats identified within the study area, other than the dam, are ephemeral and are characterised by rocky and gravel based substrates, with moderate riparian vegetation cover and small pool sections, which retained water for short periods (less than three weeks) following rainfall events. Due to the ephemeral nature of these water bodies, the aquatic habitats contained within the study area are likely to provide habitat for only a limited range of common aquatic animals (Parsons Brinckerhoff 2015a and Appendix J). Furthermore, targeted frog surveys carried out by Parsons Brinckerhoff along the identified ephemeral drainage lines only identified a small number of commonly occurring amphibian species such as Common Eastern Toadlet (*Crinia signifera*) Striped Marsh Frog (*Limnodynastes peronii*) and Red-backed Toadlet (*Pseudophryne coriacea*) (Appendix J).

The freshwater dam located in the north-western section of the study area would retain water year-round, and has moderate native aquatic vegetation cover. This dam however, is considered to only offer limited foraging habitat for water birds and herpetofauna species due to its small size, disturbed condition due it its location within mowed parkland, its accessibility by domestic animals and lack of riparian vegetation/habitat complexity.

Waterways within the study area are mostly classified as Class 1 and a small area of Class 3 (Strahler method stream ordering) ephemeral freshwater creek and/or drainage lines, and fish passage classification Class 4 – unlikely fish habitat (NSW DPI 2013) (Figure 2-2).

The identified aquatic habitats, excluding the dam, did not support native aquatic or wetland vegetation, and are not considered key fish habitat in accordance with the NSW DPI *Policy and Guidelines for Fish Habitat Conservation and Management – Update (2013)*.

No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in the study area and no significant impacts on riparian vegetation or habitats downstream of the project site are anticipated as a result of the project. There would be no impact on key fish habitat as a result of the project.

Planted and parkland vegetation

This habitat is located in the northern portion of the study area where patches of vegetation occurred as cleared open areas with scattered trees. There are also manicured lawns, garden beds, retained trees and planted trees. The ground cover was often dominated by exotic grasses and herbaceous weeds (Parsons Brinckerhoff 2015a). This area is likely to provide foraging habitat for common species typical of urban parklands and gardens (eg birds, skinks, possums etc).

Hollow-bearing trees

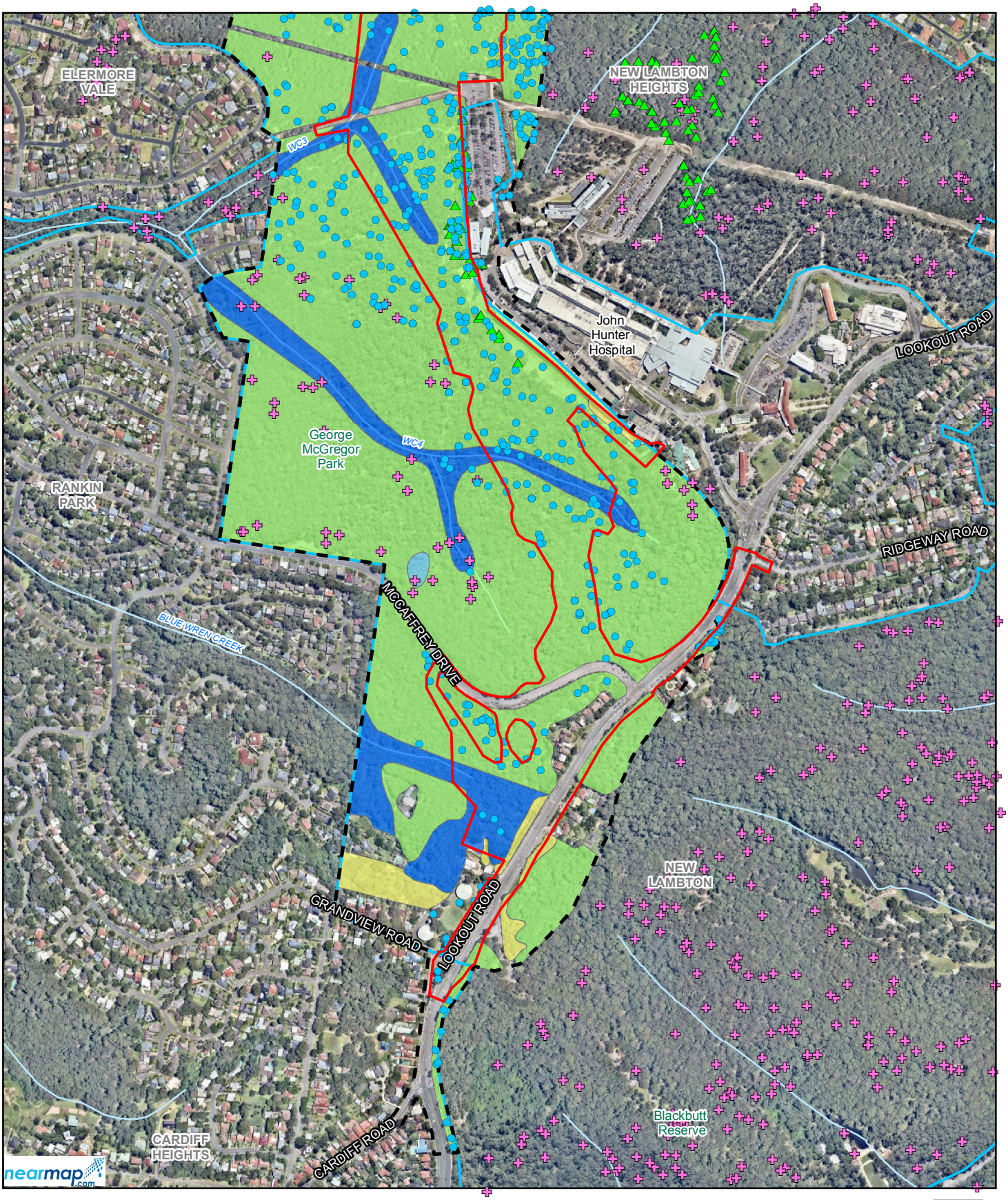
A total of 450 hollow-bearing trees, containing about 1312 hollows were recorded within the study area. Of these hollows, about 567 are small (less than 10 centimetres), 642 are medium (10 to 20 centimetres) and 103 are large (greater than 20 centimetres). Hollow-bearing trees consisted of 13 different tree species and are likely to provide habitat for a number of hollow-dependent fauna, such as possums, gliders, microchiropteran bats and a variety of birds (Parsons Brinckerhoff 2015a). The most common trees within the study area to contain hollows were Grey Gum *(Eucalyptus punctata*), Smooth-barked Apple (*Angophora costata*), Spotted Gum *(Corymbia maculata*), Broad-leaved mahogany *(Eucalyptus umbra*) and Sydney Peppermint *(Eucalyptus. piperita*). A large number of hollows were also recorded within dead trees (stags). Large hollows are critical breeding habitat for large forest owls, such as the Powerful Owl (*Ninox strenua*), which was identified breeding within the study area.

Feed trees

The study area supports a range of trees that provide foraging resources for native birds, bats and arboreal mammals. This includes a variety of flowering eucalypts, including profusely flowering species identified as keystone nectar feed trees (DECC 2007). When flowering, these trees would be used by native nectarivorous birds, including the Little Lorikeet (*Glossopsitta pusilla*), Scarlet Honeyeater (*Myzomela sanguinolenta*) and Lewin's Honeyeater (*Meliphaga lewinii*), by arboreal mammals such as the Squirrel Glider (*Petaurus norfolcensis*) and Common Brushtail Possum (*Trichosurus vulpecula*) and by Grey-headed Flying-fox (*Pteropus poliocephalus*), all of which were recorded during surveys. Eucalypts recorded within the study area include both summer and winter flowering species meaning the study area would be able to support nectarivorous species at most times of year, although flowering times and productivity may vary from year to year. Winter flowering species are particularly important for threatened species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), which suffers food bottlenecks in winter and spring (Eby and Law 2008).

Eucalypts and other canopy species including *Allocasuarina* also provide foraging substrates for birds such as the Willy Wagtail (*Rhipidura leucophrys*), Spotted Pardelote (*Pardalotus quadragintus*), Grey Fantail (*Rhipidura albiscapa*) and Glossy-black Cockatoo *(Calyptorhynchus lathami)* (Parsons Brinckerhoff 2015a).

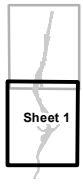
Eucalypt species present in the study area would provide potential foraging resources, including sap, foliage or nectar for a range of threatened species, including: birds such as the Little Lorikeet (*Glossopsitta pusilla*); threatened arboreal mammals, including Squirrel Glider (*Petaurus norfolcensis*) and bats such as the Grey-headed Flying-fox (*Pteropus poliocephalus*). Other threatened species may also forage within or above the canopy or on the trunks of these trees, including the Varied Sittella (*Daphoenositta chrysoptera)* and a range of threatened microbats (Parsons Brinckerhoff 2015a).



LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area
- Watercourse
- Habitat trees (NCC)
- Hollow Bearing Tree
- Nest boxes
- Aquatic habitat
- Cleared land / planted parkland trees
- Dry forest
- Wet forest

Sheet layout



Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Rankin Park to Jesmond
Biodiversity Assessment Report

Fauna habitat
sheet 1 of 2

Job Number	22-17656
Revision	0
Date	26 Aug 2016

Figure 4-1a

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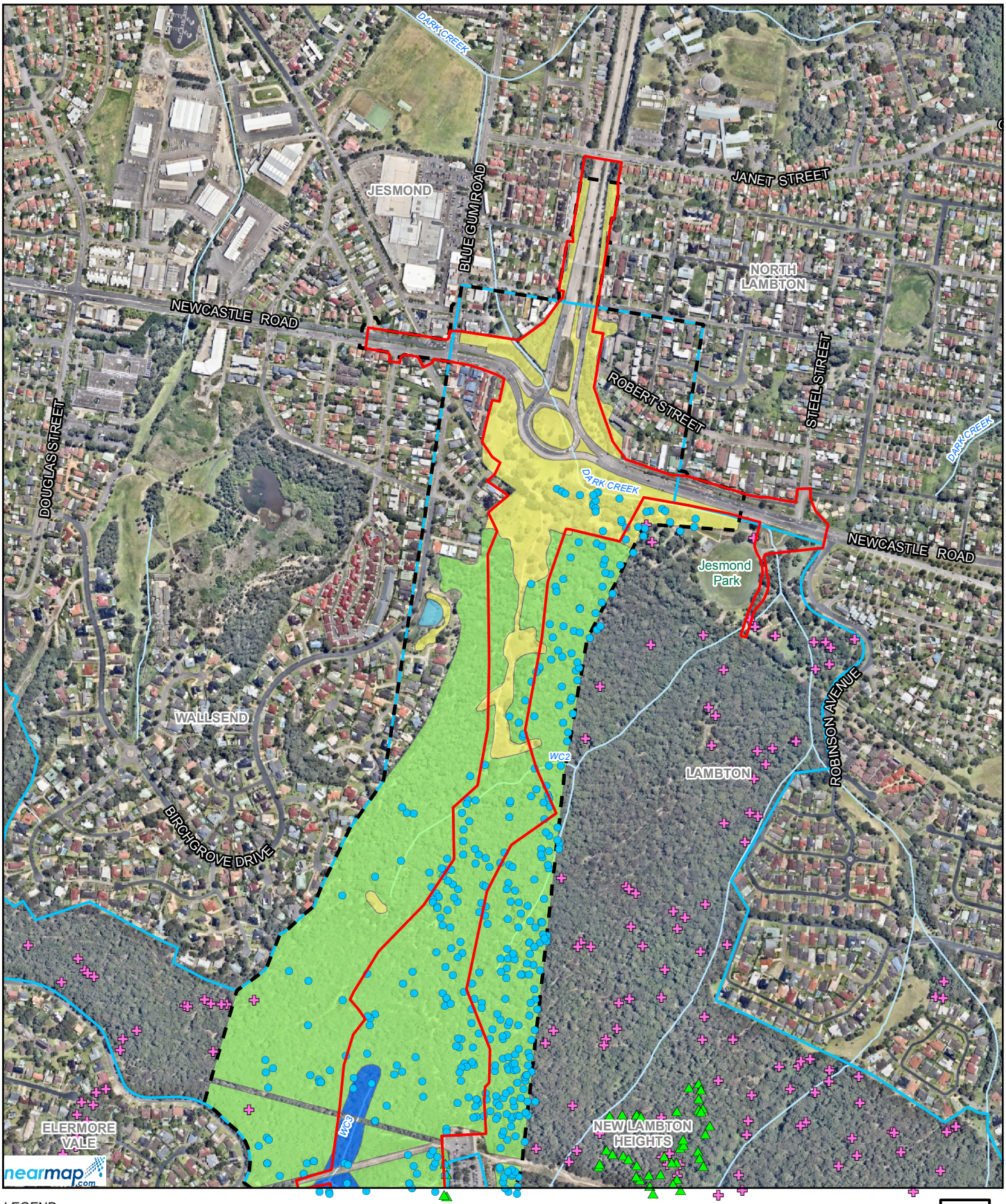
G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA011_FaunaHabitat_Corridors_DDP_0.mxd

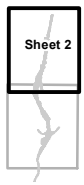
Data source: Aurecon: Construction footprint, 2016: PB: Study area, Habitat and fauna Mapping, 2015; DECCW: GHFF, 2008. NCC: Habitat trees, 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton



LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area
- Watercourse
- Habitat trees (NCC)
- Hollow Bearing Tree
- Nest boxes
- Aquatic habitat
- Cleared land / planted parkland trees
- Dry forest
- Wet forest

Sheet layout



Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number 22-17656
Revision 0
Date 26 Aug 2016

Fauna habitat
sheet 2 of 2

Figure 4-1b

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Data source: Aurecon: Construction footprint, 2016: PB: Study area, Habitat and fauna Mapping, 2015; DECCW: GHFF, 2008. NCC: Habitat trees, 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton

4.2 Threatened species survey

4.2.1 Terrestrial flora surveys

Guidelines

Targeted surveys within the development site were conducted by Parsons Brinckerhoff. Surveys were completed in accordance with the FBA and methodologies detailed in the NSW *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities (Working Draft)* (DEC 2004), EPBC Act Referral guidelines for the vulnerable Black-eyed Susan, *Tetratheca juncea* (DSEWPaC 2011) and the *Draft Survey Guidelines for Australia's Threatened Orchids* (DotE 2013b).

Methodology

Terrestrial flora surveys included:

- Initial site stratification and vegetation mapping.
- BioBanking plot/transect surveys.
- Identification of flora species.
- Targeted seasonal threatened flora surveys.

Survey effort that has directly contributed to this biodiversity assessment is summarised in Table 4-5 and is described in further detail in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Section 2.5) (Parsons Brinckerhoff 2015a) (Appendix C). Additional surveys were also carried out by Parsons Brinckerhoff in 2015 and 2016 (Appendix G to Appendix J) including:

- *Diuris praecox and Corybas dowlingii targeted surveys* (Parsons Brinckerhoff 2015d).
- *Cryptostylis hunteriana and Threatened Frog targeted surveys* (Parsons Brinkerhoff 2016).

Targeted threatened flora surveys

Targeted surveys for threatened flora species were carried out over five different periods to coincide with the flowering period for each threatened species identified as potentially occurring within the study area.

Targeted surveys were carried out to quantify the number of clumps/stems within the study area, the number impacted by the project and to calculate the number of species credits that would be required to be secured to offset these impacts. This data was collected by both random meander technique and parallel transects (Cropper 1993).

Further details regarding targeted flora surveys are provided in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Section 2.5.3.3) (Parsons Brinckerhoff 2015a) (Appendix C) and are summarised in Table 4-7.

Reference populations

Reference sites with known populations of threatened flora species: Leafless Tongue-orchid (*Cryptostylis hunteriana*), Red Helmet Orchid (*Corybas* Dowlingii) and Rough Doubletail (*Diuris praecox*) were surveyed and flowering periods confirmed before targeted surveys being carried out in the study area. In each instance, reference sites were visited within the parameters of the recommended period for surveying to ascertain if the targeted species was in flower, thereby enabling surveys of the study area to take place during the optimum time for detection.

Extensive surveys within vegetation communities with greatest potential for on-site occurrences and seasonal suitability were then conducted adhering to the methods described in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* 2004 (DEC 2004) and the *Draft survey guidelines for Australia's threatened orchids* (DotE 2013b). No Leafless Tongue-orchid, Red Helmet Orchid or Rough Doubletail stems were recorded within the study area.

Due to all surveys being carried out during peak flowering for each species, as determined by flowering in local reference populations, it is highly unlikely that these species occur within the study area.

Determination of *Tetratheca juncea* peak flowering time

The survey methodology for determination of Black-eyed Susan (*Tetratheca juncea*) peak flowering followed the guidelines outlined in the federal species profile for *Tetratheca juncea* (DotE 2013). Surveys were conducted in the study area within the peak flowering period for this species, being from 1 September to 31 October outlined in the referral guidelines for Black-eyed Susan *(*Department of Sustainability Environment Water Population and Communities 2011). The targeted surveys for this species covered all areas contained within the construction footprint.

Survey conditions

The weather conditions during the surveying period varied from cool to hot temperatures (4–40.5 degrees celsius), dry to slight rainfall (0–18.2 millimetres) and from calm to strong windy (calm–37 kilometres per hour) weather (Table 4-4).

Table 4-4 Weather conditions during flora surveys

Date	Survey type	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/hr)/ direction)[1]
17 July 2014	Plot/transect data collection	8.2	18.3	1.8	4/NE
18 July 2014	Plot/transect data collection	8.2	16.4	0	19/NW
29 July 2014	Plot/transect data collection	8.7	20.8	0.1	19/NW
30 July 2014	Plot/transect data collection	10.4	22.5	0	28/NW
31 July 2014	Plot/transect data collection	13.2	24.5	0	28/NW
5 August 2014	Plot/transect data collection	5.9	21.2	0.2	9/SE
6 August 2014	Plot/transect data collection	4.4	20.2	0	4/NW
13 August 2014	Plot/transect data collection	6.0	17.3	18.2	19/SE
20 August 2014	Plot/transect data collection Targeted threatened flora surveys	10.6	17.2	7.6	28/SW

Date	Survey type	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/hr)/ direction)[1]
22 August 2014	Plot/transect data collection Targeted threatened flora surveys	11.4	18.6	8.6	Calm
29 August 2014	Plot/transect data collection Targeted threatened flora surveys	9.9	18.0	2.4	2.4 4/SE
17 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	11.7	23.5	0	4/NW
18 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	9.2	20.0	0	Calm
19 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	9.4	19.8	0	Calm
22 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	9.0	20.8	0	Calm
23 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	7.5	21.7	0	Calm
24 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	9.2	25.2	0	Calm
25 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	14.4	21.2	0	Calm

Date	Survey type	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/hr)/ direction)[1]
26 September 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	14.2	21.2	0	Calm
2 October 2014	Plot/transect data collection Vegetation survey (mapping) Targeted threatened flora surveys	7.4	23.8		4/NW
8 October 2014	Plot/transect data collection Vegetation survey (mapping)	15.2	19.0	0.2	4/S
9 October 2014	Plot/transect data collection Vegetation survey (mapping)	13.4	22.4	9.4	Calm
10 October 2014	Plot/transect data collection Vegetation survey (mapping)	11.5	26.0	0	Calm
13 October 2014	Plot/transect data collection Vegetation survey (mapping)	15.0	30.0	0	4/NW
14 October 2014	Plot/transect data collection Vegetation survey (mapping)	12.9	19.9	14.6	4/S
27 October 2014	Plot/transect data collection Fauna survey and trapping	17.2	32.0	0	9/NE
28 October 2014	Plot/transect data collection Fauna survey and trapping	14.1	30.8	0	4/NE
29 October 2014	Plot/transect data collection Fauna survey and trapping	15.0	25.0	0	9/SW
30 October 2014	Plot/transect data collection Fauna survey and trapping	12.8	29.8	0	9/SE
31 October 2014	Plot/transect data collection Fauna survey and trapping	13.0	33.0	0	9/SE

Date	Survey type	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/hr)/ direction)[1]
13 November 2014	Targeted threatened flora surveys	16.9	26.0	0.2	19/SE
17 February 2015	Vegetation survey (mapping) – extended proposal area	19.0	29.2	0	37/E
23 July 2015	Threatened plant *Corybas dowlingii* surveys	7.0	18.7	1.4	Calm
5 August 2015	Threatened plant *Diuris praecox* surveys	4.0	15.5	0	19/NW
19 November 2015	*Cryptostylis hunteriana* surveys	17.6	31.8	0	Calm
26 November 2015	*Cryptostylis hunteriana* surveys	20.0	40.5	0	9
30 November 2015	*Cryptostylis hunteriana* surveys	19.0	27.7	0	19
1 December 2015	*Cryptostylis hunteriana* surveys	17.2	38	0	9
3 December 2015	*Cryptostylis hunteriana* surveys	15.8	23.0	2.8	9
4 December 2015	*Cryptostylis hunteriana* surveys	14.3	24.4	0	9

Notes: 1 Data obtained from Bureau of Meteorology Newcastle University NSW AWS Station (Station number 061390)

2 Data obtained from Bureau of Meteorology Newcastle Nobbys Signal Station AWS (Station number 061055) .

Table 4-5 Targeted flora survey details

Survey technique	Target species	Survey type	Survey effort	Date carried out	Ideal survey detection period	Minimum survey requirements
Field verification of existing vegetation mapping	All vegetation communities Collection of plot data in accordance with the FBA.	BioBanking Assessment Methodology (BBAM) Random meanders	This included a total of 30 quadrat/transect surveys 44.5 person hours	September-October 2014 February 2015	N/A	2 x 100 metre traverses per 2-50 hectares of stratification unit for gathering information on floristics, structure and vegetation boundaries. Number of plots as per BioBanking methodology (dependant on area of each vegetation zone and its condition).
Targeted threatened flora surveys	*Caladenia tessellata*	Random meander surveys	263 person hours	17, 18, 19, 22, 23, 24, 25 and 26 September 2014 2 October 2014 13 November 2014	September	Random meander surveys during flowering period to detect species, followed by targeted parallel transects.
	Callistemon linearifolius	Random meander surveys and parallel transects	64 person hours	18, 19, 22, 23, 24, 25 and 26 September 2014 2 October 2014	September	Random meander surveys where a minimum 30 minutes is spent per each quadrat sampled within same stratification unit.
	Corybas dowlingii	Random meander surveys	24 person hours	20, 22 and 29 August 2014 July-August 2015	June to August	Random meander surveys during flowering period to detect species, followed by targeted parallel transects.

Survey technique	Target species	Survey type	Survey effort	Date carried out	Ideal survey detection period	Minimum survey requirements
		Reference site surveys at George McGregor Park, and Rankin Park	8 person hours	12, 15, 19 and 26 June 2015 5, 7, 15 and 23 July 2015 5 August 2015	June to August	N/A
		Reference site surveys at Stoney Ridge Reserve, Soldiers Point.	2 person hours	20 July 2015	June to August	N/A
	Cryptostylis hunteriana	Random meander surveys	30 person hours	14 October 2014 13 November 2014 19, 24 November 2015 1 December 2015	November to December	Random meander surveys during flowering period to detect species, followed by targeted parallel transects.
		Reference site surveys at Wallarah Peninsula	1 person hours	24 November	November to December	N/A
		Reference site surveys at Rankin Park Survey site	13 person hours	19 November 2015 1 December 2015	November to December	N/A

Survey technique	Target species	Survey type	Survey effort	Date carried out	Ideal survey detection period	Minimum survey requirements
	Diuris praecox	Random meander surveys	24 person hours	20, 22, 29 August 2014 July-August 2015	August to September	Random meander survey where a minimum 30 minutes is spent for each quadrat sampled within same stratification unit.
		Reference site surveys at Glenrock State Conservation Area, Mereweather Heights	7 person hours	21, 28 June 2015 5, 15, 21 July 2015 3 August 2015	August to September	N/A
	Grevillea parviflora subsp. parviflora	Random meander surveys and parallel transects	253 person hours	20, 22, 29 August 2014 17, 18, 19, 22, 23, 24, 25, 26 September 2014 2 October 2014	August to September	Random meander survey where a minimum 30 minutes is spent for each quadrat sampled within same stratification unit.
	Rutidosis heterogama	Random meander surveys	64 person hours	18, 19, 22, 23, 24, 25, 26 September 2014 2 October 2014	September	Random meander survey where a minimum 30 minutes is spent for each quadrat sampled within same stratification unit.

Survey technique	Target species	Survey type	Survey effort	Date carried out	Ideal survey detection period	Minimum survey requirements
	Syzygium paniculatum	Random meander surveys	33 person hours	18, 19, 22, 24, 25, 26 September 2014 27, 28, 29, 30, 31 October 2014	August to September	Random meander survey where a minimum 30 minutes is spent for each quadrat sampled within same stratification unit.
	Tetratheca juncea	Random meander surveys, parallel transects and quadrats	390 person hours	17, 18, 19, 22, 23, 24, 25 September 2014 2, 8, 9, 13, 14 October 2014 13 November 2014	Peak flowering Mid-September to October	Surveys to be conducted between 1st of September and 31st of October. A minimum of 75% of buds should be in flower before conducting surveys at the proposed affected area. Carry out initial coarse level survey, followed by detailed targeted survey (where plant clumps are recorded along belt transects about 4-5 metres apart to then calculate plant density per hectare of suitable habitat).

Flora species

A total of 312 flora species were recorded within the study area, comprising of 256 (82 per cent) native species and 56 (18 per cent) exotic species. The full list of flora species recorded within the study area is presented in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Appendix B of Parsons Brinckerhoff 2015a, provided in Appendix C).

Three threatened flora species were recorded in the study area and are detailed further in Section 4.3.2 and Figure 4-3.

4.2.2 Terrestrial fauna surveys

Survey guidelines

Targeted surveys within the study area were conducted by Parsons Brinckerhoff. Surveys were completed in accordance with the FBA and methodologies detailed in the:

- *NSW Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities (Working Draft)* (DEC 2004).
- *Survey Guidelines for Australians Threatened Birds* (DEWHA 2010a).
- *Threatened Species survey and assessment guidelines: field survey and methods for fauna -Amphibians* (DECC 2009).
- *Survey Guidelines for Australia's Threatened Bats* (DotE 2010).
- *Survey Guidelines for Australia's Threatened Frogs* (DEWHA 2010b).
- *Survey Guidelines for Australia's Threatened Reptiles* (DotE 2011a).
- *Survey Guidelines for Australia's Threatened Mammals* (DotE 2011b).
- *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014c).

Survey effort

Survey effort that has directly contributed to this biodiversity assessment is summarised in Table 4-7 and is described in further detail in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Section 2.5 of Parsons Brinckerhoff 2015a) (Appendix C). Additional surveys were also carried out by Parsons Brinckerhoff in 2015 (Parsons Brinckerhoff 2015b, 2015c, 2015d and 2016) (Appendix G to Appendix J).

Two types of fauna surveys were conducted across the study area; standard fauna survey sites and supplementary targeted threatened species surveys (Parsons Brinckerhoff 2015a, 2015b and 2015c). Standard fauna surveys sites were carried out at three locations within the study area (refer Figure 4-2), which were located based on stratification of fauna habitat types within the study area. At each standard fauna survey site, the following were carried out:

- Arboreal mammal trapping.
- Remote camera trapping.
- Diurnal bird surveys.
- Microchiropteran bat surveys (harp and Anabat surveys).
- Spotlighting.
- Call playback.
- Herpetofauna active searches.

- Threatened bird surveys (Regent Honeyeater and Swift Parrot).
- Targeted Koala habitat searches (SPOT surveys).
- Fauna habitat assessment (fauna habitats were assessed by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, shelter roosting and breeding).

Supplementary surveys to target specific habitat features likely to be used by threatened fauna species included:

- Hollow-bearing tree survey.
- Assessment and targeted survey of Powerful Owl breeding habitat.
- Targeted threatened bird surveys.
- Targeted threatened frog surveys (Green and Golden Bell Frog, Green Thighed Frog, and Red-crowned Toadlet).
- Nest box surveys (Squirrel Glider).

Fauna survey effort is summarised in Table 4-7 and shown on Figure 4-2, with further detail provided in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Section 2.5) (Parsons Brinckerhoff 2015a) (Appendix C). Additional fauna surveys were also carried out by Parsons Brinckerhoff in 2015 and 2016 (Appendix G to Appendix J) including:

- *Newcastle Inner City Bypass - Rankin Park to Jesmond: Additional Powerful Owl and Hollow-bearing Tree Surveys* (Parsons Brinckerhoff 2015b).
- *Newcastle Inner City Bypass - Rankin Park to Jesmond*: *Nest box assessment* (Parsons Brinckerhoff 2015c).

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. Opportunistic fauna observations were made in suitable areas of habitat during the course of the survey and while incidentally traversing the site (Parsons Brinckerhoff 2015a).

Hollow-bearing tree data was also obtained from Newcastle City Council for the entirety of the study area. This data was utilised in the review and assessment of habitat resources in the study area and nearby areas. The hollow-bearing tree data obtained during hollow-bearing tree surveys for this project (Parsons Brinckerhoff 2015a) was used for the impact assessment and discussion of habitat resources within the project construction footprint.

Survey conditions

The weather conditions during the surveying period varied from cool to hot temperatures (5.2–40.5 degrees celsius), dry to slight rainfall (0–10.8 millimetres) and from calm to strong windy (calm–43 kilometres per hour) weather (Table 4-6).

Table 4-6 Weather conditions during fauna surveys

Date	Survey type	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/hr)/ direction)[1]
21 July 2014	Powerful Owl breeding habitat survey	8.7	17.6	0	Calm
22 July 2014	Powerful Owl breeding habitat survey	8.5	17.9	0	4/W
23 July 2014	Powerful Owl breeding habitat survey	5.2	18.2	0.2	Calm
24 July 2014	Powerful Owl breeding habitat survey	-	18.2	0.1	-
26 July 2014	Powerful Owl breeding habitat survey	10.0	19.2	10.8	4/N
28 July 2014	Powerful Owl breeding habitat survey	7.8	19.2	0	4/SW
27 October 2014	Fauna survey and trapping	17.2	32.0	0	9/NE
28 October 2014	Fauna survey and trapping	14.1	30.8	0	4/NE
29 October 2014	Fauna survey and trapping	15.0	25.0	0	9/SW
30 October 2014	Fauna survey and trapping	12.8	29.8	0	9/SE
31 October 2014	Fauna survey and trapping	13.0	33.0	0	9/SE
15 June 2015	Hollow-bearing tree survey	8.4	18.7	0	43/ENE [2]
16 June 2015	Hollow-bearing tree survey	11.2	18.4	1.3	30/NE [2]
22 June 2015	Powerful Owl survey	5.4	17.6	0	26/NW [2]
23 June 2015	Powerful Owl survey	5.8	18.7	0	33/NW [2]
24 June 2015	Powerful Owl survey	8.6	18.2	0	28/NW [2]
29 June 2015	Powerful Owl survey	7.9	19.8	0	20/NW [2]
30 June 2015	Powerful Owl survey	7.3	15.2	0.2	33/NW [2]
1 July 2015	Powerful Owl survey	8.2	17.2	0	31/NW [2]
2 July 2015	Powerful Owl survey	5.6	15.5	0	43/NW [2]
7 October 2015	Nest box monitoring	-	21.2	-	-
19 November 2015	Threatened frog species surveys	17.6	31.8	0	Calm

Date	Survey type	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/hr)/ direction)[1]
26 November 2015	Threatened frog species surveys	20.0	40.5	0	9
30 November 2015	Threatened frog species surveys	19.0	27.7	0	19
1 December 2015	Threatened frog species surveys	17.2	38	0	9
3 December 2015	Threatened frog species surveys	15.8	23.0	2.8	9
4 December 2015	Threatened frog species surveys	14.3	24.4	0	9

Notes:

1 Data obtained from Bureau of Meteorology Newcastle University NSW AWS Station (Station number 061390)

2 Data obtained from Bureau of Meteorology Newcastle Nobbys Signal Station AWS (Station number 061055)

Table 4-7 Summary of threatened fauna survey effort

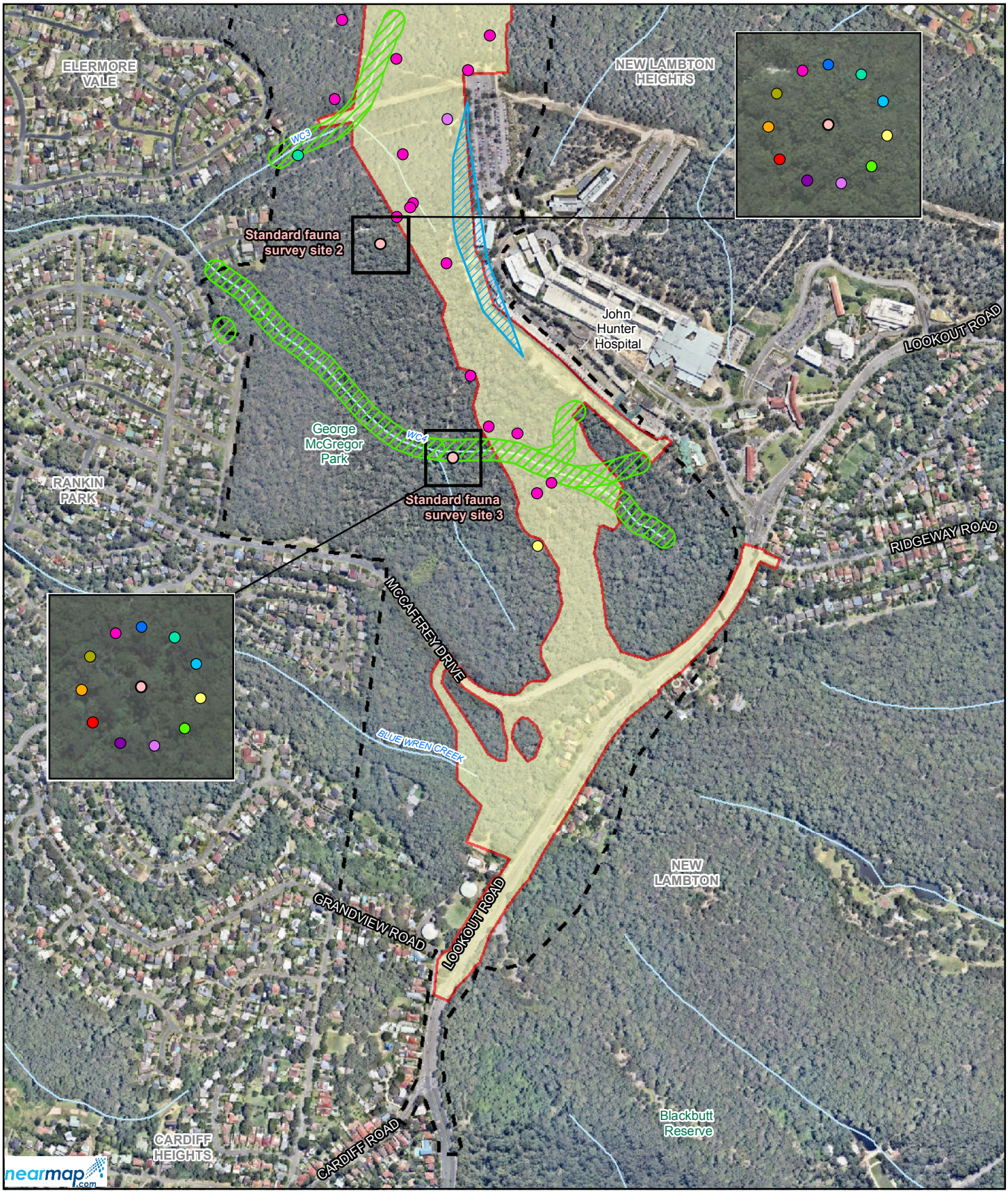
Survey	Target species	Survey type	Survey effort	Survey completed	Ideal detection period	Recommended survey requirements [1]
Threatened arboreal mammals	Squirrel Glider (*Petaurus norfolcensis*) Yellow-bellied Glider (*Petaurus australis*)	Arboreal mammal trapping using Elliot B type traps	4 nights 3 trap lines each with 6 traps Total of 72 trap-nights	27-31 October 2014	Spring/summer	10 Elliott B or cage traps placed 2-4 metres above the ground about 50 metres apart in two parallel straight lines. One sampling site per representative habitat. Set traps for 4 consecutive nights.
	Koala (*Phascolarctos cinereus*) Squirrel Glider (*Petaurus norfolcensis*) Yellow-bellied Glider (*Petaurus australis*) Grey-headed Flying –fox (*Pteropus poliocephalus*)	Spotlight surveys	4 nights on foot	27-31 October 2014	Spring/summer	Survey at least two 200 metre transects per 5 hectare site, maintaining an interval of minimum 100 metres between them. Replicated over a minimum of two nights.
	Squirrel Glider (*Petaurus norfolcensis*) Yellow-bellied Glider (*Petaurus australis*)	Camera traps	One camera per standard fauna survey site (total of 3 cameras over 15 trap nights	27-31 October 2014	Spring/summer	Cameras should be deployed for at least 14 nights at about 10 cameras per hectare. Camera traps should be used in conjunction with other standard survey techniques.
	Squirrel Glider (*Petaurus norfolcensis*) Yellow-bellied Glider (*Petaurus australis*)	Nest box inspections	1 day, 38 nest boxes inspected	7 October	Spring/summer	N/A
Hollow-bearing tree surveys	All hollow-dwelling threatened species	Parallel transects at 50 metre intervals	8 days, in construction footprint	18-23 July 2014	N/A	Conduct the diurnal search along transects spaced at 50–100 metre intervals across the subject site. Minimum effort dependant on size of study area.
Large Forest Owls	Powerful Owl (*Ninox strenua*) Masked Owl (*Tyto novaehollandiae*) Sooty Owl (*Tyto tenebricosa*)	Call playback Spotlight surveys	2 hours 8 person-hours over four nights	27-30 October 2014	Winter	Broadcast surveys (playback) for a total of 8 hours over 4 nights. Area searches or transect spotlight surveys in suitable habitat in and around study area, particularly soon after dusk and before dawn.

Survey	Target species	Survey type	Survey effort	Survey completed	Ideal detection period	Recommended survey requirements [1]
	Powerful Owl (*Ninox strenua*)	Powerful Owl habitat tree stag watch	2 hours by 1-4 persons over 12 nights 64 person-hours	21-24, 26, 28 and 31 of July 2014 5, 6, and 8 of August 2014	Winter	Observing potential roost hollows for 30 minutes before sunset and 60 minutes following sunset.
Threatened diurnal birds	Little Eagle (*Hieraaetus morphnoides*) Regent Honeyeater (*Anthochaera phrygia*) Swift Parrot (*Lathamus discolour*) Gang-gang Cockatoo (*Callocephalon fimbriatum*) Glossy Black-Cockatoo (*Calyptorhynchus lathami*) Varied Sittella (*Daphoenositta chrysoptera*) Speckled Warbler (*Chthonicola sagittata*) Little Lorikeet (*Glossopsitta pusilla*) Scarlet Robin (*Petroica boodang*) Fork-tailed Swift (*Apus pacificus*) Cattle Egret (*Ardea ibis*) White-throated Needletail (*Hirundapus caudacutus*) Rainbow Bee-eater (*Merops ornatus*) Black-faced Monarch (*Monarcha melanopsis*) Satin Flycatcher (*Myiagra cyanoleuca*)	Standard 20 minute, 2 hectare search	3.3 person-hours across the standard survey sites (sites 1-3)	27-31 October 2014	Morning	Standard 20 minute, 2 hectare search.

Survey	Target species	Survey type	Survey effort	Survey completed	Ideal detection period	Recommended survey requirements [1]
	Rufous Fantail (*Rhipidura rufifrons*)					
Targeted threatened bird surveys (winter migrants)	Regent Honeyeater (*Anthochaera phrygia*) Swift Parrot (*Lathamus discolour*)	Active survey and habitat assessment	20 person-hours over 5 days (Regent Honeyeater) 20 person-hours over 8 days(Swift Parrot)	17-18 July 2014	Winter	20 hours of area searches, targeting areas of heavily flowering trees and flocks of other blossom feeders.
Threatened microchiropteran bats	Little Bentwing Bat (*Miniopterus australis*) Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) Eastern Freetail Bat (*Micronomus norfolkensis (syn. Mormopterus norfolkensis*) Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) Greater Broad-nosed Bat (*Scoteanax rueppellii*) Large-eared Pied Bat (*Chalinolobus dwyeri*) Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) Southern Myotis (*Myotis macropus*)	Active ultrasonic bat detection Passive ultrasonic bat detection	8 hours during spotlighting events 2 nights full recording at each standard survey location	27-30 October 2014	Spring/summer	Three complete nights of passive ultrasonic bat detection. 6 hours of active ultrasonic bat detection over three nights. To be conducted spring/summer.
		Harp trapping	4 trap-nights over 2 consecutive nights	27-30 October 2014	Spring/summer	16 trap nights over 4 nights. Harp trapping to be used in conjunction with ultrasonic bat detection.

Survey	Target species	Survey type	Survey effort	Survey completed	Ideal detection period	Recommended survey requirements [1]
Targeted Koala surveys	Koala (*Phascolarctos cinereus*)	(SPOT) Assessment Scat searches Spotlight survey	3 person-hours	29-30 October 2014	Spring	SPOT Assessment (inclusive of scat searches) must include sampling of 30 trees. Minimum two 1 hour spotlight searches over two separate nights.
All threatened fauna species	-	Opportunistic sightings	5 days	27-31 October 2014	Spring/summer	N/A
Additional hollow-bearing tree surveys for Powerful Owl – confirmation of breeding and roost site locations	Powerful Owl (*Ninox strenua*)	Hollow-bearing tree survey (parallel transects at 50 metre intervals)	2 days	15-16 June 2015	N/A	N/A
	Powerful Owl (*Ninox strenua*)	Targeted Powerful Owl Survey (including stag watch of potential habitat trees and inspection of potential roost trees for pellets, scratching's and white wash).	34 person-hours	22-14 June 2015 29-30 June 2015 1-2 July 2015	Winter	Observing potential roost hollows for 30 minutes before sunset and 60 minutes following sunset.
	Powerful Owl (*Ninox strenua*)	Opportunistic sightings	7 days	15-16 June 2015 22-24 June 2015 29-30 June 2015 1-2 July 2015	Winter	N/A

Survey	Target species	Survey type	Survey effort	Survey completed	Ideal detection period	Recommended survey requirements [1]
Threatened frog surveys	Green and Golden Bell Frog (*Litoria aurea*) Green-thighed Frog (*Litoria brevipalmata*) Red-crowned Toadlet (*Pseudophryne australis*)	Targeted nocturnal spotlighting searches in streamside shorelines and vegetation, frog call detection and frog call playback.	12.5 Hours	19 November 2015 26 November 2015 1 December 2015 3 December 2015	Spring/summer	Green and Golden Bell Frog: Minimum of four consecutive nights between September and March, at the time of peak activity for the species and during warm and windless weather conditions following rainfall, using a combination of diurnal surveys for basking frogs, nocturnal spotlight surveys, call detection, call playback and tadpole surveys. Preferably using a reference site. All other frogs: Survey at least two 200 metre transects per 5-hectare site, maintaining an interval of minimum 100 metres between them. Replicated over a minimum of two nights.



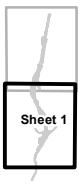
LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse

Fauna Surveys

- Standard fauna survey site
- Anabat
- Arboreal trap line
- Bird survey
- Call playback
- Habitat assessment
- Harp trap
- Herpetofauna search
- Koala habitat search
- Remote camera trapping
- Spotlighting
- Stag watch
- Frog survey areas
- Nest box survey area

Sheet layout



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

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Fauna survey locations
sheet 1 of 2

Figure 4-2a

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

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Data source: Nearmap: Aerial imgaery 20160331; Aurecon: Construction footprint, 2016: PB: Study area and Fauna Surveys, 2015; Wildthing Environmental: nest box location, 2015; LPI: DTDB, 2012. Created by: tmorton, fmackay

LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse

Fauna Surveys

- Standard fauna survey site
- Anabat
- Arboreal trap line
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- Frog survey areas

Sheet layout

Sheet 2

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Fauna survey locations
sheet 2 of 2

Figure 4-2b

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

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Data source: Nearmap: Aerial imgaery 20160331; Aurecon: Construction footprint, 2016: PB: Study area and Fauna Surveys, 2015; LPI: DTDB, 2012. Created by: tmorton, fmackay

Habitat assessments

Fauna habitat assessments were completed by Parsons Brinckerhoff (2015a) to assess the likelihood of threatened fauna species occurring in the study area. Habitat assessments included the assessment and identification of habitat features through targeted meander surveys.

Fauna habitats were assessed generally by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, shelter roosting and breeding. The criteria detailed in Table 4-8 were used to evaluate habitat values.

Table 4-8 Habitat assessment criteria

Good	A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
Moderate	Some fauna habitat components are missing (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
Poor	Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

Specific fauna habitat features were assessed at each standard fauna survey site (Figure 4-2) in the study area.

4.2.3 Summary of survey effort

Fauna

Three standard fauna survey sites were located within the study area based on habitat stratification. Standard fauna surveys were carried out at each of the three sites, which were also supplemented with additional targeted fauna surveys within the study area. Surveys were focussed on habitats contained within the proposed construction footprint, but also addressed nearby vegetation comprising the study area.

Field survey techniques employed were selected and carried out in accordance with relevant state and federal fauna survey guidelines. Field survey techniques utilised included, arboreal trapping, camera trapping, harp trapping, ultra-sonic bat detection, call playback, spotlighting, stag watching, hollow-bearing tree surveys, Koala SPOT surveys, incidental observations and nest-box inspections.

A summary of total fauna field survey effort for the project between 2014 and 2016 includes:

- A total of 72 mammal trap-nights.
- 12 camera trap-nights.
- 116 spotlighting and stag-watching person-hours.
- One day of nest box inspections.
- 10 days of hollow-bearing tree mapping.
- 32 person hours' bird survey.
- Four harp trap-nights.

- Three Koala SPOT assessment person hours.
- 12.5 person-hours' targeted frog surveys.
- 96 opportunistic sighting person-hours.

Flora

Field survey techniques employed were selected and carried out in accordance with relevant state and federal fauna survey guidelines. Field survey techniques utilised included, random meanders, BBAM plots and transects and parallel transects in targeted threatened flora surveys.

- 44.5 person hours' vegetation community mapping.
- 303 threatened species surveys.

Several of the project's identified target species are cryptic in nature or limited in their detectability due to seasonal variances. Consequently, surveys were carried out during optimum conditions and in accordance with relevant threatened fauna survey guidelines. Where appropriate, reference populations in the locality were also utilised to determine detectability and activity of targeted species.

4.2.4 Limitations

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on-site during surveys. The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.

It is possible that some species that utilise the study area (permanently, seasonally or transiently) were not detected during the survey. Although surveys were carried out during identified optimal detection periods, some fauna species are highly mobile and transient in their use of resources and some species are seasonal migrants. Due to this it is likely that not all species that potentially occur in the study area were recorded during the survey period.

Fieldwork for this study was completed during mid-winter and spring with cool to moderate overnight temperatures and occasional rainfall recorded. This may have impacted the activity (and therefore detectability) of some nocturnal species of frogs, reptiles, and small mammals. However, if suitable habitat for locally occurring threatened fauna was observed, a precautionary approach was taken and it was assumed that the species was likely to be present on at least an intermittent basis**.**

All survey techniques were carried out in accordance with relevant guidelines and during identified optimum detection periods. Where surveys were carried out during suboptimal conditions, surveys were repeated during optimum conditions. In some circumstances reference populations were also utilised to confirm the activity and detectability of target species.

Site conditions (including the presence of threatened species of flora and/or fauna) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This report has been prepared based on information provided in reports and spatial data provided by Parsons Brinckerhoff (2015a, 2015b, 2015c, 2015d, 2016). These data have in turn been relied upon in the FBA calculations and the determination of key thresholds such as whether the project would have a direct impact on a EEC, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated project design and/or spatial data.

4.3 Threatened species results

4.3.1 Likelihood of occurrence assessments

A summary of the findings of the habitat assessments for threatened species based on the likelihood of occurrence methodology is provided in Table 4-9.

4.3.2 Threatened flora species

Three threatened flora species were recorded within the study area during targeted field surveys completed by Parsons Brinckerhoff (2015a) and additional targeted surveys (refer Appendix C and Appendix G to Appendix J). These species are listed in Table 4-10 and the locations of where these species were recorded are shown on Figure 4-3.

Table 4-9 Habitat assessment results

Scientific name	Common name	TSC Act status	EPBC Act status	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification
Flora						
Caladenia tessellata	Thick Lip Spider Orchid	E	V	-	Moderate [1]	Potential habitat recorded within the study area [1]
Callistemon linearifolius	Netted Bottle Brush	-	V	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]
Corybas dowlingii	Red Helmet Orchid	E	-	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]
Diuris praecox	Rough Doubletail	V	V	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	Species credit species	Recorded [1]	Two small populations recorded within the study area.
Rutidosis heterogama	Heath Wrinklewort	V	V	Species credit species	Moderate [1]	Potential habitat recorded within the study area [1]
Syzygium paniculatum	Magenta Lilly Pilly	E	V	-	Recorded [1]	Recorded within the study area however occurred outside the construction footprint
Tetratheca juncea	Black-eyed Susan	V	V	Species credit species	Recorded [1]	Large population recorded within study area
Fauna						
Anthochaera phrygia	Regent Honeyeater	CE	CE	Species credit species	Moderate	Potential habitat recorded within the study area [1]

Scientific name	Common name	TSC Act status	EPBC Act status	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	Ecosystem credit species	Moderate	Potential habitat recorded within the study area [1]
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	V	Ecosystem credit species	Moderate	Potential habitat recorded within the study area [1]
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	-	Moderate	Potential habitat recorded [1]
Chthonicola sagittata	Speckled Warbler	V	-	Ecosystem credit species	Moderate	Potential habitat recorded in study area [2]
Daphoenositta chrysoptera	Varied Sittella	V	-	Ecosystem credit species	Moderate	Potential habitat recorded [1]
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Ecosystem credit species	Moderate	Potential habitat recorded in study area [1]
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Ecosystem credit species	Moderate	Potential habitat recorded within the study area [1]
Glossopsitta pusilla	Little Lorikeet	V	-	Ecosystem credit species	Recorded [1]	-
Hieraaetus morphnoides	Little Eagle	V	-	Ecosystem credit species	Moderate	Potential habitat recorded within the study area [1]
Lathamus discolor	Swift Parrot	E	E	Ecosystem credit species	Moderate	Potential habitat recorded [1]
Litoria aurea	Green and Golden Bell Frog	V	E	Species credit species	Low	No preferred habitat recorded [2]
Litoria brevipalmata	Green-thighed Frog	V	-	Species credit species	Low	No potential habitat recorded [2]
Lophoictinia isura	Square-tailed Kite	V	-	Ecosystem credit species	Moderate	Potential habitat recorded [2]
Miniopterus australis	Little Bent-wing Bat	V	-	-	Recorded [1]	
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	-	High	Previously recorded in study area (Umwelt, 2006)[1]

Scientific name	Common name	TSC Act status	EPBC Act status	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification
Mormopterus norfolkensis	Eastern Freetail-bat		-	Ecosystem credit species	High	Previously recorded in study area (Umwelt, 2006)[1]
Myotis macropus	Southern Myotis	V	-	-	Moderate	Potential habitat recorded [1]
Ninox strenua	Powerful Owl	V	-	Ecosystem credit species	Recorded [1]	-
Petaurus australis	Yellow-bellied Glider	V	-	Ecosystem credit species	Moderate	Potential habitat recorded [2]
Petaurus norfolcensis	Squirrel Glider	V	-	Ecosystem credit species	Recorded [1]	-
Peteropus poliocephalus	Grey-headed Flying-fox	V	V	-	Recorded [1]	
Petroica boodang	Scarlet Robin	V	-	Ecosystem credit species	Moderate	Potential habitat recorded [2]
Phascolarctos cinereus	Koala	V	V	Species credit species	Moderate	Potential habitat recorded within the study area [1]
Pseudophryne australis	Red-crowned Toadlet	V	-	Species credit species	Moderate	Potential habitat recorded [2]
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Ecosystem credit species	High	Previously recorded in study area (Umwelt, 2006)[1]
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Ecosystem credit species	High	Previously recorded in study area (Umwelt, 2006)[1]
Tyto novaehollandiae	Masked Owl	V	-	Ecosystem credit species	Moderate	Potential habitat recorded in study area [1]
Tyto tenebricosa	Sooty Owl	V	-	Ecosystem credit species	Moderate	Potential habitat recorded [1]

Scientific name	Common name	TSC Act status	EPBC Act status	Species credit species or ecosystem credit species	Likelihood of occurrence	Justification
Migratory species						
Apus pacificus	Fork-tailed Swift	-	M	-	Moderate	Potential habitat identified in study area [1]
Ardea ibis	Cattle Egret	-	M	-	Recorded	Recorded in study area
Hirundapus caudacutus	White-throated Needletail	-	M	-	Moderate	Potential habitat identified in study area [1]
Merops ornatus	Rainbow Bee-eater	-	M	-	Moderate	Potential habitat identified in study area [1]
Monarcha melanopsis	Black-faced Monarch	-	M	-	Recorded	Recorded in study area
Myiagra cyanoleuca	Satin Flycatcher	-	M	-	Moderate	Potential habitat identified in study area [1]
Rhipidura rufifrons	Rufous Fantail	-	M	-	Recorded	Recorded in study area

Key – V = vulnerable E= endangered, CE= critically endangered, M = migratory

Notes: 1 Parsons Brinckerhoff, 2015a

2 Assessment prepared as desktop assessment using existing information sources.

Table 4-10 Threatened flora (candidate species) results

Scientific name	Common name	Identification method	Species credit species or ecosystem credit species [1]	Can the species withstand further loss?	Corresponding PCT	Direct impacts (ha/number of stems)
Caladenia tessellata	Thick Lip Spider Orchid	Not present in study area [2]	-	N/A	HU803 [3], HU806 [3], HU841 [3]	18/0
Callistemon linearifolius	Netted Bottle Brush	Not present in study area [2]	Species credit species	N/A	HU803 [3], HU806 [3], HU833 [3], HU841 [3]	34.8/0
Corybas dowlingii	Red Helmet Orchid	Not present in study area [2]	Species credit species	N/A	HU782 [3]	4.4/0

Scientific name	Common name	Identification method	Species credit species or ecosystem credit species [1]	Can the species withstand further loss?	Corresponding PCT	Direct impacts (ha/number of stems)
Cryptostylis hunteriana	Leafless Tongue Orchid	Not present in study area [2]	Species credit species	N/A	HU803 [3], HU806 [3], HU833 [3], HU841 [3]	34.8/0
Diuris praecox	Rough Doubletail	Not present in study area [2]	Species credit species	N/A	HU782 [3], HU803 [3], HU806 [3], HU833 [3], HU841 [3]	39.2/0
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	Recorded	Species credit species	N/A =- outside of impact area	HU803 [3], HU806 [3]	16.1/109 identified in study area outside of construction footprint
Rutidosis heterogama	Heath Wrinklewort	Not present in study area [2]	Species credit species	N/A	HU803 [3], HU806 [3]	16.1/0
Syzygium paniculatum	Magenta Lilly Pilly	Recorded	-	N/A –outside of impact area	Assumed planted	4.4/8 identified in study area outside of construction footprint
Tetratheca juncea	Black-eyed Susan	Recorded	Species credit species	Yes	HU782 [3], HU803 [3], HU806 [3], HU833 [3], HU841 [3]	39.2/846 clumps in construction footprint

Note: 1 BioBanking credit calculator Version 4.1 (linear module).
2 Absence from site determined by targeted surveys
3 Information located from threatened species profile

Threatened flora present

Black-eyed Susan (*Tetratheca juncea*)

A large population of Black-eyed Susan comprising five sub-populations totalling 10,381 plant clumps was recorded within the threatened flora study area during targeted searches for the species (Table 4-11 and Figure 4-3) (Parsons Brinckerhoff 2015a).

The largest sub-population within the threatened flora study area consists of about 8176 plant clumps (sub-population 1). This population of Black-eyed Susan meets several of the criteria for an important population as set out by the *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable black-eyed susan, Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011 and Parsons Brinkerhoff 2015).

Table 4-11 Number of Black-eyed Susan plant clumps recorded (Parsons Brinckerhoff (2015a)

Location	No. of *Tetratheca juncea* plant clumps
Sub-population 1 (west of Lookout Road including Invermore Close and Dangerfield Drive reserves and bushland generally to the south and west of the John Hunter Hospital precinct)	8176
Sub-population 2 (west of Lookout Road and north of the John Hunter Hospital precinct)	4
Sub-population 3 (Blackbutt Reserve, east of Lookout Road)	5
Sub-population 4 (Blackbutt Reserve, east of Lookout Road)	2162
Sub-population 5 (Blackbutt Reserve, east of Lookout Road)	34
Total number of clumps identified within the threatened flora study area	**10,381**

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

Small-flower Grevillea was found growing in association with Smooth-barked Apple – Red Bloodwood open forest in one part of the study area. A total of 109 stems were recorded.

Magenta Lily Pilly (*Syzygium paniculatum*)

Eight stems of the Magenta Lily Pilly were recorded at one location on the western edge of the study area. This species was found growing in association with Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant along the banks of an unnamed creek (Parsons Brinckerhoff 2015a). It is possible that these plants have colonised as a result of bird dispersal from nearby gardens, as this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (Parsons Brinckerhoff 2015a).

Threatened flora species with potential to occur

A likelihood of occurrence assessment was carried out for threatened flora species identified by the desktop assessment (Parsons Brinkerhoff 2015a). This assessment identified a total of six flora species in addition to those recorded on-site, with a moderate or higher likelihood of occurrence based on habitat contained within the study area.

Targeted surveys were carried out for all six species, including the use of reference sites in the locality to determine flowering periods and species detectability. None of these species were identified during targeted field surveys (Parsons Brinckerhoff 2015a). Based on the survey effort carried out in the study area for this assessment (Section 4.2.1) it is considered unlikely that these species occur within the study area and construction footprint.

Netted Bottle Brush (*Callistemon linearifolius*)

Netted Bottle Brush occurs in dry sclerophyll forest, open woodland, scrubland or woodland on sandstone. Found in damp habitats such as gullies. This species has potential habitat within the study area in the HU782 Blackbutt-Turpentine-Sydney Blue Gum mesic tall open forest and HU782 Blackbutt -Turpentine - Sydney Blue Gum mesic tall open forest (atypical variant).

Leafless Tongue Orchid (*Cryptostylis hunteriana*)

Leafless Tongue Orchid is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park and Ben Boyd National Park (OEH 2016). Grows in swamp-heath and drier coastal forest on sandy soils on granite and sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Parsons Brinckerhoff 2015a). Potential habitat for this species within the study area occurs in the HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark –Hairpin Banksia heathy open forest of coastal lowlands.

Thick Lip Spider Orchid (*Caladenia tessellata*)

Thick Lip Spider Orchid has been recorded in the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. This species is generally found in grassy sclerophyll woodland on clay loam or sandy soils, although the population near Braidwood is in low woodland with stony soil (OEH 2016). This species has potential habitat within the study area within HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark –Hairpin Banksia heathy open forest of coastal lowlands and HU803 Spotted Gum-Broad Leaved Mahogany – Grey Gum grass- shrub open forest on coastal lowlands on the Central Coast (*E. fergusonii* variant) and HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands.

Heath Wrinklewort (*Rutidosis heterogama*)

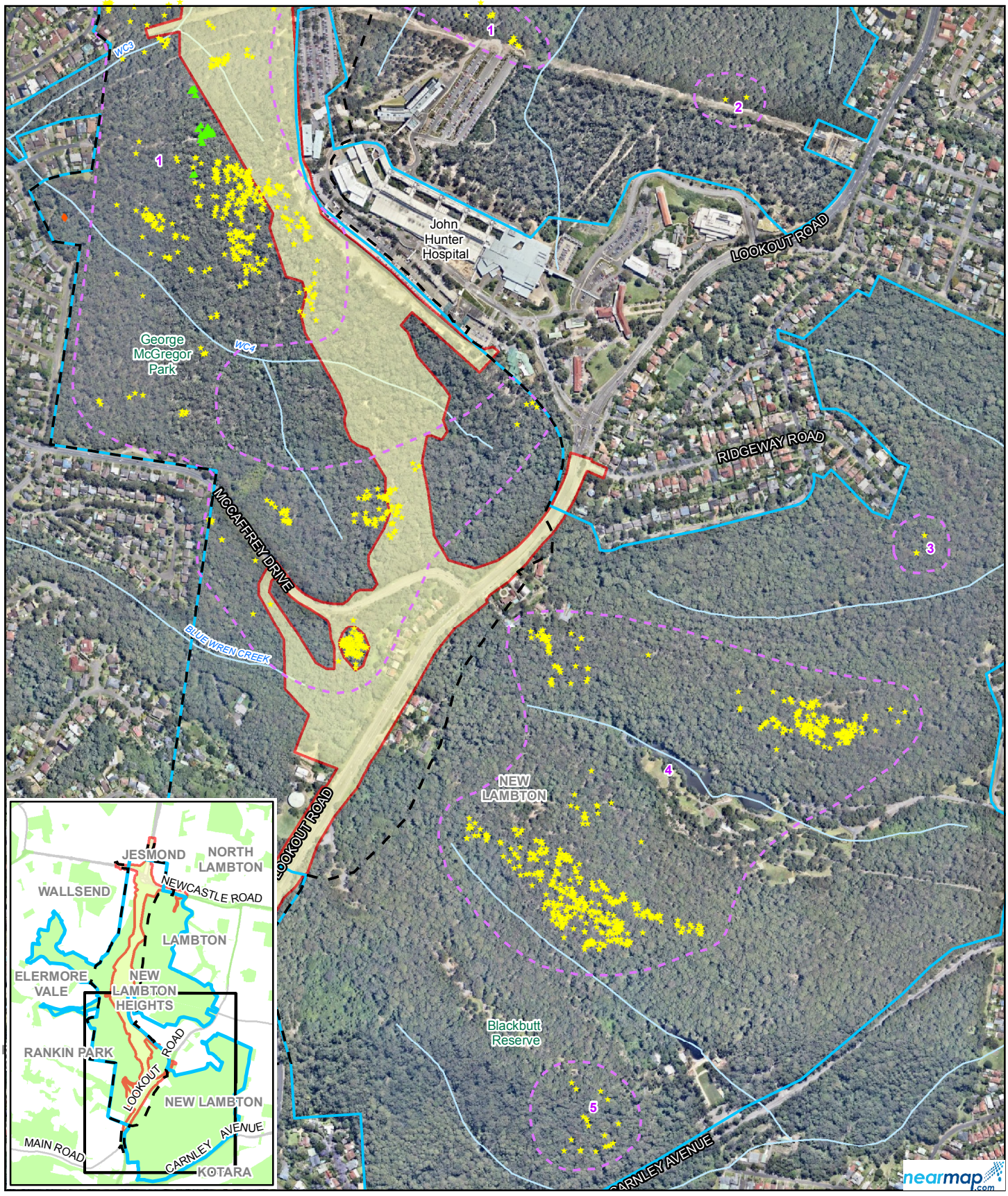
Heath Wrinklewort has been previously recorded from near Cessnock to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. The species grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides. This species has potential habitat within the study area within HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark –Hairpin Banksia heathy open forest of coastal lowlands and HU803 Spotted Gum-Broad Leaved Mahogany – Grey Gum grass- shrub open forest on coastal lowlands on the Central Coast (*E. fergusonii* variant) and HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands.

Newcastle Doubletail (*Diuris praecox*)

Newcastle Doubletail typically inhabits hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey (OEH 2016). Its distribution is known from Bateau Bay on the NSW Central Coast to Smiths Lake NSW. This species has potential habitat within the study area within HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark –Hairpin Banksia heathy open forest of coastal lowlands and HU803 Spotted Gum-Broad Leaved Mahogany – Grey Gum grass- shrub open forest on coastal lowlands on the Central Coast (*E. fergusonii* variant) and HU833 Smooth-Barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands.

Red Helmet Orchid (*Corybas dowlingii*)

Red Helmet Orchid is restricted to the central coast and Hunter regions of NSW where is it known to occur from eth Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole regions (OEH 2016). The occurs in gullies of tall open forest, typically between 10 and 200 metres elevation and on well-drained gravelly soil (Parsons Brinckerhoff 2015a). Potential habitat for this species within the study area occurs in HU782 Blackbutt-Turpentine-Sydney Blue Gum mesic tall open forest and HU782 Blackbutt -Turpentine - Sydney Blue Gum mesic tall open forest (atypical variant).



LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area
- Native vegetation
- Watercourse

Threatened Flora Species

- *Grevillea parviflora*
- *Syzygium paniculatum*
- *Tetratheca juncea*
- Subpopulation of Tetratheca juncea

Sheet layout

Sheet 1

Paper Size A4

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Metres

Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 56

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Biodiversity Assessment Report

Job Number 22-17656
Revision 1
Date 30 Sep 2016

Threatened flora species recorded in the study area - sheet 1 of 2

Figure 4-3a

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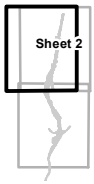
Data source: Aurecon: Construction footprint, 2016; PB: Threatened Species / Study area, 2015; LPI: DTDB 2012; Nearmap: Aerial Imagery, 20160331. Created by: fmackay, gmcdiarmid, tmorton

LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Threatened flora study area
- Native vegetation
- Watercourse
- **Threatened Flora Species**
  - *Tetratheca juncea*
- Subpopulation of Tetratheca juncea

Sheet layout



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Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number 22-17656
Revision 1
Date 30 Sep 2016

Threatened flora species recorded in the study area - sheet 2 of 2

Figure 4-3b

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

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Data source: Aurecon: Construction footprint, 2016; PB: Threatened Species / Study area, 2015; LPI: DTDB 2012; Nearmap: Aerial Imagery, 20160331. Created by: fmackay, gmcdiarmid, tmorton

4.3.3 Threatened fauna species

A total of 79 fauna species were recorded within the study area, including 12 mammals, 63 bird, two frog and two reptile species. Only one of the species recorded within the study area is introduced (the Spotted Turtle-dove). A full list of fauna species recorded in the study area is presented in *Newcastle Inner City Bypass: Rankin Park to Jesmond, Biodiversity Survey Report* (Appendix C of Parsons Brinckerhoff 2015a, provided in Appendix C).

Five threatened fauna species were recorded within the study area during field surveys completed by Parsons Brinckerhoff (2015a) and an additional four species have been previously identified within the study area during prior field surveys (Umwelt Environmental Consultants 2006). These species are listed in Table 4-12 and locations of species (excluding Umwelt Environmental Consultants 2006 species due to unavailable data) are shown on Figure 4-4.

A discussion on threatened fauna species recorded in the study area is provided in the following sections.

Table 4-12 Threatened fauna (candidate species) results

Scientific name	Common name	Identification method (assumed, recorded or expert report)	Species credit species or ecosystem credit species	Can the species withstand further loss?	Corresponding PCT	Direct Impact area (ha)
Anthochaera phrygia	Regent Honeyeater	Not present on-site [3]	Species credit species	Yes	HU806 [4], HU803 [4]	16.1
Callocephalon fimbriatum	Gang-gang Cockatoo	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Calyptorhynchus lathami	Glossy Black-Cockatoo	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Chalinolobus dwyeri	Large-eared Pied Bat	Not present on-site [3]	-	Yes	HU782 [4], HU806 [4], HU803 [4]	16.4
Chthonicola sagittata	Speckled Warbler	Not present on-site [3]	Ecosystem credit species	Yes	HU803, HU806, HU833, HU841	34.8
Daphoenositta chrysoptera	Varied Sittella	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Dasyurus maculatus	Spotted-tailed Quoll	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Glossopsitta pusilla [1]	Little Lorikeet	Recorded	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Hieraaetus morphnoides	Little Eagle	Not present on-site [3]	Ecosystem credit species	Yes	HU803, HU806, HU833, HU841	34.8
Lathamus discolor	Swift Parrot	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Litoria aurea	Green and Golden Bell Frog	Not present on-site [3]	Species credit species	Yes	HU803 [4], HU806 [4], HU833 [4], HU841 [4]	34.8
Litoria brevipalmata	Green-thighed Frog	Not present on-site [3]	Species credit species	Yes	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]	39.2

Scientific name	Common name	Identification method (assumed, recorded or expert report)	Species credit species or ecosystem credit species	Can the species withstand further loss?	Corresponding PCT	Direct Impact area (ha)
Lophoictinia isura	Square-tailed Kite	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Miniopterus australis [1, 2]	Little Bent-wing Bat	Recorded [2]	N/A	Yes	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]	39.2
Miniopterus schreibersii oceanensis [2]	Eastern Bent-wing Bat	Recorded [2]	N/A	Yes	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]	39.2
Micronomus norfolkensis (syn. Mormopterus norfolkensis)[2]	Eastern Freetail-bat	Recorded [2]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Myotis macropus	Southern Myotis	Not present on-site [3]	N/A	Yes	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]	39.2
Ninox strenua [1, 2]	Powerful Owl	Recorded	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Petaurus australis	Yellow-bellied Glider	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Petaurus norfolcensis [1]	Squirrel Glider	Recorded	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Pteropus poliocephalus [1, 2]	Grey-headed Flying-fox	Recorded	N/A	Yes	HU782, HU803, HU806, HU833, HU841,	39.2
Petroica boodang	Scarlet Robin	Not present on-site [3]	Ecosystem credit species	Yes	HU803, HU806, HU833, HU841	34.8
Phascolarctos cinereus	Koala	Not present on-site [3]	Species credit species	Yes	HU782 [4], HU803 [4], HU806 [4], HU833 [4], HU841 [4]	39.2
Pseudophryne australis	Red-crowned Toadlet	Not present on-site [3]	Species credit species	Yes	HU841 [4]	1.9
Saccolaimus flaviventris [2]	Yellow-bellied Sheathtail-bat	Recorded [2]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Scoteanax rueppellii [2]	Greater Broad-nosed Bat	Recorded [2]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2

Scientific name	Common name	Identification method (assumed, recorded or expert report)	Species credit species or ecosystem credit species	Can the species withstand further loss?	Corresponding PCT	Direct Impact area (ha)
Tyto novaehollandiae	Masked Owl	Not present on-site [3]	Ecosystem credit species	Yes	HU782, HU803, HU806, HU833, HU841	39.2
Tyto tenebricosa	Sooty Owl	Not present on-site [3]	Ecosystem credit species	Yes	HU841	4.8
Migratory species						
Apus pacificus	Fork-tailed Swift	Moderate	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.2
Ardea ibis	Cattle Egret	Recorded	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.9
Hirundapus caudacutus	White-throated Needletail	Moderate	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.2
Merops ornatus	Rainbow Bee-eater	Moderate	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.2
Monarcha melanopsis	Black-faced Monarch	Recorded	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.2
Myiagra cyanoleuca	Satin Flycatcher	Moderate	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.2
Rhipidura rufifrons	Rufous Fantail	Recorded	N/A	Yes	HU782, HU803, HU806, HU833 HU841, Remnant Native Vegetation	39.2

Note: 1 Identified during current surveys by Parsons Brinckerhoff (2015a)

2 Identified during previous surveys by Umwelt Environmental Consultants (2006)

3 Absence from site determined by targeted surveys

4 Information sourced from threatened species profile (OEH, 2014c)

Blossom dependant fauna

The Grey-headed Flying-fox (*Pteropus poliocephalus*) and Little Lorikeet (*Glossopsitta pusilla*) were recorded flying over the study area (Parsons Brinckerhoff 2015a). Blossom producing trees within the study area are likely to provide foraging resources for these threatened species. Hollow-bearing trees within the study area would also provide potential breeding sites for the Little Lorikeet.

There is a known Grey-headed Flying-fox camp near the project within Blackbutt Reserve (Figure 4-4). It is likely that individuals from this camp would forage within the construction footprint when feed trees are flowering. An assessment of significance (Appendix M) was prepared for the EPBC referral (GHD, 2015), as this camp is considered a regionally important population as it is known to support breeding females, is the only known camp in the Newcastle LGA and provides a year-round foraging resource and is the only continuously occupied camp in the Lower Hunter region (Geolink 2013).

Microchiropteran bats

Previous surveys by Umwelt Environmental Consultants (2006) have recorded five threatened microchiropteran bats (microbats), comprising the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern Freetail Bat (*Micronomus norfolkensis (syn. Mormopterus norfolkensis*), Little Bentwing Bat (*Miniopterus australis*), Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*), within the study area.

Field surveys carried out by Parsons Brinckerhoff (2015a) recorded only one species of microbat, the Little Bentwing Bat (*Miniopterus australis*) within the study area. Suitable foraging and roosting habitat was identified within the study area for hollow-dependent microbats.

Suitable foraging habitat was identified within the study area for cave-dwelling microbat species, however no caves were observed within the study area that would provide suitable roosting/breeding habitat for cave-dwelling microbats.

Arboreal mammals

One threatened arboreal mammal, the Squirrel Glider (*Petaurus norfolcensis),* was recorded within the study area. This species is found to be widely, yet sparsely, distributed through dry woodlands and forests in the Lower Hunter. Woodland within the study area was highly suited to a range of arboreal mammals, including Squirrel Gliders, due to the relatively high-density of hollow-bearing trees.

The hollow-bearing tree assessment that was completed within study area identified a total of 450 hollow-bearing trees, containing 1312 tree hollows. This included 567 small hollows, 642 medium hollows and 103 large hollows which were recorded from 13 different tree species (Figure 4-1). Eleven of the 22 fauna species that area considered to have potential habitat in the study area use hollows for breeding and roosting (Parsons Brinckerhoff 2015b). It is therefore likely that small to medium sized hollows within the construction footprint may be used by arboreal mammals, including threatened gliders.

Thirty-eight nest boxes have been installed as part of an offset for the John Hunter Hospital expansion site. About twenty-seven of these nest boxes would be removed as a result of the project, with the remaining 11 boxes subject to indirect impacts from the project including noise and light. To determine whether these nest boxes were being utilised by native fauna and in particular any threatened species such as the Squirrel Glider, Parsons Brinckerhoff completed inspections of all nest boxes at the site on 7 October 2015. Of the 38 nest boxes inspected, only one was being utilised. This box was occupied by a Common Brushtail Possum (*Trichosurus vulpecula).* No signs of fauna occupancy were observed in any of the remaining nest boxes (Parsons Brinckerhoff 2015c).

Forest owls

Powerful Owls (*Ninox strenua*) were recorded within the study area on numerous occasions during surveys by Parsons Brinckerhoff. The high abundance of hollow-bearing trees at the site (refer Figure 4-1) provide a nesting resource for Powerful Owl (Figure 4-4) and the presence of small arboreal mammals provide a good source of prey. A pair of Powerful Owls was observed during targeted surveys in July 2014, demonstrating breeding behaviour (Parsons Brinckerhoff 2015b).

Further monitoring of Powerful Owl was conducted in June and July 2015, including stag watching of the 20 hollow-bearing trees within the study area that were considered suitable for use by Powerful Owl. A pair of Powerful Owls exhibiting breeding behaviour was observed within the project construction footprint. A nest tree for this pair was located to the north of the gully in the southern section of the study area, immediately next to the western boundary of the construction footprint (Parsons Brinckerhoff 2015b).

Threatened fauna species with potential to occur

A likelihood of occurrence assessment was carried out for threatened fauna species identified by the desktop assessment (Parsons Brinkerhoff 2015a). This assessment identified a total of 13 fauna species with a moderate likelihood of occurrence, based on known distributions, previous local records and the presence of suitable habitat in the study area, which are listed in Table 4-12.

Although these species are predicted to occur in the study area, detailed targeted surveys have been carried out for all candidate species. Consequently, any of these species not recorded during targeted surveys are considered unlikely to occur within the construction footprint.

There are no aquatic fauna species listed under the FM Act that have potential to occur within the study area due to lack of any substantial aquatic habitat within the study area.

Forest owls and Raptors

The Masked Owl (*Tyto novaehollandiae novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Little Eagle (*Hieraaetus morphnoides*) were assessed as having a moderate likelihood of occurrence within the study area based on potential habitat. None of these species were recorded during current or previous surveys (Parsons Brinckerhoff 2015a).

Masked Owl and Sooty Owl both require large tree-hollows in large, mature trees for nesting. Large mature trees are abundant in the study area. A large proportion of these trees contain hollows which may be of a sufficient size for these two threatened owls. The Little Eagle nests in mature living trees in open woodland or along tree-lined watercourses.

The Masked Owl, Sooty Owl and the Little Eagle may all forage in habitats within the study area. Woody debris and small tree-hollows in the study area provide shelter and foraging habitats for small mammals, birds, reptiles and frogs which would provide potential prey for these birds. The Masked Owl and Sooty Owl have very large home ranges (in the order of hundreds to thousands of hectares), and individuals of these species may use roosting, nesting and foraging habitats within the study area as part of a much larger territory. The Little Eagle has a smaller home range (up to 10 kilometres) but may still use the study area as part of a larger home range.

Woodland birds

None of the five species of threatened woodland birds considered to have the potential to occur were observed within the study area (Parsons Brinckerhoff 2015a).

The Regent Honeyeater (*Anthochaera phrygia*) is a generalist forager that feeds mostly on nectar from a wide range of eucalypts and mistletoes. They will also feed on insects, lerp and honeydew. This species inhabits areas of woodland that contain a large number of mature trees with high canopy cover and a shrubby understorey. There are two known breeding areas in NSW, Capertee Valley and the Bundarra-Barraba region, neither of which occurs near the study area (OEH 2015a). Potential foraging habitat is present within the study area within areas of Spotted Gum forest and Smooth Barked Apple forest. Spotted Gum in particular is an important winter-flowering tree that may be utilised by the Regent Honeyeater during winter months.

In NSW, the breeding distribution is confined to two main areas, within the Capertee Valley and Bundarra-Barraba regions and surrounding fragmented woodland. In some years' flocks converge on flowering coastal woodlands and forests (OEH 2014b). A key habitat for the species on the coast and coastal plains of New South Wales is Lower Hunter Spotted Gum - Ironbark Forest which provides important foraging habitat when box-ironbark forests are drought affected (Menkhorst *et al.* 1999). Preferred feed trees for this species include Spotted Gum (*Eucalyptus maculata*), and Swamp Mahogany (*Eucalyptus robusta*) both of which occur within the project construction footprint and study area. These trees potentially provide important foraging habitat for the species during flowering periods.

The Glossy Black-Cockatoo (*Calyptorhynchus lathami*) requires large hollows for nesting and may nest within a subset of the tree-hollows within the study area. This species feeds almost exclusively on the seeds of *Casuarina* and *Allocasuarina* species which occur in low abundance scattered in the study area. It is likely that the Glossy Black-cockatoo would forage within the site on occasion. Only one record for the Glossy Black-Cockatoo occurs within a 10 kilometre radius of the project (OEH 2016).

There is potential habitat for the Gang-gang Cockatoo (*Callocephalon fimbriatum*) within the study area. This species requires large hollows for nesting and may nest within a subset of the hollows within the study area. Gang-gang Cockatoos feed on seeds, primarily the seeds of eucalypts and Acacias, which are abundant in the study area. One record for the Gang-gang Cockatoo occurs within a 10 kilometre radius of the project, immediately north-east of the John Hunter Hospital precinct (OEH 2016).

The Swift Parrot (*Lathamus discolor*) breeds in Tasmania and migrates to mainland Australia during the autumn and winter months (OEH 2015b). While over-wintering in NSW, this species feeds primarily on flowering eucalypts, including Spotted Gum (*Corymbia maculata*) and Red Bloodwood (*Corymbia gummifera*) both of which occur in the study area. In NSW the species mostly occurs on the coast and south west slopes. Swift Parrots will return to some foraging sites on a cyclic basis depending on food availability. Two records for the Swift Parrot occur within a 10 kilometre radius of the project (OEH 2016).

The Varied Sittella (*Daphoenositta chrysoptera*) may forage and breed within the study area. This species is insectivorous and would forage on rough barked eucalypts (such as *Eucalyptus resinifera, Corymbia intermedia* and *Eucalyptus carnea*) which occur within the study area. Three records of the Varied Sittella occur within a 10 kilometre radius of the project (OEH 2016).

Terrestrial mammals

The study area contains potential habitat for the Spotted-tailed Quoll (*Dasyurus maculatus maculatus*). The Spotted-tailed Quoll has been recorded across a range of habitats from rainforest through woodland, heath and inland riparian forest from the coast to the sub-alpine zone. This species is nocturnal and will shelter in hollow-bearing trees, fallen logs, caves, crevices and cliff faces during the day.

Their home range is large, with females occupying home ranges of up to 750 hectares and males up to 3500 hectares which they often traverse along densely vegetated cliff lines. Quolls will predate a variety of prey from arboreal and terrestrial mammals to insects, carrion and domestic chickens (OEH 2014b). Spotted-tailed Quolls use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (OEH 2014b).

Shelter habitat for this species is present within the study area, including hollow-bearing trees (including trees with ground-level hollows), logs and other woody debris. Woody debris and other shelter within the study area is likely to provide habitat for Spotted-tailed Quoll prey species such as small terrestrial mammals, frogs and reptiles, such as skinks and lizards.

Bats

Three additional species of microbat are considered to have the potential to occur within the study area given local records and the habitats present. Microbat species with the potential to occur within the study area may be divided into cave-roosting species (Large-eared Pied Bat *(Chalinolobus dwyeri)* and Southern Myotis *(Myotis macropus*)) which would use the study area as foraging habitat only, and hollow-roosting species which may roost and/or breed within the study area (Eastern False Pipistrelle *(Falsistrellus tasmaniensis))*.

The construction footprint has an abundance of small and medium sized hollows that may provide roosting habitat for hollow-dependent microchiropteran bats. There is also an abundance of foraging habitat in the construction footprint for all three microbat species.

Arboreal mammals

There are no known occurrences of the Koala within the study area and no evidence of the Koala (*Phascolarctos cinereus*) was detected during field surveys by Parsons Brinckerhoff (2015a). The most recent record of the Koala in the locality was two kilometres from the study area, near Blackbutt Reserve in 1986 (OEH 2015f).

The Koala is widely distributed in eastern Australia, occurring from north-eastern Queensland to the south-east corner of SA (ANZECC 1998). This distribution equates to about one million square kilometres. In NSW, the Koalas range occurs along the coast and extends west to the Darling Riverine Plains and Mulga Lands bioregions in the north of the state; to the Cobar Peneplain bioregion in the centre of the state; and to the Riverina and eastern most parts of the Murray-Darling Depression bioregions in the south. It is restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from less than two hectares to several hundred hectares (DotE 2015b).

One species of Koala feed tree (Grey Gum (*Eucalyptus punctata*)) was identified within the study area (Parsons Brinckerhoff 2015a). The Department of the Environment Koala habitat assessment tool (DotE 2014a) was used to determine the quality of Koala habitat in the study area and if it contained habitat critical to the survival of the Koala (Parsons Brinckerhoff 2015a). Habitat within the study area scored three out of 10. Based on this assessment it was determined that the study area does not contain critical habitat for the survival of the Koala.

Based on this information, the presence of the Koala was considered to have a moderate likelihood of occurrence within the study area (Parsons Brinckerhoff 2015a).

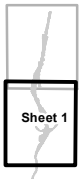
LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse

Threatened Fauna Species

- Powerful Owl nest tree
- Powerful Owl roost tree
- Grey-headed Flying-fox
- Grey-headed Flying-fox camp
- Little Bentwing-bat
- Little Lorikeet
- Squirrel Glider

Sheet layout



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0 40 80 160 240 320

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

Job Number	22-17656
Revision	0
Date	26 Aug 2016

Threatened fauna species recorded in the study area - sheet 1 of 2

Figure 4-4a

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Data source: Aurecon: Construction footprint, 2016: PB: Threatened Species / Study area, 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2006. Created by: tmorton

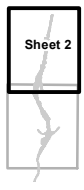
LEGEND

- Construction footprint
- Study area (Parsons Brinckerhoff, 2015a)
- Watercourse

Threatened Fauna Species

- Grey-headed Flying-fox
- Little Bentwing-bat

Sheet layout



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

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Threatened fauna species recorded in the study area - sheet 2 of 2

Figure 4-4b

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Data source: Aurecon: Construction footprint, 2016: PB: Threatened Species / Study area, 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2006. Created by: tmorton

4.4 Aquatic habitat and threatened species

4.4.1 Aquatic surveys

As no significant aquatic habitat was identified within the study area, no detailed aquatic habitat surveys were carried out. Rapid visual aquatic habitat assessments however, were made during field surveys carried out by Parsons Brinckerhoff (2015a, 2016. Visual aquatic habitat assessments required making visual observations of aquatic habitat in the study area, including emergent vegetation species and density, stream floor substrate and stream persistence (permanent or ephemeral).

No detailed aquatic assessment was carried out within aquatic habitat identified on the site such as fish trapping or macroinvertebrate sampling, as the habitat contained in the study area does not meet the assessment threshold (ie Class 1 and 2 stream classification as per NSW DPI Fisheries (2013) methodology). The site only contains Class 1 and Class 2 waterways as per Strahler methodology which constitute Class 4 fish habitat waterways according to DPI Fisheries (2013)

4.4.2 Aquatic results

Aquatic habitats identified within the study area include Blue Wren Creek, Styx Creek, Dark Creek, several unnamed tributaries of Ironbark Creek, and a small dam located in the north-west corner of the study area (refer Figure 2-2) (Parsons Brinckerhoff 2014 and 2015a). All aquatic habitats identified within the study area, other than the dam, are ephemeral and are characterised by rocky and gravel based substrates, with moderate riparian vegetation cover and small pool sections which retained water for short periods (less than three weeks) following rainfall events. Due to the ephemeral nature of these water bodies, the aquatic habitats contained within the study area are likely to provide habitat for only a limited range of common aquatic animals (Parsons Brinckerhoff 2015a).

The freshwater dam located in the north-western section of the study area would retain water year-round, and has moderate native aquatic vegetation cover. This dam however, is considered to only offer limited foraging habitat for water birds and herpetofauna species due to its small size, disturbed condition due it its location within mowed parkland, its accessibility by domestic animals and lack of riparian vegetation/habitat complexity.

Most of the waterways within the study area are ephemeral freshwater creek and/or drainage lines and classified as Class 1 waterways with two occurring as Class 2 waterways (according Strahler method stream ordering), All the waterways within the study area are Class 4 – unlikely fish habitat fish passage classification (NSW DPI Fisheries 2013) (Figure 2-2).

The identified aquatic habitats, excluding the dam, were not observed to support native aquatic or wetland vegetation, and are not considered key fish habitat in accordance with the NSW DPI Fisheries *Policy and Guidelines for Fish Habitat Conservation and Management – Update (2013)*.

No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in the study area and no significant impacts on riparian vegetation or habitats downstream of the project site are anticipated as a result of the project. There would be no impact on key fish habitat as a result of the project.

5. Matters of National Environmental Significance

5.1 Background

An EPBC referral was prepared and submitted for the project for potential significant impacts to MNES in August 2015 (GHD, 2015). The project was determined to be a controlled action given the potential for a significant impact on the following matters protected by the EPBC Act:

- Black-eyed Susan (*Tetratheca juncea*).
- Grey-headed Flying Fox (*Pteropus poliocephalus).*
- Leafless Tongue Orchid (*Cryptostylis hunteriana*).
- Newcastle Doubletail (*Diuris praecox*).
- Ecological character of the downstream Hunter Estuary Wetlands Ramsar site.

Assessments of significance pursuant to the EPBC Act guidelines were prepared for the following species (refer Appendix M):

- Koala (*Phascolarctos cinereus*).
- Large-eared Pied-bat (*Chalinolobus dwyeri*).
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*).
- Swift Parrot (*Lathamus discolor*).
- Regent Honey Eater (*Anthochaera phrygia*).
- Leafless Tongue-orchid (*Cryptostylis hunteriana*).
- Newcastle Double Tail (*Diuris praecox*).
- Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*).
- Heath Wrinklewort (*Rutidosis heterogama*).
- Magenta Lilly Pilly (*Syzigium paniculatum*).

The EPBC referral for the project (GHD, 2015) has informed this section of the BAR.

5.1.1 World heritage properties

There are no World Heritage Properties located within 10 kilometres of the project (DotE 2014a).

5.1.2 National Heritage places

Coal River (Mulubinba) and Government Domain Newcastle is a distinctive area of public land at the mouth of the Hunter River and an area to the south of the city, on ‘The Hill’, located about eight kilometres to the east of the project construction footprint. The area is of cultural and historical significance and provides both tangible and intangible expressions of Newcastle’s Aboriginal and European Heritage (DotE 2015a).

5.1.3 Wetlands of International Importance (declared Ramsar wetlands)

The Hunter Estuary Wetlands (Australian Ramsar site number 24) is located about six kilometres to the north of the construction footprint. These wetlands comprise two components: Kooragang Nature Reserve (located on the north arm of the Hunter River) and Shortland Wetlands which is located about six kilometres downstream of the project. The Hunter Estuary Wetlands provide an extremely important feeding and roosting site for a large seasonal population of shorebirds and a waylay site for transient migrants (DotE 2015b).

5.1.4 Threatened ecological communities

There are no EPBC Act listed threatened ecological communities recorded or predicted likely to occur within the study area, or likely to be affected by the project (Parsons Brinckerhoff 2015a).

5.1.5 Threatened flora species

Threatened flora species

Three threatened flora species listed as vulnerable under the EPBC Act, Black-eyed Susan (*Tetratheca juncea*), Small Flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) and Magenta Lilly Pilly (*Syzygium paniculatum),* were recorded in the study area during surveys (Parsons Brinckerhoff 2015a). Only Black-eyed Susan occurs within the construction footprint. Small Flower Grevillea and Magenta Lilly Pilly both occur outside of the construction footprint and will not be impacted by the project. Table 5-1 provides a summary of EPBC listed flora likely to occur in the study area.

Black-eyed Susan (*Tetratheca juncea*)

A large population of Black-eyed Susan comprising five sub-populations totalling 10381 plant clumps was recorded within the threatened flora study area during targeted searches for the species (Parsons Brinckerhoff 2015a). The largest subpopulation within the study area consists of about 8176 plant clumps. This population of Black-eyed Susan meets several of the criteria for an important population as set out by the *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable black-eyed susan, Tetratheca juncea* (DSEWPaC 2011 and Parsons Brinkerhoff 2015a). A total of 846 clumps of *Tetratheca juncea* were identified within the construction footprint during targeted searches for the species. They project is considered to have a significant impact on the *Tetratheca juncea* population and is assessed in detail in Section 5.3.

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

Small-flower Grevillea was found growing in association with Smooth-barked Apple – Red Bloodwood open forest. A total of 109 stems were recorded within the study area and outside of the construction footprint.

Magenta Lily Pilly (*Syzygium paniculatum*)

Eight stems of the Magenta Lily Pilly were recorded at one location within the study area, outside of the construction footprint. This species was found growing in association with Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia* variant, along the banks of an unnamed creek. It is possible that these plants have colonised as a result of bird dispersal from nearby gardens as this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (Parsons Brinckerhoff 2015a).

Species likely to occur

Potential habitat has been identified within the study area for an additional four threatened flora species listed under the EPBC Act (Table 5-1). These species have relatively specific habitat requirements and were not recorded in the study area during any targeted field surveys during optimum survey times (Section 4.2.1). Furthermore, identified reference populations in the locality were also used to identify optimum detectability periods and determine flowering activity for timing surveys in the study area. Due to the survey effort carried out in the study area it is considered unlikely that any species not already recorded occur in the study area.

Table 5-1 EPBC Act listed flora species likely to occur in the construction footprint

Scientific name	Common name	EPBC Act status	Likelihood of occurrence [1]	Presence in construction footprint [2]	Residual likelihood of occurrence following targeted surveys
Cryptostylis hunteriana	Leafless Tongue Orchid	Vulnerable	Moderate	Not recorded during extensive targeted surveys carried out during the appropriate flowering periods and utilising local reference populations.	Low Species not identified during targeted surveys during peak detectability period. Impacts to potential habitat will be suitably offset as part of the BOS.
Caladenia tessellata	Thick Lip Spider Orchid	Endangered	Moderate	Not recorded during targeted surveys carried out within the appropriate flowering period.	Low Species not identified during targeted surveys during peak detectability period. Impacts to potential habitat will be suitably offset as part of the BOS.
Rutidosis heterogama	Heath Wrinklewort	Vulnerable	Moderate	Not recorded during targeted surveys carried out within the appropriate flowering season.	Low Species not identified during targeted surveys during peak detectability period. Impacts to potential habitat will be suitably offset as part of the BOS.
Diuris praecox	Newcastle Doubletail	Vulnerable	Moderate	Not recorded during extensive targeted surveys carried out during the appropriate flowering periods and utilising local reference populations.	Low Species not identified during targeted surveys during peak detectability period. Impacts to potential habitat will be suitably offset as part of the BOS.

Note: 1 Parsons Brinckerhoff, 2015a

2 Taken from EPBC Referral (GHD, 2015)

5.1.6 Threatened fauna species

One EPBC Act listed threatened fauna species, the Grey-headed Flying-fox (*Pteropus poliocephalus*), was identified flying over the construction footprint during field surveys (Parsons Brinckerhoff 2015a).

Grey-headed Flying-foxes were observed flying over the construction footprint and blossom producing trees within the construction boundary provide a foraging resource for this species. A known camp is located about 230 metres from the southern extent of the construction footprint within Blackbutt Reserve. The Grey-headed Flying-fox is likely to forage in the study area and construction footprint on a regular basis when feed trees are in flower.

An assessment of significance (Appendix M) was prepared for this species which determined this camp to be a regionally important population as it is known to support breeding females, is the only known camp in the Newcastle LGA, provides a year-round foraging resource and is the only continuously occupied camp in the Lower Hunter region (Geolink 2013).

Species likely to occur

No other threatened fauna species listed under the EPBC Act have been recorded within the construction footprint or study area, however as shown in Table 5-2, potential habitat for an additional five threatened fauna species listed under the EPBC Act exists in the construction footprint.

Table 5-2 EPBC Act listed fauna species likely to occur in the study area

Scientific name	Common name	EPBC Act status	Likelihood of occurrence [1]	Presence in construction footprint [2]	Residual likelihood of occurrence following targeted surveys
Anthochaera phrygia	Regent Honeyeater	E	Moderate	Not recorded during the survey period. Favoured winter-blossom producing tree, Spotted Gum (*Corymbia maculata*) identified in the indicative construction footprint.	Moderate Species not identified during targeted surveys during peak detectability period, but suitable foraging identified. Impacts to potential habitat will be suitably offset as part of the BOS.
Lathamus discolor	Swift Parrot	E	Moderate	Not recorded during the survey period. Favoured winter-blossom producing trees, Spotted Gum (*Corymbia maculata*) and Ferguson's Ironbark (*Eucalyptus fergusonii*) identified in the indicative construction footprint.	Moderate Species not identified during targeted surveys during peak detectability period, but suitable foraging identified. Impacts to potential habitat will be suitably offset as part of the BOS.
Dasyurus maculatus	Spotted-Tailed Quoll	E	Moderate	Not recorded during surveys. Potential habitat and denning sites available in the construction footprint	Low Species was not identified during targeted surveys and only marginal habitat identified on-site. Impacts to potential habitat will be suitably offset as part of the BOS.
Phascolarctos cinereus	Koala	V	Moderate	No previous records (OEH 2014b) and not recorded during surveys. The habitat value of the construction footprint was assessed in accordance with the *EPBC Act referral guidelines for the Koala* (DotE 2014) as part of the Biodiversity Survey Report (Parsons Brinckerhoff 2015a). The assessment produced a habitat score of 3/10 and concluded that the area did not contain habitat critical to the survival of the species.	Low Species was not identified during targeted surveys and no recent local records. Impacts to potential habitat will be suitably offset as part of the BOS.
Chalinolobus dwyeri	Large-eared Pied Bat	V	Moderate	Not recorded during surveys. No identified roosting areas although considered to use the indicative construction footprint from time to time for foraging purposes.	Low Not recorded during targeted surveys in the construction footprint. Impacts to potential habitat will be suitably offset as part of the BOS.

Note: 1 Parsons Brinckerhoff, 2015a

2 Taken from EPBC Referral (GHD, 2015)

5.1.7 Migratory species

Three migratory species listed under the EPBC Act were recorded within the study area and a further four migratory bird species listed under the EPBC Act are considered to have a moderate likelihood of occurring on an occasional or transient basis in response to favourable conditions within the study area (Table 5-3).

The Rufous Fantail (*Rhipidura rufifrons*) and Black-faced Monarch (*Monarcha melanopsis*) were both recorded in the study area during surveys and both use breeding territories in wet forests similar to those located within the study area. These two species could potentially use the site for breeding and foraging purposes.

The Cattle Egret (*Area ibis*) was recorded in the study area during surveys and is known to roost at the Shortland Wetlands to the north of the site. The species is likely to visit the disturbed areas of the study area in association with the presence of horses that are kept nearby.

Table 5-3 Migratory listed species likely to occur within the study area

Scientific name	Common name	Likelihood of occurrence [1]
Apus pacificus	Fork-tailed Swift	Moderate
Hirundapus caudacutus	White-throated Needletail	Moderate
Merops ornatus	Rainbow Bee-eater	Moderate
Myiagra cyanoleuca	Satin Flycatcher	Moderate

Note: 1 Parsons Brinckerhoff (2015a)

5.1.8 Other matters of MNES

The nationally and internationally important Hunter Estuary Wetlands Ramsar site (site 24) is located downstream of the project and has potential for impact, as identified by the project's SEARs and the EPBC protected matters search (Appendix D), The Hunter Estuary Wetlands Ramsar site occurs about 6 kilometres downstream of the project and comprises two components, the Shortland Wetlands Centre and the north-eastern portion of the Hunter Estuary Wetlands National Park (formerly known as Kooragang Nature Reserve). Ironbark Creek, which has tributaries within the study area, flows directly through the Shortland Wetlands Centre and into the Hunter River which supports the Ramsar site.

The project would not result in any direct impacts on these wetlands, and with the implementation of appropriate management measures during construction and operation, it is considered unlikely there would be any significant indirect impacts to these wetlands (Sections 5.1.3, 8.3.1 and 8.4.5).

5.2 Measures to avoid or reduce impacts

The project has been subject to a number of route selection and environmental assessment studies since the project was first planned in the 1950's. This has included the development and refinement of the concept design that considered a range of criteria, including minimisation of environmental, heritage and social impacts. For more detail on impact avoidance and minimisation (Section 7).

The key measures that have been and will be implemented to avoid or reduce impacts are summarised in the following sections.

5.2.1 Avoiding and minimising impacts during design

Potential impacts of the project on biodiversity values have been avoided or minimised as far as practicable and feasible through the route selection and refinements processes. Conservation of biological diversity was identified as a key issue during the previous route selection study (2007) and current refined strategic design and concept design processes. Avoidance through design is provided in detail in Section 7.

5.2.2 Mitigating Impacts

Where ecological impacts cannot be avoided or minimised through design, additional mitigation measures will be developed and are detailed in Section 9. These will then be implemented as part of a construction environmental management plan (CEMP). The CEMP, which will be part of the contract between Roads and Maritime and the construction contractor, would include the following sections related to protection of MNES:

- Staff induction and environmental awareness training.
- Staff roles and responsibilities relative to environmental activities, reporting and compliance.
- A series of management actions to address issues such as sediment and erosion control, noise and dust.
- Environmental design features which stipulate mitigation attributes related to issues such as nearby habitat protection and fauna crossings.
- Measures to minimise impacts on relevant MNES.

In relation to biodiversity measures, the CEMP, subject to the findings of the EIS, could include the following:

- Pre-clearing and clearing procedures to reduce impacts on flora and fauna.
- Protection of in-situ threatened flora populations.
- Translocation of threatened plants (if required).
- Measures to maintain habitat connectivity and fauna movements.
- Management of weeds and diseases.
- Measures to restore habitat features (compensatory habitat).
- Landscape rehabilitation.
- Management of water and soils.

5.2.3 Offsetting unavoidable impacts

Unavoidable impacts to biodiversity have been assessed and quantified in accordance with the NSW FBA. A Biodiversity Offset Strategy has been prepared for the project which includes an assessment of any required offsets, particularly offsetting impacts to MNES, in accordance with the FBA (OEH 2014a) and the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014b) (Appendix B).

5.3 Impacts on matters of national environmental significance

This section provides a summary of the project's potential impacts on MNES.

The project would result in the clearing of about 39.2 hectares of native vegetation that contains known and potential habitat for EPBC Act listed biota. About 39.2 hectares of known habitat for the vulnerable Black-eyed Susan (*Tetratheca juncea*) (comprising about 846 plant clumps) and foraging habitat for migratory bird species and the vulnerable listed Grey-headed Flying-fox (*Pteropus poliocephalus*) would be removed by the project. The Hunter Estuary Wetlands Ramsar site which occurs about six kilometres downstream of the construction footprint is unlikely to be impacted by the project. A detailed assessment of project impacts on MNES is provided in Section 9.

6. Summary of biodiversity values

6.1 Biodiversity values assessed under the FBA

This section provides a summary of the biodiversity values that occur within the construction footprint and that have been assessed under the FBA. Table 6-1 lists all species and communities assessed under the FBA, this includes the total direct and indirect impact areas as discussed in section 8.2.1. This includes all species with a moderate to high likelihood of occurrence post-targeted surveys (Section 4.3), presumed present, or that have been recorded during the surveys (Section 4.3). Absence of identified predicted species from the construction footprint was determined by targeted surveys (Section 4.2).

Table 6-1 Summary of biodiversity values assessed under the FBA

Biodiversity value	Species credit species or ecosystem credit species	Identification method (assumed, recorded, expert report)	Area (ha) habitat (indirect and direct impact areas)/individuals in construction footprint
Flora			
Black-eyed Susan (*Tetratheca juncea*)	Species credit species	Recorded [1]	46.2 ha/846 clumps [3]
Fauna			
Little Lorikeet (*Glossopsitta pusilla*)	Ecosystem credit species	Recorded [1]	46.2 ha
Eastern Freetail-bat (*Mormopterus norfolkensis*)	Ecosystem credit species	Recorded [2]	46.2 ha
Powerful Owl (*Ninox strenua*)	Ecosystem credit species	Recorded [1]	46.2 ha
Squirrel Glider (*Petaurus norfolcensis*)	Ecosystem credit species	Recorded [2]	46.2 ha
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	Ecosystem credit species	Recorded [2]	46.2 ha
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	Ecosystem credit species	Recorded [2]	46.2 ha
PCTs			
HU833 - Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Ecosystem credit	Recorded [1]	19.1 ha
HU782 - Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Ecosystem credit	Recorded [1]	4.8 ha
HU806 - Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter (EEC)	Ecosystem credit	Recorded [1]	5.1 ha
HU803 - Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	Ecosystem credit	Recorded [1]	15 ha
HU841 - Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Ecosystem credit	Recorded [2]	2.2 ha

Notes:
1 Parsons Brinckerhoff, 2015a (Appendix C)
2. Identified during previous surveys by Umwelt Environmental Consultants (2006)
3. Directly impacted within the construction footprint

6.2 Biodiversity values outside the FBA

This section provides a summary of the biodiversity values that occur in the construction footprint and have not been assessed under the FBA. This includes species, populations, and communities that have been recorded or presumed to be present, listed under the FM Act, TSC Act and EPBC Act.

Table 6-2 Summary of biodiversity values outside the FBA

Biodiversity value	Presence in study area and identification method.	Area (ha) habitat (indirect and direct impact areas)
Migratory species	Three migratory species have been recorded within the study area during surveys and an additional four species have potential habitat within the study area.	About 46.2 ha of potential foraging habitat for Migratory species.
Groundwater dependent ecosystems (GDEs)	Three GDEs were recorded within the study area during surveys (Parsons Brinkerhoff 2015a) Only one intermittent GDE occurs within the construction footprint.	About 4.4 ha of Sydney Blue Gum – White Mahogany shrubby tall open forest GDE forest (both the *Syncarpia glomulifera* and atypical variants)
Little Bent-wing Bat (*Miniopterus australis*)	Recorded [1]	46.2 ha of foraging habitat
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	Recorded [1]	46.2 ha of foraging habitat
Grey-headed Flying-fox (*Peteropus poliocephalus*)	Recorded [1]	46.2 ha of critical foraging habitat for an important population

Note: 1 Parsons Brinckerhoff, 2015a (Appendix C)

7. Avoid and minimise impacts

7.1 Impact avoidance

The project is a regionally significant road infrastructure project in an area which has been conserved since the 1950's for the purpose of an inner city bypass for Newcastle. The area is surrounded by residential and commercial infrastructure (mostly associated with the John Hunter Hospital precinct). Most of the construction footprint occurs on undisturbed lands in moderate condition with some existing impacts from nearby land uses, such as weeds, dog walking, noise and light spill. A portion of the project would also occur on lands previously disturbed by existing road infrastructure and residential activities.

In 2007, a strategic design for the project was displayed for community comment, with the finalised the preferred route corridor reserved in the Newcastle local environmental plan.

Roads and Maritime has carried out a comprehensive review of the 2007 strategic design and as a result the preferred route corridor for the project has been substantially realigned and the design further refined during the concept design phase in order to avoid sensitive ecological constraints such as threatened ecological communities and threatened species as far as possible. A fauna connectivity strategy has also been developed and will be implemented as part of the project to reduce potential impacts to biota (refer Section 7.3).

Detailed targeted surveys have been carried out in the study area to determine the presence, absence and/or extent of threatened species and communities and their associated habitat. Results of the field survey were used to identify ecological constraints within the construction footprint. This information was used during the route alignment selection and concept design phase of the project, to modify the design to avoid and reduce impacts on areas of high ecological constraint, including identified areas of EEC and threatened biota. The significant design changes made for the project in relation to avoidance of sensitive ecological areas are outlined in the following sections and shown in Figure 7-1.

In summary, the modifications made to the project construction footprint design and the associated ecological benefits include the following:

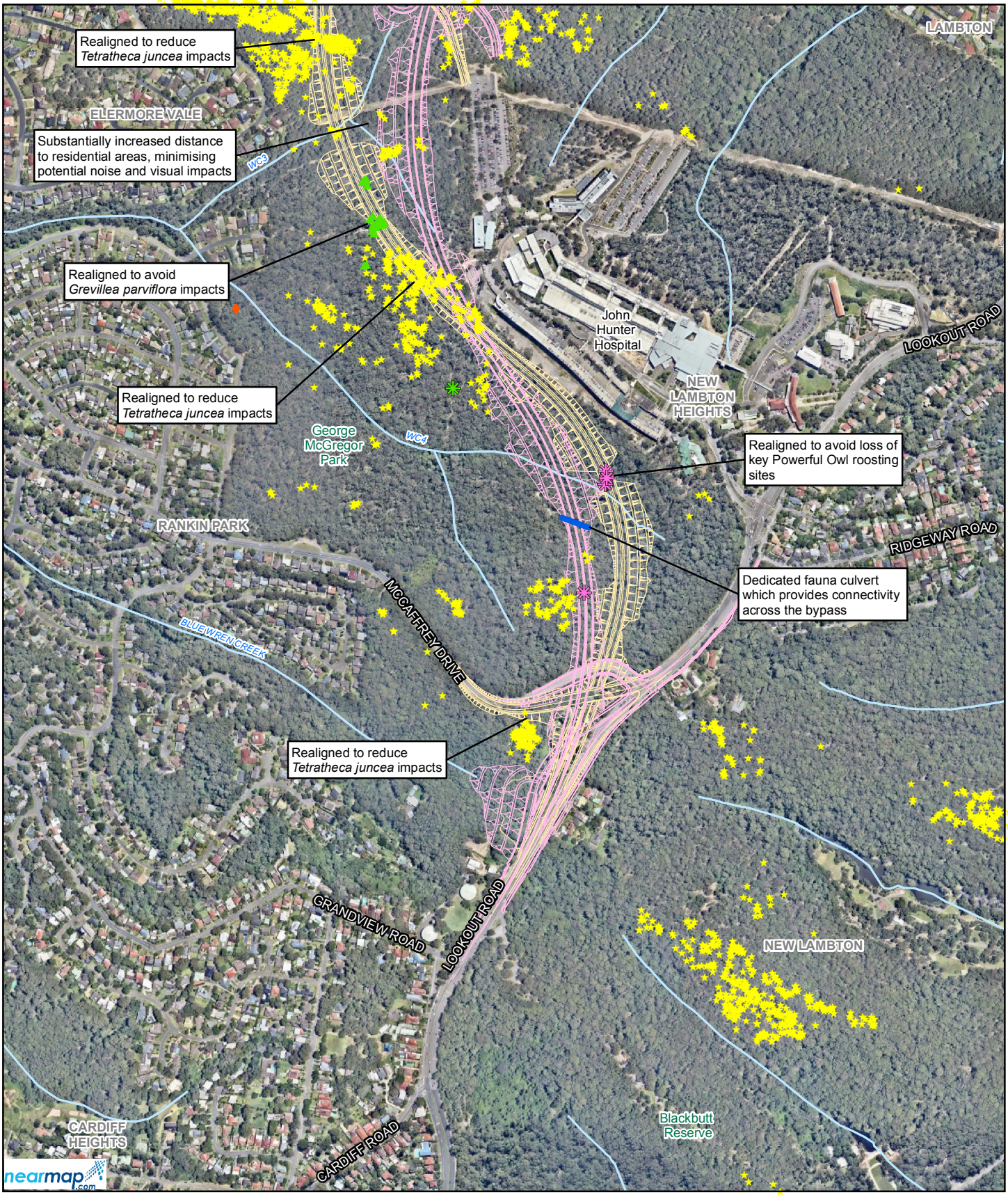
- The project was realigned to:
  - Minimise the loss of key Powerful Owl breeding trees and identified roost trees.
  - Reduce impacts on identified populations of Black-eyed Susan, the 2007 strategic design impacted an additional 112 clumps.
  - Avoid impacts on identified threatened flora species Small Flower Grevillea *(Grevillea parviflora* subsp*. Parviflora*) and Magenta Lilly Pilly *(Syzygium paniculatum*).
  - Reduce impacts on Lower Hunter Spotted Gum Ironbark Forest EEC.
  - Retain a wider vegetation corridor west of the alignment to improve connectivity.
- The realignment of the project to the east of the 2007 strategic design allows for retention of a wider vegetated corridor on the western side of the alignment, which improves connectivity of vegetation and associated habitat and increases the viability of segregated populations.
- The overall construction footprint has been minimised wherever possible to minimise disturbance to existing vegetation and maximise retention of remnant vegetation.
- A bridge has been included instead of fill to span the northern Dark Creek tributary and provide connectivity across the alignment.

- The southern interchange was modified and realigned to retain a large sub-population of Black-eyed Susan *(Tetratheca juncea*).
- Construction access tracks and construction compounds have been located as close as possible to the final road formation and have used existing or future fire trails where possible to minimise disturbance

A detailed fauna connectivity strategy has been developed for the project to maintain terrestrial and arboreal connectivity across the alignment which is detailed in Section 7.3 and Figure 7-2. The fauna connectivity strategy details the proposed locations and types of fauna-friendly infrastructure along the alignment such as glider pole and rope crossings, fauna culvert and fencing.

7.2 Impact mitigation

Recommended mitigation measures provided in Section 9 of this report have been developed to minimise the impact of the project on native flora, fauna and ecological processes within the study area. These measures would be incorporated into a CEMP for the project to mitigate unavoidable and residual impacts and would include the preparation of a detailed site-specific flora and fauna management plan.



LEGEND

- Concept design
- 2007 strategic design
- Watercourse
- Dedicated fauna culvert
- Powerful Owl nest tree
- Powerful Owl roost tree

Threatened Flora Species

- *Grevillea parviflora*
- *Syzygium paniculatum*
- *Tetratheca juncea*

Sheet layout

Paper Size A4

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

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Impact avoidance through concept design sheet 1 of 2

Figure 7-1a

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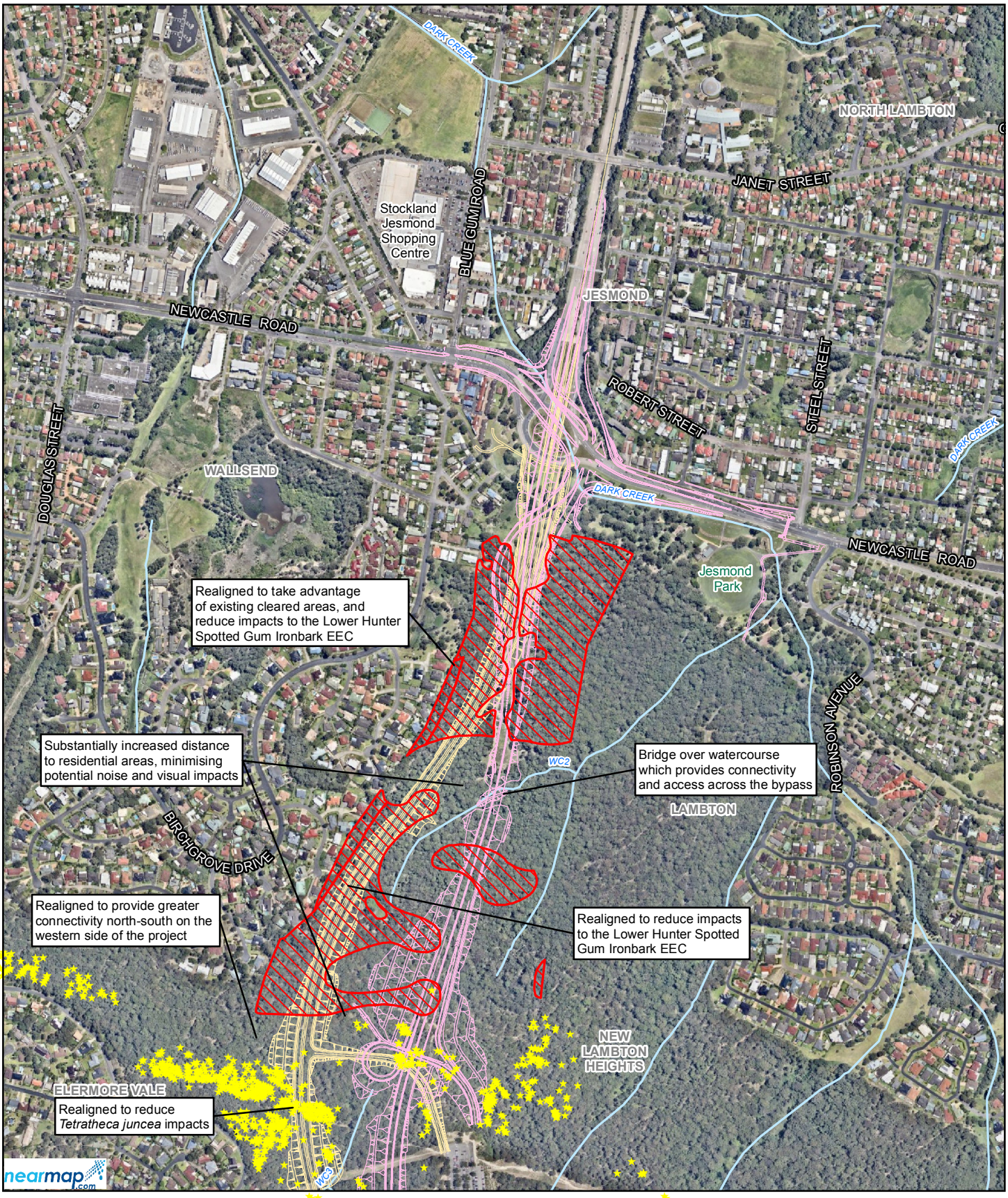
Data source: BELL: EEC 2015; Aurecon: Construction Corridor / Design, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012; PB: Study area / Threatened Species, 2015. Created by: tmorton, fmackay



LEGEND

- Concept design
- 2007 strategic design
- Watercourse
- Endangered Ecological Community (NSW TSC Act) (Lower Hunter Spotted Gum Ironbark Forest)

Threatened Flora Species

- *Tetratheca juncea*

Sheet layout

Paper Size A4

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Impact avoidance through concept design sheet 2 of 2

Figure 7-1b

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Data source: BELL: EEC 2015; Aurecon: Construction Corridor / Design, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012; PB: Study area / Threatened Species, 2015. Created by: tmorton, fmackay

7.3 Fauna connectivity strategy

The project would result in clearing of vegetation and fragmentation of fauna habitats. The project would largely bisect an existing large patch of remnant vegetation. Threatened fauna species, such as the Squirrel Glider (*Petaurus norfolcensis*), are likely to utilise the entirety of the study area for foraging and roosting and consequently require good habitat connectivity within the study area.

A fauna connectivity strategy has been designed to allow terrestrial and arboreal fauna to cross the alignment. This locations of fauna infrastructure is detailed on Figure 7-2 and include:

- One dedicated fauna culvert of appropriate size and dimension (three by three metres) for terrestrial fauna, including macropods, with fauna fencing and fauna 'furniture'.
- A bridge designed to allow for incidental fauna passage beneath the bridge span.
- Rope bridges for arboreal fauna erected at two separate locations along the alignment.
- Fencing to guide fauna to the crossing infrastructure. The fencing will be erected as close as possible to the final road formation to maximise available habitat for fauna and include fauna escape points.

7.3.1 Fauna crossing infrastructure

Generally, a combination of fauna crossing infrastructure has been found effective for linear infrastructure projects such as roads (Biosis 2012). Fauna underpasses have been found to work well for terrestrial mammal species such as dasyurids, macropods, rodents and bandicoots, reptiles and amphibians (Bond and Jones 2008). Monitoring of rope bridges has shown that a range of possum species will utilise these structures (Goosem et al. 2005). Fauna fencing, can be utilised to funnel animals toward underpasses and has been found to be extremely effective in preventing most road-kill (Bond and Jones 2008).

The effectiveness and useability of crossing infrastructure by fauna is dependent on factors such as the target fauna species, local environment, size and length of the crossing and proximity to habitat (Biosis 2012). The type and positioning of fauna crossing infrastructure was determined based on known existing and future constraints such as width of the final disturbance corridor, overhead electrical wiring and estimated extent of future development. This was specifically relevant to proposed arboreal crossings near the hospital interchange, which were determined unfeasible given the current constraints of the existing John Hunter Hospital carpark, the final disturbance footprint of the project and likely development extent of the John Hunter Hospital precinct.

This was also relevant to the investigation of the feasibility of an opportunistic arboreal crossing across Lookout Road to Blackbutt Reserve, where existing electrical infrastructure posed a considerable constraint to the success of arboreal fauna crossing infrastructure. Consequently, fauna crossing infrastructure has been positioned in areas considered likely to be utilised by target fauna species (Figure 7-2).

Underpasses

Underpasses can be either constructed solely for the purpose of fauna movements or can be modified from existing structures such as box culverts. Suitability of the structures as fauna underpasses depends on a number of factors (Biosis 2012), including:

- The regional continuity of habitat in the area.
- Habitat directly on either side of the structure.
- Proximity to vegetation cover either side of the structure.

- Unimpeded view of habitat on the other side of the structure.
- Road width, traffic volume and associated noise.
- The dimensions of the structure (width, height and length).
- The target species.

Ideally, fauna crossing structures should be located where regular crossing and/or migration pathways are identified (Veage and Jones 2007). Structures such as exclusion fences and fauna 'furniture' can also increase the effectiveness of underpasses (Bond and Jones 2008, Goosem *et al*. 2005).

The proposed fauna dedicated culvert has been designed purely for the function of providing fauna connectivity under the alignment and has been designed of an appropriate grade and dimension to accommodate use by a range of terrestrial fauna, particularly for macropods (eg Swamp Wallaby) and dasyurids (eg Spotted-tailed Quoll). The culvert would be of a maximum grade of eight per cent. The culvert would be located within a naturally sloped terrain which is not expected to hinder fauna usage. Culvert dimensions are three by three metres which would accommodate larger terrestrial fauna such as macropods. The length of the dedicated fauna culvert would be about 50-60 metres which is considered suitable for fauna usage.

The bridge crossing over the northern tributary of Dark Creek indicated on Figure 7-2 would provide a suitable site for incidental fauna movements across the alignment. This bridge is of sufficient length (about 100 metres) to allow for unrestricted and dry fauna passage through the creek line and vegetation underneath the bridge span. Fauna fencing would also be installed to guide fauna movements underneath the bridge span.

Rope bridges

Aerial overpasses (rope/canopy bridges) have been recommended for Australian roads (Goosem and March 1997, QDMR 2000). These may comprise simple rope bridges, rope 'ladders' or more elaborate tunnel-like structures which span the full width of the road. Recent studies have found that arboreal mammals will use all types of rope bridges however they tend to cross tunnel-like structures across the top surface (Goosem *et al.* 2005 and Bax 2006). Rope bridges would be installed across the alignment at two locations (Figure 7-2 for indicative locations). The final locations of rope bridges would be determined during detailed design through an on-site assessment by an ecologist. Rope bridge target species include arboreal mammal species, including the Squirrel Glider (*Petaurus norfolcensis*), Sugar Glider (*Petaurus breviceps*) and Brushtail Possum (*Trichosurus vulpecula).*

LEGEND

- Design
- Pavement
- Bridge
- Earthworks cut
- Earthworks fill
- Permanent fencing
- Dedicated fauna culvert
- Arboreal crossing (rope bridge)
- Fauna escape point
- Potential noise barrier

Sheet layout

Paper Size A4

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Indicative fauna connectivity structures - sheet 1 of 2

Figure 7-2a

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G:\22\17656\GIS\Maps\Deliverables\BiodiversityAssessment\2217656_BA013_FaunaConectivity_DDP_0.mxd

Data source: Aurecon: Design / cycleways, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton

LEGEND

- Design
- Pavement
- Bridge
- Earthworks cut
- Earthworks fill
- Permanent fencing
- Arboreal crossing (rope bridge)
- Terrestrial fauna corridor access under bridge
- Fauna escape point
- Potential noise barrier

Sheet layout

Paper Size A4

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
Biodiversity Assessment Report

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Indicative fauna connectivity structures - sheet 2 of 2

Figure 7-2b

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Data source: Aurecon: Design / cycleways, 2016; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton

8. Impact assessment

8.1 Areas not requiring assessment

In accordance with the FBA an assessor is not required to assess areas in a project site without native vegetation unless the SEARs for the project specifically require it.

In the northern section of the construction footprint, vegetated areas associated with Jesmond Park occur as planted native vegetation (canopy only) with an exotic understorey. This area was found to contain a combination of remnant and planted tree species, unlikely to self-propagate, and was not found to constitute a native vegetation community. Furthermore, this community was assumed to have a site value score less than the benchmark value (less than 17) as it exists as paddock trees only with an introduced grass groundcover and, as such, would not likely comprise native vegetation or threatened species habitat according to the FBA. Consequently, impacts associated with this PCT are not required to be offset in accordance with Table 4 of the FBA (OEH 2014b), and consequently only one plot was sampled within the vegetation type (Figure 3-1).

Table 8-1 provides a summary of the direct and indirect impact areas not requiring assessment, which do not meet the requirements for BBCC assessment.

Table 8-1 Impacts to areas not requiring assessment

Plant Community	TSC Act Status	EPBC Act Status	Direct impact area (ha)	Indirect impact area (ha)
Remnant and planted native trees	Not listed	Not listed	0.7	0.1
Exotic vegetation and planted trees	Not listed	Not listed	10.2	0.9
TOTAL			**10.9**	**1.0**

All native vegetation within the construction footprint was in moderate/good condition and determined to have a site value score at or above benchmark (equal to or greater than 17). Therefore, in accordance with Table 4 of the FBA, all areas mapped as native vegetation within the project construction footprint require offsetting. This is the trigger for completing the credit impact calculations in accordance with section 9.3.1.1(c) of the FBA (OEH 2014b).

8.2 Areas requiring assessment

An overview of the areas requiring assessment is provided in Figure 8-1.

8.2.1 Removal of native vegetation

The project would require the clearing of about 39.2 hectares of native vegetation, of which about 4.1 hectares is an EEC listed under the TSC Act (worst case estimate) (Table 8-2). Vegetation clearing would involve removal of a moderately diverse range of non-threatened native plants, including mature trees, as well as potential habitat for threatened biota. The extent of proposed clearing within each vegetation community is summarised in Table 8-2.

Table 8-2 Direct impacts to native vegetation

PCT code	Plant Community	TSC Act Status	EPBC Act Status	Condition	Area Impacted (ha)	Per cent cleared in CMA
HU833	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Not listed	Not listed	Moderate/Good	16.8	45%
HU782	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Not listed	Not listed	Moderate/Good	4.4	40%
HU806	Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion	Not listed	Moderate/Good	4.1	44%
HU803	Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	Not listed	Not listed	Moderate/Good	12	71%
HU841	Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Not listed	Not listed	Moderate/Good	1.9	9%
TOTAL					**39.2**	

Clearing of native vegetation is listed as a key threatening process (KTP) under both the NSW TSC Act and the Commonwealth EPBC Act. Under the TSC Act, native vegetation is made up of plant communities, comprising primarily indigenous species. Clearing is defined as the destruction of a sufficient proportion of one or more strata layers within a stand or stands of native vegetation so as to result in the loss, or long-term modification of the structure, composition and ecological function of a stand or stands (NSW Scientific Committee 2001). There would be a total of about 39.2 hectares of native vegetation cleared for construction of the project, including about 4.1 hectares of EEC listed under the TSC Act (Table 8-2). Indirect impacts which may result from the project are described in detail in the following sections.

Indirect impacts

It is anticipated that the project would result in indirect impacts such as noise, lighting and vibration to habitats within 20 metres of the construction footprint, reducing the suitability of this habitat for flora and fauna species. The FBA requires indirect impacts to be quantified in terms of biodiversity credits and considered in the overall calculation of offsets required to compensate for the impacts of the project.

There are two options available to assess such impacts in the credit calculator. The first involves entering an impact area of 20 metres surrounding the construction footprint and entering the impact as 'partially cleared'. The second is to enter an impact area of 10 metres surrounding the construction footprint and entering the impact as totally cleared. Both approaches end up estimating about the same credit requirements with the second option being easier to complete in the credit calculator.

Consequently, the project's impacts have been assessed by inclusion of a 10 metre disturbance buffer (assuming total clearing within the 10 metre buffer to compensate for an estimated 20 metre indirect impact area) surrounding the project construction footprint as part of the credit impact calculations (refer Appendix E). The inclusion of a 10 metre disturbance buffer to account for indirect impacts associated with the project has resulted in an additional seven hectares of native vegetation being included in the BioBanking impact calculations as detailed in Table 8-3.

Table 8-3 Indirect impacts to native vegetation

PCT code	Plant Community	TSC Act Status	EPBC Act Status	Condition	Area indirectly impacted (ha)
HU833	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Not listed	Not listed	Moderate/Good	2.3
HU782	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Not listed	Not listed	Moderate/Good	0.4
HU806	Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	Listed as EEC (Lower Hunter Spotted Gum Ironbark Forest)	Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin	Moderate/Good	1.0

PCT code	Plant Community	TSC Act Status	EPBC Act Status	Condition	Area indirectly impacted (ha)
			Bioregion		
HU803	Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	Not listed	Not listed	Moderate/Good	3.0
HU841	Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Not listed	Not listed	Moderate/Good	0.3
TOTAL					**7.0**

There are likely to be ongoing impacts on fauna utilising nearby areas of habitat associated with noise, light and other road corridor disturbance, although existing major road corridors currently impact parts of the study area and resident fauna are likely to be adapted to these disturbances.

Total area assessed

The total vegetation clearing extent for the project assessed under the FBA includes the direct (39.2 hectares) and indirect impact areas (7 hectares), totalling 46.2 hectares, which has been assessed in the BBCC.

8.2.2 Removal of threatened fauna species habitat and habitat features

The project would remove about 50.1 hectares of vegetation comprising about 39.2 hectares of native vegetation and associated habitat, which provides foraging and sheltering habitat for several EPBC Act and TSC Act listed fauna species. The project would also remove a portion of an identified local area biodiversity corridor. A summary of impacts on threatened species is provided in Table 8-5.

These impacts have been avoided and minimised where possible, and residual impacts will be offset.

Terrestrial fauna

The proposed clearing of habitat has potential to have impacts on local fauna populations within the study area, including displacement or mortality of individuals and removal of habitat resources within the construction footprint.

Large hollows in the study area provide suitable roosting and breeding habitat for birds and arboreal mammals. The project would remove canopy species which contain a range of hollows suitable for habitation by arboreal fauna, including known roosting habitat for the TSC Act and EPBC Act threatened Powerful Owl (*Ninox strenua*). Although the design has been realigned to avoid and reduce the loss of key Powerful Owl roosting and breeding sites, about 320 hollow-bearing trees and 17 potential Powerful Owl breeding/roost trees would be removed by the project. Additionally, a total of five known Powerful Owl roost trees would be cleared as part of the project (Parsons Brinckerhoff, 2015a).

The Powerful Owl is known to occupy a large home range (up to 4000 hectares per breeding pair) and the breeding pair identified is likely to utilise the study area as part of a larger home range (OEH 2015). The species are also highly mobile and will travel long distances to forage. The project is unlikely to significantly impact the identified breeding pair of Powerful Owls in the study area given the availability and persistence of similar habitat in the region.

The project would also remove a range of flora species such as Spotted Gum (*Corymbia maculata*) and Fergusons Ironbark (*Eucalyptus fergusonii*) which provide winter-flowering foraging resources for the Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Anthochaera phrygia*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Squirrel Glider (*Petaurus norfolcensis*) (Parsons Brinckerhoff 2015a). Red Bloodwood (*Corymbia gummifera*) is also an important feed tree for nectarivorous fauna during the autumn period. The project will also remove a variety of canopy species in the Myrtaceae family and understorey plants, including a high abundance of proteaceous shrubs that produce nectar and pollen for gliders were identified within the construction footprint.

A range of other fauna microhabitats will also be removed by the project, including fallen timber, leaf litter, loose rocks, and shrubby ground cover. These habitat attributes are likely to support a diverse range of ground dwelling fauna, including reptiles and small mammals. It is likely that arboreal mammals utilising these areas of habitat would also provide a source of prey for predatory species utilising the study area such as the Powerful Owl (*Ninox strenua*).

Known foraging habitat for threatened fauna species Grey-headed Flying-fox (*Pteropus poliocephalus*) and Squirrel Glider (*Petaurus norfolcensis)* occurs within the construction footprint and study area. The project would remove about 39.2 hectares of foraging and potential roosting habitat for these species. Mitigation measures outlined in Section 9 would mitigate impacts on these species by maintaining connectivity across the alignment as part of the fauna connectivity strategy (Section 7.3). Furthermore, given the available areas of alternative habitat which would remain within the study area after construction of the project completion, the project is unlikely to significantly impact habitat resources for arboreal and hollow-dependant fauna in the locality.

Large mobile terrestrial fauna that may occur within the site (eg Swamp Wallabies (*Wallabia bicolor*)) are likely to utilise habitats contained within the construction footprint. These species could readily evade injury and move into alternative habitats retained within the study area. Mitigation measures outlined in Section 9 will be implemented to reduce impacts to terrestrial fauna from the project, including the implementation of a fauna connectivity strategy to maintain connectivity for terrestrial fauna species across the alignment.

A number of widespread and common native reptiles have the potential to occupy habitats contained within the construction footprint. No threatened reptiles are likely to occur within the site. It is possible that individuals would be adversely affected during clearing, particularly those which burrow or shelter beneath woody debris. Mitigation measures outlined in Section 9 would partially ameliorate impacts on these species.

Aquatic fauna

No endangered aquatic communities, aquatic fauna or protected marine vegetation listed under the FM Act occur in the study area and no significant impacts on riparian vegetation or habitats downstream of the construction footprint are anticipated as a result of the project. There would be no impact on key fish habitat as defined by NSW DPI Fisheries (2013) as a result of the project.

Key threatening processes

A key threatening process (KTP) is defined under the TSC Act (DEC 2005) as an action, activity or proposal that:

- Adversely affects two or more threatened species, populations or ecological communities.
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

There are currently 38 KTPs listed under the TSC Act, 21 KTPs listed under the EPBC Act and eight listed under the FM Act. A number of KTPs are listed under more than one Act. Those relevant to this project are listed in Table 8-4. Mitigation measures to limit the impacts of these KTPs are discussed in Chapter 9.

Table 8-4 Key threatening processes of relevance to the project

Key Threatening Process	Status	Comment
Clearing of native vegetation	TSC Act EPBC Act	About 39.2 ha of native vegetation would be cleared for the project, including about 4.1 ha of the TSC Act listed Lower Hunter Spotted Gum Ironbark Forest EEC.
Clearing of hollow-bearing trees	TSC Act	About 320 hollow-bearing trees and 17 identified suitable and five known Powerful Owl hollow-bearing trees would be removed for the project.
Removal of dead wood and dead trees	TSC Act	The vegetation to be removed contains a low-moderate density of dead wood and dead trees similar to that in surrounding habitat to be retained, which would be retained within the study area. Mitigation measures are provided in Section 9 to limit the potential for impacts to native biota as a result of removal of dead wood and dead trees.
Invasion and establishment of exotic vines and scramblers	TSC Act	Vegetation within the study area has the potential to be invaded by exotic vines and scramblers. Vehicles and plant have the potential to introduce propagules of exotic vines and scramblers, as could soil disturbance during construction activities. The implementation of a weed management plan is recommended to limit the spread of weeds.
Invasion establishment and spread of *Lantana camara*	TSC Act	*Lantana camara* is already present within the construction footprint and has invaded areas of the study area. This KTP is likely to be exacerbated on-site without the implementation of weed management.
Invasion of plant communities by perennial exotic grasses	TSC Act	Parts of the study area have been subject to previous disturbances (including historical tramway, mining, shanty town, access tracks, walking, cycling and fire trails), and as a result, there are exotic weed species in the study area. Weeds may also be introduced due to an increase in edge areas as part of the construction of the road alignment. Vehicles and plant could further spread exotic grass species, as could soil disturbance during vegetation clearing and road construction. There is the potential for perennial exotic grasses to invade retained and nearby native vegetation through project activities. The implementation of a weed management plan would limit the spread of weeds.

Key Threatening Process	Status	Comment
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Road construction activities have the potential to introduce Myrtle Rust to the study area. Mitigation measures to reduce the potential for the introduction Myrtle Rust would be implemented.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC Act; EPBC Act	Road construction activities have the potential to introduce amphibian chytrid to the study area, which could lead to death of frogs and tadpoles. A flora and fauna management plan with specific measures to reduce the potential for the introduction chytrid fungus would be implemented.
Predation by the European Red Fox	TSC Act; EPBC Act	Evidence of foxes were observed in the study area. The project may lead to an increase in the incidence of this species by providing an increase in access routes through the study area.
Bushrock Removal	TSC Act	Construction activities would remove bushrock identified within the construction footprint. Habitat salvage would be carried out wherever possible to reduce impacts on bushrock inhabiting biota.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act	The road construction would impact three ephemeral creek lines in the study area, which vary from Class 1 to Class 2 waterways (Strahler method). These creek lines feed the waterways which flow to the Hunter Wetlands Ramsar site about six kilometres downstream of the construction footprint.
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act	The project would be constructed utilising primarily diesel powered machinery and plant. While all machinery would be operated and maintained in good operational working order to reduce emissions, the construction of the project would result in the emission of greenhouse gases and would incidentally contribute to climate change.

8.2.3 Removal of threatened plants

Flora

One TSC Act listed threatened flora species, Black-eyed Susan (*Tetratheca juncea*), will be removed for the project.

A large population of Black-eyed Susan (*Tetratheca juncea*) comprising five sub-populations totalling 10381 plant clumps was recorded within the threatened flora study area during targeted searches for the species (Parsons Brinckerhoff 2015a). The project would remove about 846 clumps of TSC Act Vulnerable listed Black-eyed Susan , representing about eight per cent of the population identified in the study area (Table 8-5).

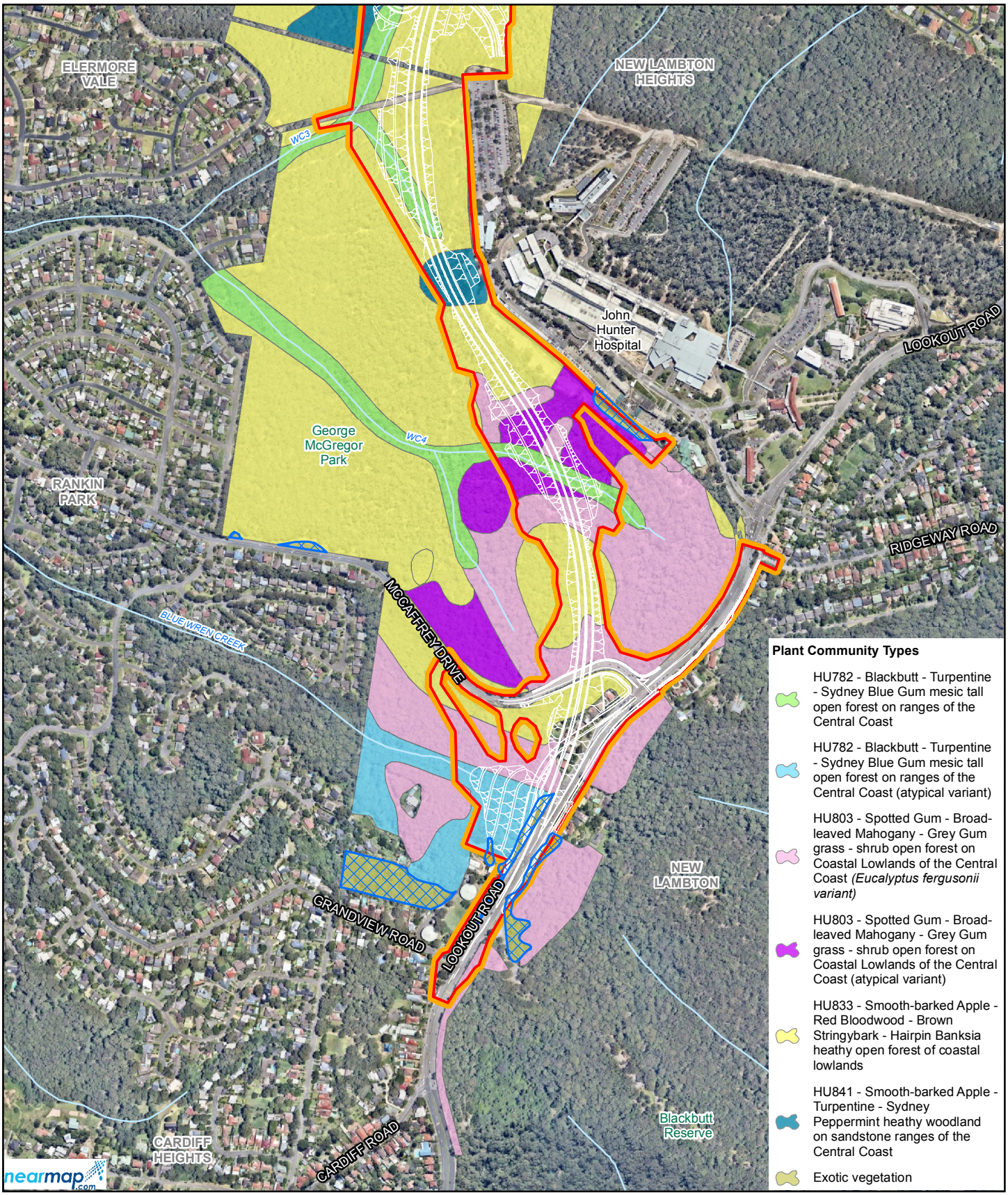
The largest subpopulation within the study area consists of about 8176 plant clumps. This population of Black-eyed Susan meets several of the criteria for an important population as set out by the *EPBC Act referral guidelines for the vulnerable black-eyed susan, Tetratheca juncea* (DSEWPaC 2011 and Parsons Brinkerhoff 2015).

Appropriate mitigation and management implementation of the Biodiversity Offset Strategy.

All other TSC Act listed flora species occur outside of the construction footprint and will not be impacted by the project.

Table 8-5 Summary of threatened species impacts

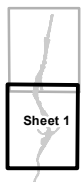
Threatened species	Ecosystem or species credit species	Status		Number of clumps to be impacted	Number of clumps in the study area
		TSC Act	EPBC Act		
Tetratheca juncea (Black-eyed Susan)	Species credit species	Vulnerable	Vulnerable	846	10,381



LEGEND

- Construction footprint
- Design
- Watercourse
- Areas not requiring assessment
- Indirect Impact Assessment Buffer (10 meters)

Sheet layout



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
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Areas requiring assessment
sheet 1 of 2

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Figure 8-1a

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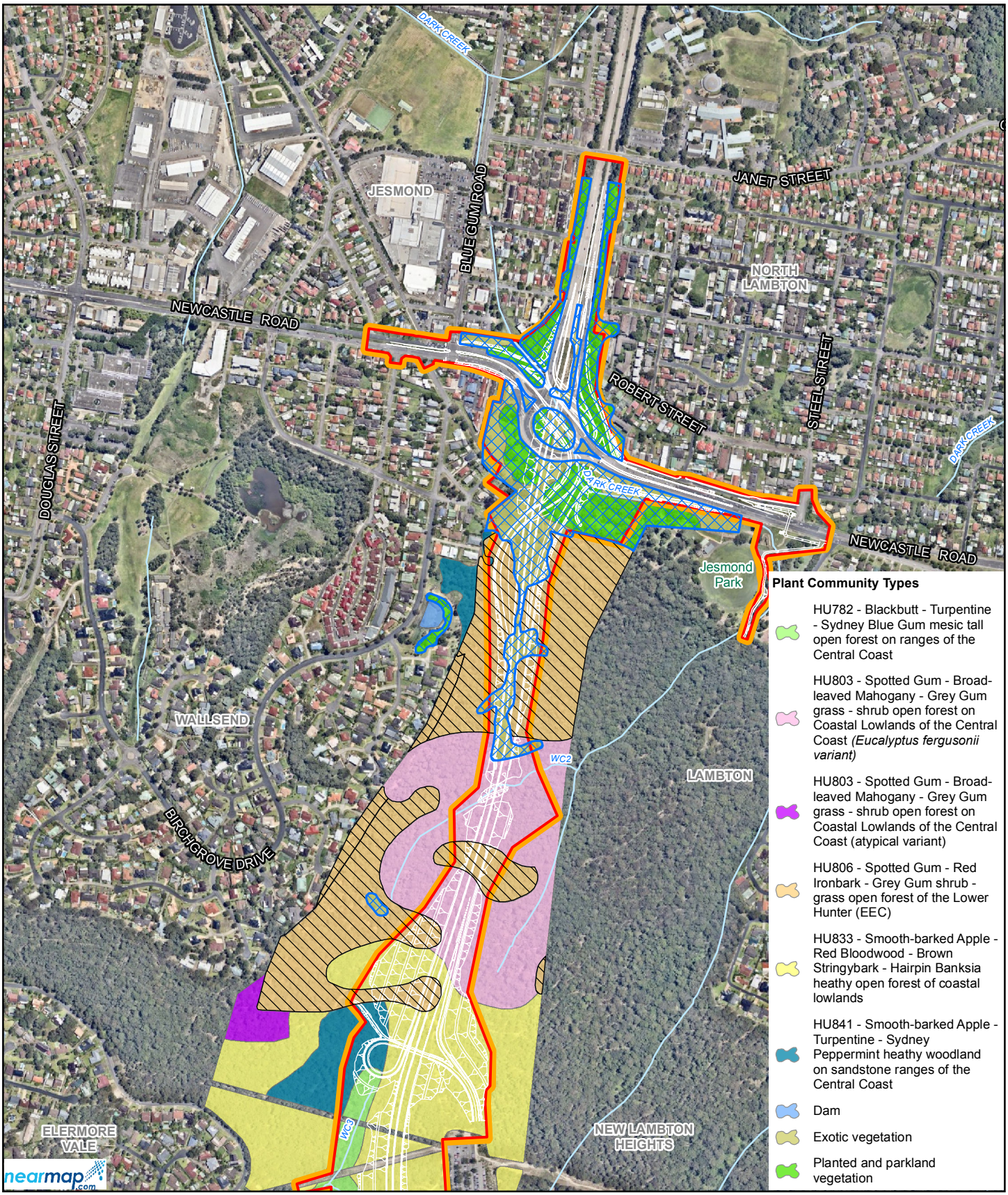
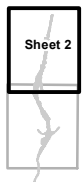
Data source: Aurecon: Construction footprint/ Design, 2016: PB: Vegetation Mapping / study area, 2015; BELL: EEC 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton, fmackay



LEGEND

- Construction footprint
- Design
- Watercourse
- Endangered Ecological Community (NSW TSC Act) (Lower Hunter Spotted Gum Ironbark Forest)
- Areas not requiring assessment
- Indirect Impact Assessment Buffer (10 meters)



Sheet layout

Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Rankin Park to Jesmond
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Areas requiring assessment
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Job Number	22-17656
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Figure 8-1b

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Data source: Aurecon: Construction footprint/ Design, 2016: PB: Vegetation Mapping / study area, 2015; BELL: EEC 2015; Nearmap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: tmorton, fmackay

8.3 Matters for further consideration

Certain impacts on biodiversity values of a major project require further consideration by the consent authority. These are impacts that are particularly complicated or severe. A decision will be made by the consent authority on whether it is appropriate for these impacts to occur or whether modifications to the major project are required to avoid or minimise the impact.

In accordance with Section 9.2.1.3 of the FBA (OEH, 2014b), impacts that require further consideration include:

- Significant impacts on landscape features.
- Impacts on native vegetation, including impacts on Critically Endangered Ecological Communities (CEECs) or EECs that are likely to significantly affect the persistence or viability of an EEC.
- Impacts on critical habitat or on threatened species that are likely to significantly affect the persistence or viability of a population of a threatened species that has not previously been recorded in the IBRA subregion (Section 9.2.5.1 of the FBA, OEH 2014b).

A discussion of impacts that require further consideration in accordance with these criteria for the project are detailed in the following sections.

The SEARs contained the following specific matters for consideration:

- Impacts on landscape values and biodiversity, including threatened species, populations and communities.
- *Corybas dowlingii* (Red Helmeted Orchid) – suitable targeted surveys during flowering periods within the study area.
- Lower Hunter Spotted Gum Ironbark in the Sydney Basin Bioregion EEC – additional surveys for confirmation of presence in the study area.
- Impacts to OEH estates including downstream estates (the Hunter Estuary Wetlands).

Supplementary SEARs were provided for the project on 19 November 2015. The supplementary SEARs are required to be addressed in conjunction with the original project SEARs issued on 3 March 2015. The project's supplementary SEARs provide the following additional matters for further consideration for the project:

- Identification and assessment of potential impact to:
  - Black-eyed Susan (*Tetratheca juncea*).
  - Grey-headed Flying-fox (*Pteropus poliocephalus*).
  - Leafless Tongue-orchid (*Cryptostylis hunteriana*).
  - Newcastle Doubletail (*Diuris praecox*).
  - The Hunter Estuary Wetlands Ramsar site.

8.3.1 Landscape features

Matters that are for further consideration include:

- Impacts that will substantially reduce the width of vegetation in the riparian buffer zone bordering rivers and streams fourth order or greater.
- Impacts to state biodiversity links.
- Impacts on important wetlands and their buffers.
- Impacts in the buffer zone along estuaries.

The only landscape feature for further consideration applicable to the project is in relation to important wetlands, and is detailed in the following sections.

Impacts on important wetlands

The Hunter Estuary Wetlands (Ramsar listed wetland) was identified as an important wetland for further consideration and is considered in this section.

a. **Category of wetland that is being impacted by the project**

The nationally important Hunter Estuary Wetlands occur about six kilometres downstream of the project. A portion of the site (Shortland Wetlands Centre and former Kooragang Nature Reserve) is listed as a Ramsar site of international importance and a SEPP 14 listed wetland, currently managed by the NSW National Parks and Wildlife Service.

b. **Is the wetland itself, and/or its buffer area, being impacted?**

The wetland occurs about six kilometres downstream of the project. The buffer area for important wetlands is 50 metres, in accordance with Appendix 2 of the FBA. Neither the wetland itself nor its buffer area would be directly impacted by the project.

c. **Extent of impact to the wetland and buffer area**

There would be no impact to the wetland nor its buffer area as part of the project.

d. **Condition of the area of wetland or buffer area subject to impact**

There would be no impact to the wetland nor its buffer area as part of the project.

e. **Indirect impacts on wetlands, or on wetlands or watercourses downstream of the project**

The northern portion of the project construction footprint connects to Dark Creek which flows through an urban and rural landscape and enters Ironbark Creek which feeds the Shortland Wetlands Centre Australia about 4 km downstream of the project and the Hunter Estuary Wetlands Ramsar site (about six kilometres downstream) via the Hunter River. The southern portion of the construction footprint drains through a similar landscape to the west via tributaries to Ironbark Creek.

The project would result in the removal of about 39.2 hectares of native vegetation and replacement of some of this area with an impermeable surface, about six kilometres upstream of the Hunter Estuary Wetlands Ramsar site. A water quality assessment prepared for the project by GHD (2016) determined that the project is unlikely to result in significant impacts to groundwater, surface water, groundwater dependent ecosystems or sensitive downstream receivers, including Ramsar wetlands (GHD 2016).

f. **Measures proposed to minimise the impact on the biodiversity values of the wetland area.**

With the implementation of appropriate management measures during construction and operation it is considered unlikely there would be any significant indirect impacts to Ramsar wetland as a result of the project.

This is supported by water quality studies carried out for the project and detailed in Section 5.1.3 and Section 8.4.5.

8.3.2 Native vegetation

Lower Hunter Spotted Gum Ironbark Forest EEC

Lower Hunter Spotted Gum Ironbark Forest EEC was identified as a matter for further consideration.

a. **Area and condition of the EEC to be impacted by the project.**

About 4.1 hectares of moderate/good condition Lower Hunter Spotted Gum Ironbark Forest EEC would be cleared for the project. An additional one hectare of moderate/good condition EEC would be indirectly impacted by the project. The project alignment was redesigned to avoid and reduce impact to the identified areas of EEC within the study area, which resulted in an overall reduction in impact area to the EEC.

b. **Extent and overall condition of the EEC:**

i. Within 1000 hectares of the project

Before the current field surveys, the nearest record of Lower Hunter Spotted Gum Ironbark Forest EEC was about 8.5 kilometres north-west of the study area in the Black Hill area and small remnant patches around The University of Newcastle, less than two kilometres north of the study area (Bell 2015). Field investigations have identified about 16.4 hectares of moderate/good condition Lower Hunter Spotted Gum Ironbark Forest EEC within the locality (Bell 2015). The project would therefore remove about 31 per cent of Lower Hunter Spotted Gum Ironbark Forest EEC within 1000 hectares of the project.

ii. Within 10,000 hectares of the project

No other records of Lower Hunter Spotted Gum Ironbark Forest EEC occur outside the study area within 10,000 hectares. The proposal would therefore remove about 31 per cent of Lower Hunter Spotted Gum Ironbark Forest EEC within 10,000 hectares of the project.

c. **Estimate of the extent area and overall condition of EEC remaining in the IBRA subregion after the impact of the project has been taken into consideration.**

Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is restricted to a range of about 65 by 35 kilometres centred on the Cessnock – Beresfield area in the Central and Lower Hunter Valley (NPWS 2000). Within this range, the community was once widespread. A fragmented core of the community still occurs between Cessnock and Beresfield.

Much of the remaining Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion shows evidence of disturbance. Past logging practices and fire regimes have heavily modified some parts of the community, resulting in a simplified structure and floristics. Production areas of State Forests are actively logged at intensities specified by regulations and frequent fires (less than 3 years) dramatically simplify understorey vegetation (Bell 2004).

d. **Project's impact on:**

i Abiotic factors critical to the long-term survival of the EEC

The removal of about 4.1 hectares of the EEC within the study area is the main impact associated within the project and has the potential to impact the long-term survival of the EEC. This would result in the fragmentation of the population and create a barrier to the movement of pollinators between subpopulations to the east and west of the project. The project could also potentially reduce the area of suitable floral assemblages and nesting resources required by pollinators and consequently lead to a decline in pollinator numbers. The combination of pollinator limitation and fragmentation of disjunct populations could potentially lead to minimal genetic variation within and between subpopulations and therefore potentially disrupt the breeding cycle of an important population.

ii Impacts to characteristic and functionally important species

Lower Hunter Spotted Gum – Ironbark Forest is dominated by Spotted Gum (*Corymbia maculata*), and Broad-leaved Ironbark (*Eucalyptus fibrosa*), while Grey Gum (*E. punctata*) and Grey Ironbark (*E. crebra*) () occur occasionally. Removal of these species and other vegetation will constitute 'Clearing of Native Vegetation', which is a KTP listed under Schedule 3 of the TSC Act.

iii The quality and integrity of an occurrence of the EEC through threats and indirect impacts

House (2003) estimated that about 26,500 hectares of the community remains with its tree canopy cover in a 'substantially unmodified' condition, representing about 40 per cent of its pre-European distribution. However, this estimate is based on the collective canopy cover of trees (ie where tree canopy cover was estimated to be greater than 20 per cent, the canopy was assumed to be 'unmodified' and not substantially thinned), and does not consider the growth stages of trees that contribute to the cover.

Growth stage mapping is available for about 6000 hectares of Lower Hunter Spotted Gum – Ironbark Forest on public land (RACAC 1995), of which only three per cent was assessed as containing a sub-dominance of 'overmature' and 'senescent' tree crowns indicative of old growth forest. Seventy-five per cent of this area was assessed as 'young forest', indicating regeneration from past logging and wildfire.

Some areas of Lower Hunter Spotted Gum – Ironbark Forest on private land also reflect a continuing history of degradation. In the Black Hill district, for example, much of the existing vegetation was cleared, and is now largely composed of dense stands of juvenile saplings. This regrowth has since been further affected by clearing and thinning, creation of electricity transmission easements, and ongoing grazing by goats and cattle. In addition, House (2003) estimated that there are a further 4650 hectares of Lower Hunter Spotted Gum – Ironbark Forest with a modified or substantially modified tree canopy cover.

e) Direct or indirect fragmentation and isolation of an important area of the EEC

The significance of Lower Hunter Spotted Gum Ironbark Forest EEC within the study area is such that is occurs at the eastern limit of distribution of this community within the region (Bell 2015). The project would also result in minor further fragmentation of this community as result of the project's alignment. The fragmentation and direct clearing of the EEC however, has been reduced through the preferred route alignment selection and concept design phase to avoid and reduce impacts to this community. The project is also likely to result in indirect impacts to this EEC such as weed invasion. These impacts will be mitigated in accordance with measures detailed in Section 9 and will be appropriately offset in accordance with the BOS (Appendix B).

f) Measures proposed to contribute to the recovery of the EEC in the IBRA subregion.

The Lower Hunter Spotted Gum Ironbark Forest EEC will be offset in accordance with the FBA and BioBanking methodology, as part of the BOS (Appendix B). Direct and indirect impacts of the project on this EEC will be minimised through the implementation of mitigation measures detailed in Section 9.

8.3.3 Species and populations

The threatened species identified as matters for further consideration include Black-eyed Susan (*Tetratheca juncea*), Red Helmeted Orchid (*Corybas dowlingii*) and the Grey-headed Flying-fox *(Pteropus poliocephalus).*

Black-eyed Susan (Tetratheca juncea)

An assessment of significance under the EPBC Act has been prepared for this species which assessed the potential project impact on this species in more detail (Appendix M).

a. **The size of the population directly and indirectly impacted by the development**

Targeted surveys carried out within the construction footprint and surrounds revealed a large population comprising 10381 plant clumps of this species. The population in the study area contains five subpopulations, three within Blackbutt Reserve and the remaining two subpopulations recorded to the west of Lookout Road.

An important population of Black-eyed Susan (*Tetratheca juncea*) is defined by any of the following criteria as set out by the referral guidelines (DSEWPaC 2011):

1. 'Has greater than 1000 plant clumps.
2. An area of habitat with an average estimated plant clump density of 20 clumps per hectares or greater.
3. Occurs in rare habitat (as defined by section 3 of the referral guidelines).
4. Occurs in an area of 'important habitat' as defined in Maps 4a and 4b (of the referral guidelines) and has greater than 500 plant clumps.
5. Occurs at or near the distributional limits of *Tetratheca juncea.*
6. Occurs in close proximity to a protected area (eg National Park) where *Tetratheca juncea* is known to occur. Close proximity refers to:
    i. Within 500 metres if connected by a suitable habitat corridor such as native vegetation.
    ii. Within 100 metres over disturbed habitat or non-native vegetation.'

A total of 10,381 clumps of Black-eyed Susan have been identified within the study area for the project which occur at an average density of 207 clumps per hectare. A portion of the population identified within the study area also occurs within 100 metres of Blackbutt Reserve in which a known population of this species occurs. Furthermore, the species was recorded in the study area within the Lower Hunter Spotted Gum Ironbark vegetation community, which is listed as 'rare habitat' for Black-eyed Susan under the referral guidelines (DSEWPaC 2011).

The recorded population of Black-eyed Susan within the study area (comprising 10381 clumps) meets several of the criteria (1, 2, 3 and 6) and is deemed to be an important population as defined under the EPBC Act. The construction footprint contains a total of 846 Black-eyed Susan plant clumps which are part of this identified important population.

b. **The likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to:**

i) **an estimate of the change in habitat available to the local population as a result of the proposed development**

Targeted surveys carried out within the construction footprint and surrounds revealed a large population comprising 10,381 plant clumps of this species. This population is located within the central coast metapopulation for Black-eyed Susan as indicated in the *Referral Guidelines for Tetratheca juncea* (DSEWPaC 2011), which extends from Karuah in the north, to the coast in the east, Wyong in the south and Mullbring in the west. The project would remove 846 clumps of Black-eyed Susan. The total population size for this species in NSW has previously been estimated to be between 9881 and 11,893 plant clumps (about 10,000 clumps however more recent research suggests that this figure may be a gross underestimate (TSSC 2005). This is particularly evident considering the total number of plant clumps recorded within the construction footprint and surrounds alone was 10,381. While the project would remove about 39.2 hectares of potential and known habitat for this species, suitable habitat for this species will persist within the locality.

ii) **the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and**

The project would involve the removal of about 39.2 hectares of native vegetation containing 846 Black-eyed Susan plant clumps. The project alignment has been selected to try to reduce impacts on the local population by avoiding plant clumps where possible. Regardless, the removal of these plant clumps from the central portion of an identified important population located in the eastern extent of the species known distributional range would reduce the area of occupancy of an important population for this species.

The removal of these plant clumps would fragment occurrences of Black-eyed Susan within subpopulations and also increases distances between the remaining other subpopulations located within Blackbutt Reserve. Consequently, the construction footprint could result in the fragmentation of an existing important population into two separate populations.

No critical habitat has been listed for this species on the register of critical habitat.

According to the DotE (2013), habitat critical to the survival of a species are areas necessary:

- For activities such as foraging, breeding, roosting or dispersal.
- For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species eg pollinators).
- To maintain genetic diversity and long-term evolutionary development.
- For the reintroduction of populations of recovery of the species or ecological community.

The project would result in the removal of 846 plant clumps from an important population of Black-eyed Susan, however consideration of these points shows that this population is unlikely to be critical to the survival of this species, as a whole given that a number of other populations are known within the distributional range of this species (most notable within the Wyong and Lake Macquarie LGAs), some of which are in conservation areas. Consequently, the impacts associated with the project are considered unlikely to adversely affect habitat that is critical to the survival of this species.

The identified Black-eyed Susan population in the study area comprises five subpopulations. The project would remove about 846 plant clumps from one subpopulation which comprises 8176 plant clumps. A subpopulation is defined as plant clumps that are separated by distances of less than 500 metres within suitable habitat or less than 100 metres in degraded habitat or non-native vegetation (DSEWPaC 2011). The removal of these plant clumps would fragment occurrences of Black-eyed Susan within this subpopulation and also increase distances between the remaining plant clumps within the subpopulation and other subpopulations located within Blackbutt Reserve. Consequently, the construction footprint is likely to result in the fragmentation of an existing important population into two separate populations.

iii) **modification of habitat required for the maintenance of processes important to the species life cycle**

The project would result in the removal of about 39.2 hectares of native vegetation comprising 846 plant clumps of Black-eyed Susan. This would result in the fragmentation of an identified important population and create a barrier to the movement of pollinators between subpopulations to the east and west of the project. Black-eyed Susan is rhizomatous and propagates asexually from rootstock to form plant clumps of up to 0.5 cubic metres (DotE 2015). The flowers produce no nectar attractive to pollinators and pollination is reliant on bees collecting nectar and pollen from a number of other plant species nearby (Driscoll 2003). Consequently, the project could also potentially reduce the area of suitable floral assemblages and nesting resources required by pollinators and consequently lead to a decline in pollinator numbers. The combination of pollinator limitation and fragmentation of disjunct populations could potentially lead to minimal genetic variation within and between subpopulations and therefore potentially disrupt the breeding cycle of an important population.

No recovery plan has been developed for Black-eyed Susan. It is considered that the overall impacts of the project would not be to the extent that they would substantially interfere with the recovery of the species, particular with the adoption of appropriate mitigation measures and an appropriate offset package to compensate for residual impacts.

c. **The likely impact on the ecology of the local population.**

i) **How the project is likely to affect the ecology and biology of the residual population**

The project would remove about 846 plant clumps of Black-eyed Susan. The total population size for this species in NSW has previously been estimated to be between 9881 and 11,893 plant clumps (about 10,000 clumps) however more recent research suggests that this figure may be a gross underestimate (TSSC 2005). This is particularly evident considering the total number of plant clumps recorded within and surrounding the construction footprint alone was 10,381. A tally of known populations listed on the Species Profile and Threats Database for Black-eyed Susan (DotE 2015c) shows that recorded numbers for this species are in excess of 56,000, with the largest numbers recorded within the Wyong and Lake Macquarie LGAs.

While the project would result in a decrease in the local population and the extent of potential habitat, it is considered that the overall impacts are not to the extent that the species, as a whole, is likely to decline given its total known distributional range and that total population numbers for this species are expected to be higher than is currently known.

It is clear from this information that the total population size for Black-eyed Susan is likely to be considerably larger than current estimates. Regardless, the removal of 846 plant clumps would result in the permanent removal of a portion of an important population of Black-eyed Susan (comprising 10,381 plant clumps) and consequently would lead to a long-term decrease in the size of an important population.

The FBA process has been applied to this project to determine an appropriate offsetting strategy for managing residual impacts to this species (ie the removal of 846 plant clumps) that cannot be avoided or mitigated. The BOS for the project is provided in Appendix B.

An assessment of significance pursuant to the EPBC Act significant impact guidelines (DotE 2013) has been prepared for this species and is provided in Appendix M. The assessment of significance concluded that pursuant to the significant impact guidelines (DotE 2013), the project is likely to have a significant impact on an important population of the Black-eyed Susan given that it would remove about 846 individuals from the important population and bisect connectivity and extent of habitat for this species.

Grey-headed Flying-fox (Pteropus poliocephalus)

An assessment of significance under the EPBC Act has been prepared for this species which assessed the potential project impacts on this species in more detail (Appendix M).

a. **The size of the population directly and indirectly impacted by the development**

Grey-headed Flying-fox were observed flying over the construction footprint and suitable foraging habitat (in the form of blossom-producing trees) was identified within the construction footprint (Parsons Brinckerhoff 2015a). A known breeding camp for this species occurs directly to the south-east of the construction footprint (about 230 metres from the southern extent of the construction footprint) in Blackbutt Reserve. It is likely that individuals from this camp forage within the construction footprint on a regular basis when trees are in flower (Parsons Brinkerhoff 2015a). This camp is not identified as a Nationally important camp under the *Draft EPBC Act Policy Statement Camp management guidelines for the Grey-headed and Spectacled flying-fox* (DotE 2014). However, it is considered to be regionally important as it is known to support breeding females, is the only known camp in the Newcastle LGA and provides a year-round foraging resource, being the only continuously occupied camp in the Lower Hunter region (Geolink 2013).

b. **The likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to:**

   i. **an estimate of the change in habitat available to the local population as a result of the proposed development**

The project would result in the removal of about 39.2 hectares of native vegetation identified as providing a suitable foraging resource for the Grey-headed Flying-fox. Flora species in the construction footprint provide a variety of foraging resources for the Grey-headed Flying-fox from a range of species that together would flower during much of the year. The construction footprint provides habitat for winter-flowering myrtaceous tree species such as the Spotted Gum (*Corymbia maculata*) and Ferguson's Ironbark (*Eucalyptus fergusonii*) which provide an important foraging resource for the Grey-headed Flying-fox during the winter months. Red Bloodwood (*Corymbia gummifera*), which is also present in the construction footprint, is a prolific flowering species and is important for nectarivorous fauna during the autumn months (Parsons Brinckerhoff 2015a).

The *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009) outlines the criteria for identifying foraging habitat considered critical to the survival of the species. In accordance with the plan, foraging habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat, for Grey-headed Flying-foxes:

1. Productive during winter and spring, when food bottlenecks have been identified.
2. Known to support populations of >30 000 individuals within an area of 50 kilometre radius (the maximum foraging distance of an adult).
3. Productive during the final weeks of gestation and during the weeks of birth, lactation and conception (September to May).
4. Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions).
5. Known to support a continuously occupied camp (DECCW 2009).

With consideration of the guidelines, the foraging habitat present within the construction footprint is considered critical to the survival of the Grey-headed Flying-fox due to the presence of winter flowering species which are known to support a continuously occupied camp located at Blackbutt Reserve.

However, given the relatively large tracts of native vegetation near the construction footprint, feeding resources contained within the construction footprint would only provide a small proportion of that available to the species in the wider locality (Parsons Brinckerhoff 2015a). Therefore, although native vegetation within the construction footprint is consistent with the definition for foraging habitat critical to the survival of the Grey-headed Flying-fox, it is considered to provide only a small proportion of that available in the wider locality (about 0.012 per cent based on estimates of total foraging habitat within the Lower Hunter region (Geolink 2013). Consequently, the removal of about 39.2 hectares of native vegetation identified as providing a critical foraging resource to an important population of Grey-headed Flying-fox is considered unlikely to lead to a long-term decrease in the size of the population, given the availability of similar habitat within the wider locality and the mobility of the species.

ii. the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and

The Lower Hunter region contains a number of species in the blossom diet of the Grey-headed Flying-fox that produce abundant nectar relatively frequently and therefore play a key role in supporting the seasonal pattern of camp occupation in the region, including important periods in the reproductive cycle. Forests and woodlands that provide plants in the nectar diet of the Grey-headed Flying-fox covers 56 per cent (about. 239,575 hectares) of the Lower Hunter region, or about 91 per cent of extant vegetation. Vegetation that provides plants in the fruit diet of the Grey-headed Flying-fox covers 4.4 per cent (about. 18,824 hectares) of the region (Geolink 2013).

A total of about 39.2 hectares of native vegetation, identified as providing a critical foraging resource for the Grey-headed Flying-fox would be removed as a result of the project. While the project would result in a decrease in the availability of known foraging habitat, it is considered that the overall impacts are not to the extent that this highly mobile aerial species, as a whole, is likely to decline.

The removal of about 39.2 hectares of native vegetation would also fragment the existing available foraging habitat within the construction footprint and reduce connectivity in the wider area by increasing gaps in the existing vegetation cover. These gaps would be readily traversed

by the Grey-headed Flying-fox which is a highly mobile aerial species and consequently any fragmentation of foraging habitat is considered to be overcome by this species.

c. **The likely impact on the ecology of the local population.**

The project would not remove any areas of suitable breeding or roosting habitat for the Grey-headed Flying-fox. The removal of about 39.2 hectares of foraging habitat for this species would reduce connectivity by increasing gaps on the existing vegetation, however is not considered to create a barrier to the movements of this highly mobile aerial species between the camp site and foraging habitats. Consequently, the project is not considered likely to disrupt the breeding cycle of an important population of this species.

The camp is located about 230 metres from the project construction footprint and is located about 100 metres from Lookout Road. As such, indirect impacts would be minimal and unlikely to disrupt the breeding cycle of the Grey-headed Flying-fox.

Furthermore, the project would not impact the Grey-headed Flying-fox camp-site located within Blackbutt Reserve and consequently would not fragment this important population into two or more populations.

i) How the project is likely to affect the ecology and biology of the residual population

A known breeding camp for this species occurs directly to the south-east of the construction footprint (about 230 metres from the southern extent of the construction footprint) in Blackbutt Reserve. It should be noted however that the location is about 400 metres south of the anticipated actual construction work associated with the construction footprint and that the camp is located about 100 metres to the east of Lookout Road. It is likely that individuals from this camp forage within the construction footprint on a regular basis when trees are in flower (Parsons Brinkerhoff 2015a).

This camp is not identified as a Nationally important camp under the *Draft EPBC Act Policy Statement Camp management guidelines for the Grey-headed and Spectacled flying-fox* (DotE 2014). However, it is considered to be regionally important as it is known to support breeding females, is the only known camp in the Newcastle LGA and provides a year-round foraging resource, being the only continuously occupied camp in the Lower Hunter region (Parsons Brinkerhoff 2015a).

An 'important population' under the significant impact guidelines 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 meet one or more of the following:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity.
- Populations that are near the limit of the species range.

For the purposes of this assessment, the Grey-headed Flying-fox population in the study area is considered to be an important population as it is a key source population for breeding and dispersal within the region.

With consideration of the recovery plan guidelines (refer to previous section b(i)), the foraging habitat present within the construction footprint is considered critical to the survival of the Grey-headed Flying-fox due to the presence of winter flowering species which are known to support a continuously occupied camp located at Blackbutt Reserve. However, given the relatively large tracts of native vegetation near the construction footprint, feeding resources contained within the construction footprint would only provide a small proportion of that available to the species in the wider locality (Parsons Brinkerhoff 2015a).

Therefore, although native vegetation within the indicative construction footprint is consistent with the definition for foraging habitat critical to the survival of the Grey-headed Flying-fox, it is considered to provide only a small proportion of that available in the wider locality (about 0.012 per cent based on estimates of total foraging habitat within the Lower Hunter region (Parsons Brinkerhoff 2015a). Consequently, the removal of about 39.2 hectares of native vegetation identified as providing a critical foraging resource to an important population of Grey-headed Flying-fox is considered unlikely to lead to a long-term decrease in the size of the population, given the availability of similar habitat within the wider locality.

Indirect impacts to the camp would be minimal as the camp is located about 230 metres south of the construction footprint. Any indirect impacts resulting from project construction would be unlikely and minimal due the distance of the identified camp from active work. In addition, the camp is located about 100 metres east of Lookout Road and is already subjected to the indirect impacts associated with a major road and it is considered unlikely these impacts would change significantly after construction of the project (Parsons Brinkerhoff 2015a).

The project would not remove any areas of suitable breeding or roosting habitat for the Grey-headed Flying-fox. The removal of about 39.2 hectares of foraging habitat for this species would reduce connectivity by increasing gaps on the existing vegetation, however is not considered to create a barrier to the movements of this highly mobile aerial species between the camp site and foraging habitats. Consequently, the project is not considered likely to disrupt the breeding cycle of an important population of this species.

Mitigation measures detailed in Section 9 will be implemented for the project to reduce potential for adverse indirect impacts on Grey-headed Flying-fox habitat in the study area. Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process will be applied to this project to determine an appropriate offset for residual impacts to this species (ie the removal of about 39.2 hectares of native vegetation) that cannot be avoided or mitigated.

An assessment of significance pursuant to the EPBC Act significant impact guidelines (DotE 2013) has been prepared for this species and is provided in Appendix M. The assessment of significance concluded that pursuant to the significant impact guidelines (DotE 2013), the project is likely to have a significant impact on an important population of the Grey-headed Flying-fox given that it would adversely affect foraging habitat critical to the survival of the species.

Red Helmeted Orchid (*Corybas dowlingii*)

Red Helmeted Orchid (*Corybas dowlingii*) was identified by OEH's comments attached to the project SEARs as a matter for further consideration, based on previous records in the locality made by members of the public. The supplementary SEARs required targeted surveys to be carried out for this species within appropriate flowering times in the study area to determine the species presence and extent.

The species is a tuberous orchid which grows in clonal colonies and as a solitary dark green heart-shaped to circular leaf (15 to 35 millimetres long and wide) that ends at a point (Parsons Brinckerhoff 2016). The dark purplish red flower that is produced occurs low to the ground as a solitary erect hood or 'helmet' The species flowering period is between June and August (OEH 2015b). *Corybas dowlingii* is located within the central coast and Hunter region of NSW known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. This species has been recorded in large numbers at Stoney Ridge Reserve in Soldiers Point (over 14,000 stems) being recorded (Okada 2006).

Habitat for this species is creek lines, gullies, south facing slopes and other sheltered areas on well-drained gravelly soil at elevations between 10 to 100 metres (OEH 2015b). It has also been noted it prefers the lower slopes and grows in moist areas under fallen logs (Okada 2006).

Targeted surveys were carried out for the species during initial surveys during September, October and November 2014 and during additional targeted surveys in July and August 2015 (Parsons Brinckerhoff 2016).

The previous observation of the species was made during June 2013 within George McGregor Park, Rankin Park, within the project study area. Consultation was carried out with the original observer and OEH to determine suitable survey methodology.

Two reference sites were investigated to identify whether the species was flowering before starting targeted surveys in the study area. A summary of survey effort and results of the reference site surveys is provided in Table 8-6.

Table 8-6 Red Helmeted Orchid targeted surveys

Reference site	Dates surveyed	Result
George McGregor Park and Rankin Park	12 June 2015	No Red Helmeted Orchid recorded
	15 June 2015	No Red Helmeted Orchid recorded
	19 June 2015	No Red Helmeted Orchid recorded
	26 June 2015	No Red Helmeted Orchid recorded
	7 July 2015	No Red Helmeted Orchid recorded
	15 July 2015	No Red Helmeted Orchid recorded
	23 July 2015	No Red Helmeted Orchid recorded
	5 August 2015	No Red Helmeted Orchid recorded
Stoney Ridge Reserve, Soldiers Point	20 July 2015	Numerous Red Helmeted Orchid recorded
Targeted surveys within the study area		
Construction footprint and study area	September, October and November 2014	No Red Helmeted Orchid recorded
Construction footprint and study area	23 July 2015	No Red Helmeted Orchid recorded

Despite targeted surveys carried out during peak flowering periods and when the species was known to be flowering at the Soldiers Point reference site visited on 20 July 2015, no Red Helmeted Orchid stems were observed within the study area (Parsons Brinckerhoff 2016). No stems were recorded within the potential reference site within George McGregor Park. The potential reference site was located close to a walking track and may have been removed as a result of anthropogenic factors (Parsons Brinckerhoff 2016).

Due to the extensive survey effort carried out within the study area, and the fact that the species was not observed despite the species flowering at a known reference site location in Stoney

Ridge Reserve, it is considered unlikely that this species occurs within the study area (Parsons Brinckerhoff 2016).

Due to the apparent lack of occurrence of this species in the study area, the project is considered unlikely to result in the extinction or reduce the viability of the species in the IBRA subregion. The project would however, remove about 10.4 hectares of potential habitat for this species within the construction footprint. This habitat will be appropriately offset in accordance with the NSW FBA and BBAM (Section 10 and Appendix B).

8.3.4 Critical habitat

No critical habitat listed under the Register of Critical Habitat in NSW or in accordance with Section 47 of the TSC Act is contained within the project study area.

8.4 Matters of National Environmental Significance

In accordance with the MNES Significant Impact Guidelines (DotE, 2013a) the EPBC referral determined the project likely to have significant impact on the identified important population of Black-eyed Susan (*Tetratheca juncea*) within the study area and a potential significant impact to an important population of the Grey-headed Flying-fox (*Pteropus poliocephalus).* An assessment of impacts associated with MNES is provided in the following sections.

The detailed EPBC Act assessments of significance for identified MNES, attached in Appendix M, provide a detailed assessment of the extent, nature and consequence of the likely direct and indirect consequential impacts of the project to MNES.

8.4.1 Threatened ecological communities

No TECs listed under the EPBC Act occur within the study area (Parsons Brinkerhoff 2015a), consequently the project would not impact any EPBC Act listed TECs.

8.4.2 Threatened flora species

The project would result in the clearing of about 39.2 hectares of native vegetation that contains potential habitat for EPBC Act listed flora species. Details of project specific impacts to flora of MNES identified within the study are detailed in the following sections.

Vegetation within the construction footprint provides known habitat for the EPBC Act listed vulnerable species', Black-eyed Susan (*Tetratheca juncea*). This vegetation also represents potential habitat for EPBC Act listed threatened flora identified in Table 8-7. The project would also potentially have indirect impacts on nearby areas of vegetation through increases in noise and vibration, dust generation, sedimentation and erosion, weed invasion and changes to surface and groundwater flows.

One threatened flora species listed under the EPBC Act occurs within the construction footprint, Black-eyed Susan. All other EPBC listed species occur outside of the construction footprint and would not be directly impacted by the project. The potential for impacts on the threatened species identified as known or potentially occurring within the construction footprint are summarised in Table 8-7. Assessments of significance have been prepared for each of these species, which are provided in Appendix M.

Table 8-7 Summary of real and potential impacts to MNES flora

Scientific name	Common name	EPBC Act status	Nature of impacts and outcome of significance assessment
Tetratheca juncea	Black-eyed Susan	V	Loss of about 39.2 ha of known habitat comprising about 846 plant clumps of a recorded total of 10,381 clumps (about 8% of the local population). Likely significant impact
Cryptostylis hunteriana	Leafless Tongue-orchid	V	Loss of about 18.7 ha of potential habitat. No impacts to any known habitat or stems. There are no records of the species in the locality of the project; however, it is predicted to occur within the locality. Unlikely significant impact
Rutidosis heterogama	Heath Wrinklewort	V	Loss of about 16 ha of potential habitat. No impacts to any known habitat or stems. There are no previous records of the species within five kilometres of the study area (OEH 2015a) and no stems were identified in the study area during targeted surveys. Unlikely significant impact
Grevillea parviflora	Small-flower Grevillea	V	Loss of about 16.8 ha of potential habitat. A total of 109 stems were recorded within the study area and outside of the construction footprint. No plants will be impacted by the proposed construction of the project. Unlikely significant impact
Diuris praecox	Newcastle Double Tail	V	Loss of about 34.7 ha of potential habitat. No impacts to any known habitat or stems. No stems were identified in the study area during targeted surveys. Unlikely significant impact.
Syzigium paniculatum	Magenta Lilly Pilly	V	Loss of about 4.4 ha of potential habitat. Eight stems of the Magenta Lily Pilly (*Syzygium paniculatum*) were recorded at one location within the study area, outside of the construction footprint during targeted surveys. No impacts to known habitat or stems. Unlikely significant impact.

Black-eyed Susan (Tetratheca juncea)

About 846 plant clumps of Black-eyed Susan would be removed by the project which constitutes an eight per cent loss of an identified important population under the EPBC Act comprising 10,381 clumps (Section 8.3.3). As stated previously, the total population size for this species in NSW has previously been estimated to be between 9881 and 11,893 plant clumps, however more recent research suggests that this figure may be a gross underestimate (TSSC 2005), which is particularly evident considering the total number of plant clumps recorded within the study area alone was 10,381 (GHD 2015). It is clear from this information that the total population size for Black-eyed Susan is considerably larger than current estimates. Regardless, the removal of 846 plant clumps would result in the permanent removal of a portion of an important population of Black-eyed Susan (comprising 10381 plant clumps) and consequently would lead to a long-term decrease in the size of an important population.

The identified Black-eyed Susan population (comprising 10381 plant clumps) occurs within the eastern portion of the central coast metapopulation as indicated in the referral guidelines for the species (DSEWPaC 2011). The project would involve the removal of about 39.2 hectares of native vegetation containing 846 Black-eyed Susan plant clumps. The project alignment has been realigned and designed to try to reduce impacts on the local population by avoiding plant clumps where possible.

As stated previously, the population comprises five subpopulations and the project would remove 846 plant clumps from one subpopulation which comprises 8176 plant clumps. A subpopulation is defined as plant clumps that are separated by distances of less than 500 metres within suitable habitat or less than 100 metres in degraded habitat or non-native vegetation (DSEWPaC 2011). The removal of these plant clumps would fragment occurrences of Black-eyed Susan within the subpopulation and also increase distances between the remaining plant clumps within the subpopulation and other subpopulations located within Blackbutt Reserve. Consequently, the construction footprint is likely to result in the fragmentation of an existing important population into two separate populations.

No recovery plan has been developed for Black-eyed Susan. In lieu of a formal recovery plan, the Department of the Environment (2015c) lists the following key management actions to assist this species.

'Habitat loss, fragmentation and disturbance

- *Protect and actively manage large populations and those at the limit of the species range through conservation covenanting and the preparation of site specific vegetation management plans.*
- *Monitor known populations to identify key threats.*
- *Identify populations of high conservation priority.*
- *Improve vegetative connectivity within and between populations through revegetation and regeneration programs.*
- *Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.*
- *Ensure stormwater infrastructure and associated development involving substrate or vegetation disturbance do not adversely impact on Tetratheca juncea and manage any associated hydrological change, such as increased runoff.*
- *Minimise factors that promote habitat degradation such as large edge-area ratios.*

Invasive weeds

- *Undertake weed control activities at priority sites on private and public land.*
- *Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on Tetratheca juncea.'*

The primary threat to Black-eyed Susan is habitat clearing for urban development (Gross et al 2003). The project would result in the removal of 846 Black-eyed Susan plant clumps considered to be part of an important population (comprising 10,381 plant clumps) for this species. The removal of these plant clumps would result in a decrease in the known local population and availability of potential habitat however, it is considered that the overall impacts would not be to the extent that they would substantially interfere with the recovery of the species, particular with the adoption of appropriate mitigation measures and an appropriate offset package to compensate for residual impacts.

An assessment of significance pursuant to the EPBC Act significant impact guidelines (DotE 2013) have been prepared for this species and is provided in Appendix M. The assessment of significance concluded that despite careful design consideration to avoid impacts to Black-eyed Susan where possible and the likely proposed mitigation measures, the project is likely to have a significant impact on an important population of Black-eyed Susan given that there is a real chance or possibility that it would:

- Lead to a long-term decrease in the size of an important population of the species.
- Reduce the area of occupancy of an important population.
- Fragment an existing important population into two or more populations.
- Potentially disrupt the breeding cycle of an important population.

The FBA process will be applied to this project to determine an appropriate offset for residual impacts to this species (ie the removal of 846 plant clumps) that cannot be avoided or mitigated. Consequently, the project is likely to result in a significant impact on the Black-eyed Susan important population (Appendix M and GHD, 2015). Appropriate mitigation and management measures will be implemented during the project to reduce these impacts, including the implementation of the BOS (Appendix B).

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

The Small-flower Grevillea occurs on ridge crests, upper slopes or flat plains in both low-lying areas between 30 and 65 metres above sea level (particularly in the Lower Hunter Valley and Lake Macquarie) and on higher topography between 200 and 300 metres above sea level south of Sydney (NPWS 2002). Annual rainfall across the subspecies' range is between 800 and 1000 millimetres (Benson & McDougall 2000).

Small-flower Grevillea is sporadically distributed in the Sydney Basin. There are at least 21 known populations, of which, three are thought to be extinct and several need to be confirmed (NPWS 2002).

Small-flower Grevillea was found growing in association with Smooth-barked Apple – Red Bloodwood open forest within the study area. A total of 109 stems were recorded within the study area, outside of the construction footprint. The project alignment has been realigned to avoid impacting this population. No plants would be impacted by the proposed construction of the project, however about 16.8 hectares of potential habitat would be removed by the project. The construction footprint is located at least 20 to 100 metres from two known sub-populations of Small-flower Grevillea. The interim *Lake Macquarie Grevillea parviflora* subsp*. parviflora Planning and Management Guidelines* (Lake Macquarie City Council 2013) recommend that a minimum buffer area of 20 metres around populations is considered reasonable to reduce adverse impacts from nearby development or land use.

Targeted surveys were carried out for this species within identified suitable habitat in the study area during optimum detection periods (August and October 2014). Consequently, it is assumed that this species does not occur within the construction footprint. Although the project would remove about 16.8 hectares of potential habitat for this species, it is considered that the project is not likely to result in an impact to the Small-flower Grevillea.

Magenta Lily Pilly (Syzygium paniculatum)

The Magenta Lily Pilly is a small to medium sized rainforest tree that grows to eight metres tall. The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the central coast, Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (OEH 2015b). The extent of occurrence is about 15 000 square kilometres (TSSC 2008) and the area of occupancy is estimated to be about 180 to 210 square kilometres. The total population is estimated to be between 760 and 2600 mature plants (TSSC 2008).

Eight plants of the Magenta Lily Pilly were recorded at one location within the study area, about 400 metres west of the construction footprint. This species was found growing in association with Sydney Blue Gum – White Mahogany shrubby tall open forest – Syncarpia variant along the banks of an unnamed creek. No plants would be impacted by the proposed construction of the project, however about 4.4 hectares of potential habitat would be removed by the project.

Targeted surveys were carried out for this species within identified suitable habitat in the study area during optimum detection periods (September and October 2014). It is possible that plants observed have colonised as a result of bird dispersal from nearby gardens as this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (Parsons Brinckerhoff 2015a). The individuals recorded within the study area are not considered a key source population for breeding or dispersal or necessary for maintaining genetic diversity as they do not normally grow in this habitat and have most likely colonised from nearby gardens. Consequently, it is assumed that this species does not occur within the construction footprint. Although the project would remove about 4.4 hectares of potential habitat for this species, it is considered that the project is not likely to result in an impact to Magenta Lily Pilly.

A National Recovery Plan has been prepared for the Magenta Lilly Pilly by NSW OEH (2012). The project is unlikely to interfere with any of the recovery actions detailed in the recovery plan. as no individuals would be removed as a result of the project, the work would occur 400 metres from the identified occurrence of this species and the species does not normally grow in this habitat type. Consequently, the project is unlikely to interfere with the recovery of the species. A number of mitigation measures detailed in Section 9 will be implemented to reduce any potential indirect impacts to the identified Magenta Lilly Pilly.

Leafless Tongue Orchid (Cryptostylis hunteriana)

Leafless Tongue Orchid is a small perennial terrestrial orchid that lacks leaves. In NSW, the species occurs between Batemans Bay and Nowra with additional records in Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, Ben Boyd National Park, the Catherine Hill Bay area, Dolphin Point and Bulahdelah. There are no records of the species in the locality of the project study area.

Leafless Tongue Orchid has been reported to occur in a wide variety of habitats (GHD 2015). Within the study area the Smooth-barked Apple – Red Bloodwood open forest and Smooth-barked Apple – Sydney – Peppermint – Turpentine open forest vegetation communities are considered potential habitat for Leafless Tongue Orchid. About 18.7 hectares of potential habitat for this species would be removed by the project. However, large amounts of potential habitat would remain surrounding the construction footprint (about 180 hectares) which contains suitable habitat for the species. It is considered unlikely that the availability or quality of habitat would be reduced to the extent that the species is likely to decline.

Targeted surveys were carried out for Leafless Tongue Orchid in these vegetation communities during the flowering period in October and November 2014, and in November and December 2015, but neither survey identified the species in the study area. As there are no previous records of the species within 15 kilometres of the project (OEH 2015c) and no individuals were identified at the site during surveys, key source populations for breeding or dispersal, and populations necessary for maintaining genetic diversity are therefore not likely to exist within the construction footprint.

No recovery plan has been developed for Leafless Tongue Orchid. The Department of the Environment (2015c) lists the following as threats to the survival of the species:

- Habitat management
- Habitat protection
- Monitoring
- Survey/mapping habitat assessment

OEH (2015b) lists the following threats for the species:

- Development pressure on sites where it occurs.
- Some populations are threatened by road works.
- Walkers on trails trampling adult plants causing plant mortality.
- National Parks burning resulting in unplanned, high intensity fires within the species' habitat.
- Fire spreading from local hazard-reduction burns potentially causing plant mortality.
- Weed invasion following disturbance (eg by roadworks) of perennial grasses and other herbaceous weeds which compete for space and resources.

In the unlikely event that the species occurred in the construction footprint, the project would contribute to development pressure on the species and potentially introduce weed species into the site through edge effects which would be mitigated in accordance with Section 9.

Heath Wrinklewort (Rutidosis heterogama)

Heath Wrinklewort grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (OEH 2015b) from near Cessnock to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung national parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes.

There are no previous records of the species within five kilometres of the study area (OEH 2015a) and no stems were identified in the study area during targeted surveys. The Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest – both atypical variant and *Eucalyptus fergusonii* variant vegetation communities provide potential habitat for this species. About 16 hectares of potential habitat for Heath Wrinklewort would be removed by the project. The construction footprint would fragment one large isolated patch of habitat into three smaller patches of habitat, which would fragment the available habitat within the study area for the species.

About 180 hectares of vegetation surrounding the construction footprint would remain unaffected by the project which would contain potential habitat for the species. As no individuals were observed, and large amount alternate potential habitat would remain in the locality, it is considered unlikely the removed of about 16 hectares of potential habitat would decrease the availability or quality of habitat would be reduced to the extent that the species is likely to decline.

Targeted surveys were carried out for this species within identified suitable habitat in the study area during optimum detection periods (September and October 2014). Consequently, it is assumed that this species does not occur within the construction footprint. Although the project would remove about 16 hectares of potential habitat for this species, it is considered that the project is not likely to result in an impact to Heath Wrinklewort.

No recovery plan has been developed for Heath Wrinklewort. The Department of the Environment (2015c) lists the following as known and perceived threats to the survival of the species:

- Grazing pressures and associated habitat changes.
- Habitat loss and modification due to clearance of native vegetation and pasture improvements.
- Habitat loss, modification and/or degradation.
- Loss and/or fragmentation of habitat and/or subpopulations.
- Human induced disturbance due to unspecified activities.
- Competition and/or habitat degradation from invasive species, including rabbits.
- Predation, competition, habitat degradation and/or spread of pathogens by introduced species.
- Inappropriate and/or changed fire regimes (frequency, timing, intensity).
- Habitat loss, modification and fragmentation due to urban development.
- Development and/or maintenance of roads.

The project would contribute to the loss of potential habitat for this species and has the potential to degrade potential habitat by introducing weed species into the site through edge effects. However the project is unlikely to substantially interfere with the recovery of the species as there were no individuals identified at the site and mitigation measures detailed in Section 9 will be adopted to minimise any indirect impacts associated with the project.

Newcastle Doubletail (Diuris praecox)

Newcastle Doubletail is a terrestrial orchid with two or three linear leaves. Newcastle Doubletail occurs between Ourimbah and Nelson Bay on the New South Wales coast (DECCW 2005) and has also been identified on the Wallarah Peninsula, near Lake Macquarie in NSW (Conacher Travers 2006). Newcastle Doubletail inhabits sclerophyll forests, often on hilltops and slopes, which have a grassy to fairly dense understorey (DECCW 2005).

The Smooth-barked Apple and Spotted Gum forest vegetation community provides potential habitat for Newcastle Doubletail within the study area. About 34.7 hectares of potential habitat for this species would be removed by the project. There is no critical habitat listed for this species by the NSW Office of Environment and Heritage (OEH 2015). Newcastle Doubletail has a restricted range between Ourimbah and Nelson Bay. The construction footprint is in the middle of the species range. If any Newcastle Doubletail were to occur within the construction footprint, they would not be considered to be near the limit of the species range.

Although the construction footprint contains suitable habitat for Newcastle Doubletail targeted surveys for this species carried out during the known flowering period (August 2014 and August 2015) surveys did not record any individuals within the study area. The project would however directly impact the species with the removal of about 34.7 hectares of potential habitat. About 180 hectares of potential habitat would remain surrounding the construction footprint, it is considered unlikely that the availability or quality of habitat would be reduced to the extent that the species is likely to decline.

As the closest record of the species is four kilometres from the project (OEH 2015) and no stems were identified at the site during targeted surveys during flowering periods, key source populations for breeding or dispersal, and populations necessary for maintaining genetic diversity are not likely to exist within the construction footprint (GHD 2015). It is considered a low probability that an important population of Newcastle Doubletail species would exist within the study area and therefore a long-term decrease of a population of this species is considered unlikely.

No recovery plan has been developed for Newcastle Doubletail. The Department of the Environment (2015c) states that the species is threatened by loss and fragmentation of habitat; especially through clearing for urban development, weed invasion, uncontrolled track expansion and impacts from recreational use within its habitat. In the unlikely event that the species occurred at the site, the project would contribute to clearing for development and potentially introduce weed species into study area through edge effects. The project is unlikely to contribute to uncontrolled track expansion and impacts from recreational use within its habitat.

Thick Lip Spider Orchid (Caladenia tessellata)

Thick Lip Spider Orchid occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). It prefers low open forest with a heathy or sometimes grassy understorey (Bishop, 2000). No plants were identified within the study area during targeted surveys. The Smooth-barked Apple and Spotted Gum forest vegetation community provides potential habitat for Thick Lip Spider Orchid within the study area. About 34.7 hectares of potential habitat for this species would be removed by the project.

Targeted surveys were carried out for Thick Lip Spider Orchid in this vegetation community during the optimum detection period during September, October and November 2014, but the species was not identified within the study area. As there are no previous records of the species within 10 kilometres of the project (OEH 2015c) and no individuals were identified at the site during surveys, key source populations for breeding or dispersal, and populations necessary for maintaining genetic diversity are therefore not likely to exist within the construction footprint. There is no critical habitat listed for this species by the NSW Office of Environment and Heritage (OEH 2015c) and the study area is unlikely to contain habitat critical to the survival of the species.

8.4.3 Threatened fauna species

The project would result in the clearing of about 39.2 hectares of native vegetation that contains known and potential habitat for EPBC Act listed fauna species. Details of project specific impacts to flora of MNES identified within the study are detailed in the following sections.

As mentioned previously, vegetation within the construction footprint contains known foraging habitat for the vulnerable species', Grey-headed Flying Fox (*Pteropus poliocephalus)*. This vegetation also contains potential habitat for an additional five threatened fauna species listed under the EPBC Act detailed in Table 8-8. The project is likely to result in a significant impact to the Grey-headed Flying-fox, the extent and consequence of impact is discussed in Section 8.3.3 and in the following sections. The project is unlikely to result in a significant impact to any further fauna MNES.

The project would also potentially have indirect impacts on nearby areas of vegetation and fauna habitat through increases in noise and vibration, dust generation, sedimentation and erosion, weed invasion and changes to surface and groundwater flows. Appropriate mitigation measures, detailed in Section 9, will be implemented to reduce these impacts, including the implementation of the BOS in accordance with the NSW FBA. The potential for impacts on the threatened species identified as known or potentially occurring within the construction footprint are summarised in Table 8-8.

Table 8-8 Summary of impacts to MNES fauna

Scientific name	Common name	EPBC Act status	Nature of impacts and outcome of significance assessment
Pteropus poliocephalus	Grey-headed Flying-fox	V	Loss of about 39.2 ha of known critical foraging habitat to an important population. Likely significant impact.
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	E	Loss of about 39.2 ha of potential foraging habitat. No impacts to any known habitat. Only one record of the Regent Honeyeater occurs within a 10 km radius of the project, from 1987 (OEH, 2016). Given the available habitat which will persist locally post-project construction, and the lack of recent sightings in the locality the project is unlikely to result in a significant impact to this species. Unlikely significant impact.
Lathamus discolor	Swift Parrot	E	Loss of about 39.2 ha of potential habitat. No impacts to any known habitat. The Swift Parrot is likely to forage in the construction footprint on an intermittent basis however was not recorded during targeted surveys. Two records of the Swift Parrot occur within a 10 km radius of the project (OEH, 2016). Given the high mobility of the species and the persistence of similar quality habitat within the region suitable for foraging, the project is unlikely to result in a significant impact to this species. Unlikely significant impact.
Chalinolobus dwyeri	Large-eared Pied Bat	V	Loss of about 39.2 ha of potential foraging habitat. No impacts to any known habitat. No potential roost sites for Large-eared Pied Bat in construction footprint or study area. Unlikely significant impact

Scientific name	Common name	EPBC Act status	Nature of impacts and outcome of significance assessment
Dasyurus maculatus	Spotted-tailed Quoll	E	Loss of about 39.2 ha of potential habitat. No impacts to any known habitat. The Spotted-tailed Quoll was not recorded during targeted surveys. Unlikely significant impact
Phascolarctos cinereus	Koala	V	Loss of about 32.8 ha of potential habitat. No impacts to any known habitat which does not constitute core Koala habitat in accordance with the EPBC Act referral guidelines for the Koala (DotE 2014). The Koala was not recorded during targeted surveys. The nearest record was two kilometres away in Blackbutt Reserve in 1986 (OEH, 2016). Unlikely significant impact

Assessments of Significance under the EPBC Act have been prepared for each of these species, which are provided in Appendix M.

Grey-headed Flying Fox (Pteropus poliocephalus)

The Grey-headed Flying-fox occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria however, only a small portion of this range is used at any one time, depending on the availability of food. The species is widespread in its range in summer, while in autumn it occupies coastal lowlands and is uncommon inland (DotE 2015c).

This species requires roosting sites and foraging resources comprising fruit and nectar producing canopy species in a variety of vegetation communities including rainforest, open forest, closed and open woodland, Paperbark (*Melaleuca*) swamps, Banksia woodlands and commercial fruit crops and introduced species in urban environments (DotE 2015c).

Grey-headed Flying-fox were observed flying over the construction footprint and suitable foraging habitat (in the form of blossom-producing trees) was identified within both the construction footprint and the study area (Parsons Brinckerhoff 2015a). As discussed previously, a known breeding camp for this species occurs directly to the south-east of the construction footprint (about 230 metres from the southern extent of the construction footprint) in Blackbutt Reserve. It is likely that individuals from this camp forage within the construction footprint on a regular basis when trees are in flower (Parsons Brinckerhoff 2015a).

This camp is not identified as a Nationally important camp under the *Draft EPBC Act Policy Statement Camp management guidelines for the Grey-headed and Spectacled flying-fox* (DotE 2014). However, it is considered to be regionally important as it is known to support breeding females, is the only known camp in the Newcastle LGA and provides a year-round foraging resource, being the only continuously occupied camp in the Lower Hunter region (Geolink 2013).

The project is unlikely to impact the known Grey-headed Flying-fox camp in Blackbutt Reserve however it is likely that individuals from this camp forage within the study area when feed trees are in flower (Parsons Brinckerhoff 2015a). The project would result in the removal of about 39.2 hectares of native vegetation identified as providing a suitable foraging resource for the Grey-headed Flying-fox. The project would result in a reduction of about 10 per cent of native vegetation cover within the locality.

Flora species in the construction footprint provide a variety of foraging resources for the Grey-headed Flying-fox from a range of species that together would flower during much of the year. The construction footprint provides habitat for winter-flowering myrtaceous tree species such as the Spotted Gum (*Corymbia maculata*) and Ferguson's Ironbark (*Eucalyptus fergusonii*) which provide an important foraging resource for the Grey-headed Flying-fox during the winter months. Red Bloodwood (*Corymbia gummifera*), which is also present in the construction footprint, is a prolific flowering species and is important for nectarivorous fauna during the autumn months (Parsons Brinckerhoff 2015a).

In accordance with the *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009), the foraging habitat present within the construction footprint and study area is considered critical to the survival of the Grey-headed Flying-fox due to the presence of winter flowering species which are known to support a continuously occupied camp located at Blackbutt Reserve. However, given the relatively large tracts of native vegetation near the construction footprint, feeding resources contained within the construction footprint would only provide a small proportion of that available to the species in the wider locality (Parsons Brinckerhoff 2015a).

Therefore, although native vegetation within the indicative construction footprint is consistent with the definition for foraging habitat critical to the survival of the Grey-headed Flying-fox, it is considered to provide only a small proportion of that available in the wider locality (about 0.012 per cent based on estimates of total foraging habitat within the Lower Hunter region (Geolink 2013). Consequently, the removal of about 39.2 hectares of native vegetation identified as providing a critical foraging resource to an important population of Grey-headed Flying-fox is considered unlikely to lead to a long-term decrease in the size of the population, given the availability of similar habitat within the wider locality.

The removal of about 39.2 hectares of native vegetation would fragment the existing available foraging habitat within the construction footprint and reduce connectivity in the wider area by increasing gaps in the existing vegetation cover. These gaps would be readily traversed by the Grey-headed Flying-fox which is a highly mobile aerial species and consequently any fragmentation of foraging habitat is considered to be overcome by this species.

An assessment of significance pursuant to the EPBC Act significant impact guidelines (DotE 2013) has been prepared for this species and is provided in Appendix M. The assessment of significance concluded that pursuant to the significant impact guidelines (DotE 2013), the project is likely to have a significant impact on a local important population of the Grey-headed Flying-fox given that it would adversely affect foraging habitat critical to the survival of the species. While the Grey-headed Flying-fox is likely to utilise the construction footprint as part of its larger home range, the removal of about 39.2 hectares of suitable foraging habitat for this species is likely to result in a significant impact to this species.

A number of mitigation measures detailed in Section 9 will be implemented for the project to reduce potential for adverse indirect impacts on Grey-headed Flying-fox habitat in nearby areas of the construction footprint and surrounds. Furthermore, the FBA process has been applied to this project to offset any residual impacts to this species (ie the removal of about 39.2 hectares of native vegetation) that cannot be avoided or mitigated.

Regent Honeyeater (*Anthochaera phrygia (syn. Xanthomyza phrygia)*)

The Regent Honeyeater is a migratory species which has a widespread, patchy distribution in south eastern Australia. The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia.

In NSW the breeding distribution it is confined to two main breeding areas, within the Capertee Valley and Bundarra-Barraba regions and surrounding fragmented woodland. In some years' flocks converge on flowering coastal woodlands and forests (OEH 2014b). A key habitat for the species on the coast and coastal plains of New South Wales is Lower Hunter Spotted Gum - Ironbark Forest which provides important foraging habitat when box-ironbark forests are drought affected (Menkhorst *et al.* 1999). Preferred feed trees for this species include Spotted Gum (*Eucalyptus maculata*) and Swamp Mahogany (*Eucalyptus robusta*) both of which occur within the construction footprint and study area. These trees potentially provide important foraging habitat for the species during flowering periods. The project would remove about 39.2 hectares of potential foraging habitat for this species.

The OEH Wildlife Atlas search identified 13 records of the species within 10 kilometres of the project (OEH 2015a). There is no known population of Regent Honeyeaters within the construction footprint and surrounds. The project would slightly decrease the amount of available foraging habitat in the locality, however the Regent Honeyeater is a highly mobile species with a very large range. Regent Honeyeaters would still be able to forage in large areas of similar habitat surrounding the project.

There is no critical habitat listed for this species. Stands of White box, Yellow Box, Yellow Gum and Mugga Ironbark growing on high quality sites with relatively predictable and copious nectar production have been identified as critical to the survival of the Regent Honeyeater (Menkhorst et al 1999). None of these species occur within the study area. Lower Hunter Spotted Gum Ironbark Forest is known to be important refuge habitat when box-ironbark forests are drought affected (Menkhorst et al. 1999). About 4.1 hectares of this vegetation type would be removed. However, about 180 hectares would remain unaffected next to the construction footprint.

About 180 hectares of vegetation in the study area suitable for the Regent Honeyeater would remain available for foraging post-project completion. The construction footprint is also directly north of Blackbutt Reserve in which a further 180 hectares of similar vegetation type would remain. Furthermore, Blue Gum Hills Regional Park is only three kilometres east for the project which conserves about 11,000 hectares of similar vegetation and connects with Mount Sugarloaf and Heaton State Forest. The project would therefore be highly unlikely to adversely affect any habitat critical to the survival of the species.

The National Recovery Plan for the Regent Honeyeater (DotE, 2016) identifies the following recovery objectives for the species:

- Reverse the long-term population trend of decline and increase the numbers of Regent Honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years.
- Maintain key Regent Honeyeater habitat in a condition that maximises survival and reproductive success, and provides refugia during periods of extreme environmental fluctuation.

The 2011 Action Plan for Australian Birds outlines the following conservation objectives relevant to the recovery effort of the Regent Honeyeater (Garnett et al. 2011):

- Persistence of the species in the wild.
- Breeding in the wild of the offspring of reintroduced birds.
- A viable captive population.

None of the objectives listed within these plans are relevant to the project. The removal of about 39.2 hectares of potential foraging habitat is not expected to interfere with the recovery of the species.

In conclusion, the project is not likely to have a significant impact on the Regent Honeyeater as:

- No known breeding habitat would be impacted as a result of the project.
- The species are highly mobile, migratory species and only visit the study area on occasion to forage.
- The Regent Honeyeater would still be able to move through and forage in remaining habitat surrounding the project.
- There are large areas of similar habitat in the locality that could be used by this species as foraging habitat.

Swift Parrot (*Lathamus discolor*)

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes. Swift Parrots will return to some foraging sites on a cyclic basis depending on food availability.

While over-wintering in NSW, this species feeds primarily on flowering eucalypts including Spotted Gum (*Corymbia maculata*) and Red Bloodwood (*C. gummifera*), which occur in the study area and construction footprint. The Swift Parrot is likely to forage in the construction footprint on an intermittent basis however was not recorded during targeted surveys during optimum detection periods (winter).

The project would remove about 39.2 hectares of potential foraging habitat for the Swift Parrott.

Swift Parrots are highly mobile, migratory species with extremely large ranges which breed in Tasmania and occur from South Australia to southern Queensland during winter. This nomadic species moves through a variety of vegetation types across the landscape in response to seasonal availability of food. The project would not inhibit movement of this highly mobile species through the landscape as it would continue to have access to other potential foraging areas surrounding the site.

There is no critical habitat listed for this species. The *National Recovery Plan for the Swift Parrot* (Birds Australia 2011) identities priority habitats for conservation. These include habitats which are used:

- For nesting.
- By large proportions of the Swift Parrot population.
- Repeatedly between seasons (site fidelity).
- For prolonged periods of time (site persistence).

Foraging habitat in NSW is considered to be critical to the survival of the species. The Hunter-Central Rivers is identified as a priority habitat for conservation management of Swift Parrot nesting and foraging resources (Birds Australia 2011). Swift Parrots may forage in the construction footprint during winter as Spotted Gum and Swamp Mahogany are two important feed trees for the Swift Parrot that are present within the construction footprint. The construction footprint would only impact a small portion of the resources available in the locality.

About 180 hectares of vegetation in the study area suitable for Swift Parrot would remain available for foraging post-project completion. The construction footprint is also directly north of Blackbutt Reserve in which a further 180 hectares of similar vegetation type would remain. Furthermore, Blue Gum Hills Regional Park is only three kilometres east for the project which conserves 11,000 hectares of similar vegetation and connects with Mount Sugarloaf and Heaton State Forest. The project would therefore be highly unlikely to adversely affect any habitat critical to the survival of the species.

The *National Recovery Plan for the Swift Parrot* (Birds Australia, 2011) identifies four key objectives which are:

- Identify the extent and quality of habitat.
- Manage and protect Swift Parrot habitat at the landscape scale.
- Monitor and manage the impact of collisions, competition and disease.
- Monitor population and habitat.

The project is not consistent with managing and protecting Swift Parrot habitat at the landscape scale as it would remove about 39.2 hectares potential foraging habitat within an identified priority region. Although the construction footprint was mapped as low – medium habitat value for Swift Parrots (Birdlife Australia 2011), resources in urban areas are important for the species in a highly fragmented landscape. Habitat loss and alteration through land clearing presents the greatest threat to the Swift Parrot. The species is highly mobile with a large home range, and resources would remain within the locality. Within the context of the remaining similar habitat for this species in the locality, it is highly unlikely that the removal of about 39.2 hectares of potential foraging habitat would interfere with the recovery of the species.

The project would remove about 39.2 hectares of potential foraging habitat for the Swift Parrot. The project is not likely to have a significant impact on Swift Parrot as:

- No breeding habitat would be impacted as a result of the project.
- The species are highly mobile with large home ranges and would visit the construction footprint only on a seasonal basis when preferred feed trees are flowering.
- The species would continue to be able to move through the construction footprint in which about 180 hectares of forest next to the project would be unaffected, and the vast amounts of resources to the west of the project.
- There are large areas of similar habitat in the locality that could be used by this species as foraging habitat.

Spotted-tailed Quoll (Dasyurus maculatus)

The Spotted-tailed Quoll has been recorded across a range of habitats from rainforest through woodland, heath and inland riparian forest from the coast to the sub-alpine zone. The species is nocturnal and will shelter in hollow-bearing trees, fallen logs, caves, crevices and cliff faces during the day. Their home range is large, with females occupying home ranges of up to 750 hectares and males up to 3500 hectares which they often traverse along densely vegetated cliff lines. Quolls will predate a variety of prey from arboreal and terrestrial mammals to insects, carrion and domestic chickens (OEH 2014b).

The Spotted-tailed Quoll was not recorded during surveys, however the construction footprint contains potential foraging habitat and denning sites. Habitats at the site would represent only a small proportion of the habitats utilised by this species. The project would result in the removal of about 39.2 hectares of potential habitat for this species. The project would still allow for movement under the road (in some sections) if individuals did happen to exist. Therefore, the project is highly unlikely to fragment an existing important population into two or more populations. No area of critical habitat has been listed for this species.

A Spotted-tailed Quoll population is unlikely to occur within the study area. Considering the isolated nature of the site, the lack of evidence of Spotted-tailed Quolls in the study area and no records of Spotted-tailed Quoll s within 10 kilometres of the construction footprint, the project is therefore unlikely to result in a long-term decrease in the size of a population of the species. There is little opportunity for individuals to migrate into the vegetation contained within the study area as there are no vegetated corridors through the urban areas that would allow for movement into this isolated patch of forest. About 180 hectares of forest would remain within the study area post-project completion which could contain potential habitat for the species.

A National Recovery Plan has been prepared for the Spotted-tailed Quoll (OEH 2016) which identifies a range of actions to promote the recovery of the species. These include:

- Investigate key aspects of biology and ecology of the Spotted-tailed Quoll to acquire targeted information to aid recovery.
- Reduce the rate of habitat loss and fragmentation on private land.
- Evaluate and manage the risk posed by silvicultural practices.
- Determine and manage the threat posed by introduced predators (foxes, cats, wild dogs) and of predator control practices on Spotted-tailed Quoll populations.
- Determine and manage the impact of fire regimes on populations.
- Reduce deliberate killings and frequency of road mortality.
- Assess the threat of cane toads and implement threat abatement plans if necessary.
- Determine likely impact of climate change on populations.
- Increase community awareness and involvement in the Recovery Program.

The project will contribute to one of the threats: fragmentation and reduction of 39.2 ha of potential habitat. Although the project will incrementally add to the loss of potential habitat for the Spotted-tailed Quoll, it is unlikely to interfere with the recovery of this species. Furthermore, the connectivity strategy, including crossing infrastructure and fencing aims to reduce the potential for road mortality. None of the other threats identified in the recovery plan for this species are impacted by the project.

Consequently, the project is not likely to have a significant impact on the Spotted-tailed Quoll as:

- There are no known populations of Spotted-tailed Quoll within the study area (despite targeted survey efforts) and no records have been observed within 10 kilometres of the project.
- 180 hectares of forest would remain next to the project which would contain potential habitat for the species.
- There is minimal potential for migration into the study area as it is isolated patch of vegetation. There are no vegetated corridors through the surrounding urban areas that would allow for movement into the study area suitable for use by the Spotted-tailed Quoll.

- In the unlikely event that Spotted-tailed Quolls do inhabit the site the project would not result in the fragmentation of the population as connectivity of the vegetation would be maintained as the road design contains bridges and other structures which would allow fauna to pass underneath.
- The project is highly unlikely to result in the decline of Spotted-tailed Quoll due to the introduction of invasive species and pathogens as mitigation measures detailed in Section 9 would be implemented to mitigate potential impacts from introduced species and pathogens.

Koala (Phascolarctos cinereus)

The Koala is widely distributed in eastern Australia, occurring from north-eastern Queensland to the south-east corner of South Australia (ANZECC 1998). This distribution equates to about one million square kilometres. In NSW, the Koalas range occurs along the coast and extends west to the Darling Riverine Plains and Mulga Lands bioregions in the north of the state; to the Cobar Peneplain bioregion in the centre of the state; and to the Riverina and eastern most parts of the Murray-Darling Depression bioregions in the south. It is restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from less than two to several hundred hectares (DotE 2015b). In the unlikely event that Koalas exist within the construction footprint and surrounds, the project is not near the limit of the species range given its extensive distribution and unlikely to result in a reduction of the species range.

The Koala was not recorded during targeted surveys. The nearest record was two kilometres away in Blackbutt Reserve in 1986. Potential Koala habitat is present in the three Spotted Gum vegetation communities which occur within the construction footprint all of which contain Grey Gum (*Eucalyptus punctata*), a secondary food tree species and Swamp Mahogany (*Eucalyptus robusta*) which is a preferred primary feed tree. The project would result in the removal of about 32.8 hectares of potential habitat for this species. The project would not result in any impacts to any known habitat which constitutes core Koala habitat in accordance with the EPBC Act referral guidelines for the Koala (DotE 2014). As targeted surveys for this species was carried out and no recent records occur in the locality, it is considered unlikely that the Koala occurs in the study area or construction footprint.

The project would remove about 32.8 hectares of potential foraging habitat for the Koala. The project is not likely to have a significant impact on the Koala as:

- There are no important populations of Koalas within the construction footprint and study area (despite targeted survey efforts) and no records have been observed in the locality since 1986 near Blackbutt Reserve.
- About 180 hectares of native vegetation in the study area next to the construction footprint would remain post project completion.
- There is minimal potential for migration into the construction footprint and study area as it is isolated from other areas and there are no vegetated corridors through the surrounding urban areas that would allow for movement into this isolated patch of vegetation.
- The project would not result in the fragmentation of Koala habitat.

Large-eared Pied Bat (Chalinolobus dwyeri)

The Large-eared Pied Bat is a medium-sized insectivorous bat with shiny, black fur on the body with a white stripe on the ventral side of the torso where it adjoins the wings and tail. The species' current distribution is also poorly known.

In NSW, the species is considered rare with a patchy distribution most likely due to the specific habitat requirements of the species. A maternity roost site for the species usually requires sandstone caves or cliff overhangs, although it has also been observed roosting in disused mine shafts and abandoned Fairy Martin nests (Pennay 2008). Sandstone cliffs and fertile woodland valley habitat within close proximity of each other is habitat of importance to the Large-eared Pied Bat (DECC 2007).

The construction footprint and study area does not contain habitat that would be used for breeding/maternity sites for this species and there are no potential roost sites for Large-eared Pied Bat, however the species may forage in habitat contained within the construction footprint and study area. The Large-eared Pied Bat forages in a range of vegetation types, including wet and dry sclerophyll forest. This species is known to be associated with several vegetation types recorded within the construction footprint and surrounds. These include:

- Smooth-barked Apple - Red Bloodwood open forest.
- Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest.
- Sydney Blue Gum - White Mahogany shrubby tall open forest -atypical variant and *Syncarpia glomulifera* variant.

The project would result in the removal of about 39.2 hectares of potential foraging habitat for this species.

There are no previous records of the species within 10 kilometres of the construction footprint and the species was not recorded at the site during surveys. The construction footprint and study area is an isolated patch of forest surrounded by roads and urban development. The species has very specific maternity roost habitat requirements which are unlikely to be present at the site. Large-eared Pied Bats are known to occur from Shoalwater Bay, north of Rockhampton, Queensland through to Ulladulla, on the south coast of NSW. The construction footprint and study area is therefore not near the limit of the species range (DotE 2015b).

It is highly unlikely that an important population of Large-eared Pied Bats occurs at the site. There were no records of the species during surveys, and there are no known roost camps within 10 kilometres of the construction footprint and study area. The construction footprint and study area does not contain suitable breeding or maternity habitat. The species may forage within the construction footprint on occasion. About 39.2 hectares of potential foraging habitat would be removed as a result of the project. However, about 180 hectares of forest next to the construction footprint would remain post-project completion available for the species to forage.

The *National Recovery Plan for the Large-eared Pied Bat Chalinolobus dwyeri* (DERM, 2011) discusses criteria for identifying habitat considered critical to the survival of the species. In accordance with the plan, habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival for Large-eared Pied Bat:

- Any known maternity roost site.
- Sandstone cliffs and fertile wooded valley habitat is close proximity of each other.

There are no known maternity roosts within the study area, and there are no records of the species within 10 kilometres of the construction footprint. Although there are some areas of sandstone outcropping within the study area are no sandstone escarpments or cliffs that would be utilised as maternity roosts for this species. Based on lack of suitable roosting habitat within the site, it is considered highly unlikely that the project would impact on habitat that is critical to the survival of the species.

The *National Recovery Plan for the Large-eared Pied Bat Chalinolobus dwyeri* (DERM 2011) identifies a range of actions to promote the recovery of the species. These include:

- Identify priority roost and maternity sites for protection.
- Implement conservation and management strategies for priority sites.
- Educate the community and industry to understand and participate in the conservation of the Large-eared Pied Bat.
- Research to augment biological and ecological data to enable conservation management.
- Determine the meta-population dynamics for the distribution of the Large-eared Pied Bat.

The project is unlikely to interfere with the recovery of the species as it would not impact on roost or maternity sites for this species. None of the other actions identified in the recovery plan for this species is relevant to the project.

Pursuant to the significant impact guidelines (DotE 2013), the project would not have a significant impact on an important population of the Large-eared Pied Bat as:

- There have been no records or known maternity roosts within 10 kilometres of the construction footprint.
- The Large-eared Pied Bat would only utilise the site as potential foraging habitat.
- About 39.2 hectares of potential foraging habitat would be removed which represents only as small proportion of the potential foraging habitat in the locality.
- The project would not result in the fragmentation of habitat as if present this highly mobile species would be able to continue foraging in vegetation surrounding the site and within other similar vegetation in the local area.

A number of mitigation measures detailed in Section 9 would be implemented to reduce potential for adverse indirect impacts on the Large-eared Pied Bat habitat in nearby areas of the construction footprint. Furthermore, the NSW FBA process will be applied to this project to determine an appropriate offset for potential impacts to potential habitat for this species.

8.4.4 Migratory species

The project would remove about 39.2 hectares of native vegetation which contains potential and known habitat for migratory species listed under the EPBC Act (Table 8-9).

Three migratory species listed under the EPBC Act were recorded within the study area and a further four migratory bird species listed under the EPBC Act are considered to have a moderate or high likelihood of occurring on an occasional or transient basis in response to favourable conditions within the study area (Table 5-3).

The Fork-tailed Swift (*Apus pacificus*) and White-throated Needletail (*Hirundapus caudacutus*) both breed in the northern hemisphere and are almost exclusively aerial while in Australia during the non-breeding season. These birds may forage and fly over the study area but would be unlikely to land and/or be dependent on the habitats present within the study area.

The Rufous Fantail (*Rhipidura rufifrons*) and Black-faced Monarch (*Monarcha melanopsis*) both use breeding territories in wet forests similar to those located within the study area. These two species could potentially use the site for breeding and foraging purposes.

Cattle Egret (*Area ibis*) are known to roost at the Shortland Wetlands to the north of the site and are likely to visit the disturbed areas of the study area due to the presence of horses that are kept nearby.

Two migratory woodland species may occur within the study area, Satin Flycatcher (*Myiagra cyanoleuca*) tends to prefer moist, densely vegetated habitats, though they may occur in more open habitats while migrating. The Rainbow Bee-eater (*Merops ornatus*) is generally found in open forests and woodlands and roosts in banks and sand dunes. Both of these species are likely to forage and/or breed within the study area.

Table 8-9 Migratory fauna listed under EPBC Act recorded or likely to occur within the study area

Scientific name	Common name	Likelihood of occurrence [1]
Apus pacificus	Fork-tailed Swift	Moderate
Area ibis	Cattle Egret	Recorded
Hirundapus caudacutus	White-throated Needletail	Moderate
Merops ornatus	Rainbow Bee-eater	Moderate
Monarcha melanopsis	Black-faced Monarch	Recorded
Myiagra cyanoleuca	Satin Flycatcher	Moderate
Rhipidura rufifrons	Rufous Fantail	Recorded

Note: 1 Parsons Brinckerhoff (2015a)

The significant impact guidelines (DotE 2013c) for migratory species listed under the EPBC Act define important habitat as follows:

> '*An area of 'important habitat' for a migratory species is:*
>
> – *Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or*
> – *Habitat that is of critical importance to the species at particular life-cycle stages, and/or*
> – *Habitat utilised by a migratory species which is at the limit of the species range, and/or*
> – *Habitat within an area where the species is declining'*

The study area is not considered important habitat for any of these species, according to the significant impact criteria for migratory species (DotE 2013c). This is due to the fact that potential habitat in the study area would not support an ecologically significant proportion of the population of these species, is not of critical importance to these species at particular life-cycle stages, is not at the limit of these species ranges, and is not within an area where these species are declining.

Given the absence of important habitat for any migratory species recorded or likely to occur, it is unlikely that these impacts would be significant and consequently assessments of significance have not been prepared for these species. Unavoidable impacts to potential habitat for migratory species will be further assessed as part of the NSW FBA requirements.

8.4.5 Wetlands of international significance

The project is located within the catchment of sensitive receiving environments, including SEPP 14 and Ramsar wetlands. The internationally significant Hunter Estuary Wetlands Ramsar site is located about six kilometres downstream of the project.

The construction footprint contains tributaries to Ironbark Creek which flows through an urban and rural landscape and enters the Hunter Wetlands Centre Australia about 6 km downstream which forms part of the Hunter Estuary Wetlands Ramsar site. The Hunter Wetlands Centre site then drains into the Hunter River (south arm) and into the larger portion of the Hunter Estuary Wetlands Ramsar site (formerly Kooragang Nature Reserve).

The project would result in the removal of about 39.2 hectares of native vegetation and replacement with an impermeable surface. A water quality and watercourse assessment (GHD 2016b) was carried out for the project which assessed potential impacts to the wetlands using a catchment scale MUSIC model which estimated the average pollutant loads in water reporting to the SEPP 14 and Ramsar wetlands under the existing and operational catchment conditions.

The MUSIC modelling indicates that such a minor increase in impervious area is unlikely to result in an appreciable change in pollutant loads reporting to the SEPP 14 and Ramsar wetlands.

A discussion of the project's potential for impacts to wetlands of international importance is also addressed in Section 8.3.1.

Consequently, it is considered unlikely that the project would result in a '*real chance of a substantial and measurable change in the water quality of the wetland*' (DoE 2013), and is therefore considered to be consistent with *Significant impacts guidelines 1.1: Matters of National Environmental Significance* (DoE 2013) if the mitigation and management measures detailed in Section 9 are implemented.

8.5 Other impacts not covered by the FBA

Construction of the project includes a range of ancillary facilities, including construction compounds, temporary access tracks and sedimentation basins (Figure 1-3). All construction facilities have been included within the construction footprint and have therefore been considered in the FBA calculations in Section 8.2. Potential impacts from construction and operation of the project not covered by the FBA are discussed in the following sections.

8.5.1 Removal of hollow-bearing and mature trees

About 320 habitat (hollow-bearing) trees have been identified within the construction footprint and will be cleared by the project. An additional 17 potential Powerful Owl roost trees and five known Powerful Owl roost trees were also identified within the construction footprint. Wherever possible, mature trees and hollow-bearing trees, particularly identified Powerful Owl trees, within the construction footprint will be retained. Habitat salvage and reinstalment will be carried out during vegetation clearing to minimise residual impacts to biota wherever possible (Table 9-1).

During construction as far as possible mature trees would be retained within the construction footprint to assist with rehabilitation and habitat connectivity, particularly around identified watercourses. For construction compound B, located within Jesmond Park, mature trees and hollow-bearing trees will be retained as far as possible (Table 9-1).

8.5.2 Aquatic impacts

No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in the study area and no significant impacts on riparian vegetation or habitats downstream of the construction footprint are anticipated as a result of the project as discussed in Section 8.4.5. There would be no impact on key fish habitat as a result of the project.

Aquatic habitats occur within the construction footprint as ephemeral drainage lines which retain water during periods of high rainfall. Aquatic habitats provide potential breeding and sheltering habitat for frog and reptile species however, due to the ephemeral nature of these water bodies, the aquatic habitats contained within the study area are likely to provide habitat for only a limited range of common aquatic animals (Parsons Brinckerhoff 2015a and Parsons Brinckerhoff, 2016). The watercourses in the study area have moderate riparian vegetation cover which are characterised by the identified intermittent groundwater dependent ecosystems (Section 8.5.3).

The potential for water quality impacts on receiving surface waters are considered to be low to moderate given the distance of the construction footprint from the drainage lines, the buffer of vegetated land and the use of mitigation measures during construction. Potential water quality impacts would be managed through the implementation of mitigation measures detailed in Section 9, including the provision of sedimentation basins, silt fences and other structures to intercept runoff.

The introduction of pollutants from the project into the surrounding environment, if uncontrolled, could potentially impact on water quality. Potential pollutants include:

- Fill material.
- Contaminants from neighbouring land uses (roads), areas stripped of vegetation and hardstand areas, including roads, processing areas and site facilities.
- Leakage or spillage of hydrocarbon products from vehicles, wash down areas and workshops.

The project would result in an increase in cleared area, however with implementation of appropriate mitigation and management actions detailed in Section 9, these are unlikely to result in significant changes to surface water flows or water quality in the study area. A groundwater assessment prepared for the project by GHD (2016b) determined that the project is unlikely to result in significant impacts to groundwater, surface water, groundwater dependent ecosystems or sensitive downstream receivers, including Ramsar wetlands. Consequently, the project is not considered to impact aquatic environments including downstream aquatic ecosystems such as the Ramsar listed Hunter Estuary Wetlands.

The northern branch of Watercourse 2 (Figure 2-2) would be crossed by a bridge structure which would require realignment of a short section (about 60 metres) of the watercourse at the crossing site. This section of the watercourse was observed to be of low habitat quality and in disturbed condition. The bridge structure (and associated watercourse reshaping) would include suitable scour protection measures such as ‘rip rap’ to minimise the potential for bed and bank scouring to occur (Table 9-1).

The water quality and watercourse assessment (GHD, 2016a) determined that the bridge crossing of the northern branch of Watercourse 2 (Figure 2-2) would not affect flow volumes or durations. It is therefore expected that the bridge crossing would have a negligible impact on the morphology of the northern branch of Watercourse 2 both upstream and downstream of the project. Furthermore, the project would not impact fish passage or fish habitat.

8.5.3 Groundwater dependent ecosystems

Two vegetation communities identified within the construction footprint are considered to be intermittently dependent on groundwater; these are the two variants of the Sydney Blue Gum – White Mahogany shrubby tall open forest. These PCTs are both riparian communities and are likely to rely on surface water runoff and accessing groundwater when groundwater levels are high and were therefore classified as being intermittently dependent on groundwater (Parsons Brinkerhoff 2015a).

About 4.4 hectares of Sydney Blue Gum – White Mahogany shrubby tall open forest GDE would be cleared as part of the project. These communities are likely to only rely upon groundwater resources on an intermittent basis (Parsons Brinckerhoff, 2015a) and their removal is unlikely to result in any disruption to any other GDEs in the study area. Clearing and revegetation of riparian areas will be carried out in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) and with reference to DPI Water Guidelines for Controlled Activities on Waterfront Land. Clearing of riparian vegetation will be offset in accordance with the FBA as detailed in the BOS in Appendix B.

An additional GDE, Smooth-barked Apple – Red Bloodwood open forest – *Gahnia clarkei* variant, was also identified within the study area, near McCaffrey Drive. This GDE occurs well outside of the construction footprint and would not be directly or indirectly impacted.

A detailed groundwater assessment has been prepared for the project which also discusses and assesses the potential impacts of the project on identified GDEs in the study area (GHD 2016b). The assessment identified three GDEs located within the predicted radius of influence of four of the project's cuttings:

- The known GDE, a *Gahnia clarkei* variant of the Smooth-barked Apple Red Bloodwood open forest as mapped by Parson Brinckerhoff (2015a), occurs more than 250 metres from the nearest proposed cutting (Cutting 2). Due to the hydrogeological separation of the perched aquifer that feeds the known GDE and the proposed cutting by a steep sided valley, the known GDE will continue to be fed by seepage from the perched aquifer. Therefore, the project and its cuttings would not have any impact on the known GDE.
- An intermittent GDE, an atypical variant of the Sydney Blue Gum – White Mahogany shrubby tall open forest as mapped by Parsons Brinckerhoff (2015a), occurs about 90 metres from the closest proposed cutting (Cutting 1). This intermittent GDE is within the predicted zone of impact on groundwater. This may result in some reduced baseflow to the intermittent GDE. However, the intermittent GDE would continue to be fed by surface water runoff and from groundwater flow from aquifers that are underlying Cutting 1. In addition, groundwater inflow into Cutting 1 would ultimately drain back to the watercourse that supports the intermittent GDE during both construction and operation.
- An intermittent GDE, a *Syncarpia glomulifera* variant of the Sydney Blue Gum – White Mahogany shrubby tall open forest as mapped by Parsons Brinckerhoff (2015a), occurs in two locations near a proposed cutting (Cutting 3). One community is mapped as occurring next to the proposed cutting to the north-west and the second occurrence of the GDE is located about 230 metres to the south-west of the proposed cutting. There would be limited impact on the intermittent GDE outside the footprint of the fill as it would continue to be fed by seepage from aquifers that lie below the proposed Cutting 3 and from surface water runoff. In addition, groundwater inflow into Cutting 3 would ultimately drain back to the watercourse that supports the intermittent GDE during both construction and operation.

In summary, the project would involve the construction of new fill and hardstand areas that may modify and/or impede the local movement of perched groundwater in some areas. This may result in a minor change to where perched groundwater seeps in some areas, however it is not expected to change the drainage line to which this seepage reports. Therefore, it is not expected that this change to perched groundwater flow pathways would impact on intermittent GDEs. Furthermore, the project is not predicted to result in any variation in the water table within 40 metres of any high priority GDEs (GHD 2016b).

8.5.4 Changes to hydrology

As previously discussed, a groundwater assessment prepared for the project by GHD (2016b) determined that the project is not predicted to result in any decline in groundwater pressure and is not predicted to alter the beneficial use of the perched groundwater (Section 8.5.2). Consequently, the project is unlikely to significantly alter hydrology in the study area or impact upon GDEs occurring outside of the construction footprint in the study area. Furthermore, the groundwater assessment also identified that the project is unlikely to result in significant impacts to groundwater, surface water, groundwater dependent ecosystems or sensitive downstream receivers, including Ramsar wetlands (GHD 2016b).

A water quality and watercourse assessment (GHD 2016b) was carried out for the project which assessed potential impacts to the wetlands using a catchment scale MUSIC model which estimated the average pollutant loads in water reporting to the SEPP 14 and Ramsar wetlands downstream of the project under the existing and operational catchment conditions. While the project is estimated to result in a small increase in the impervious area of the SEPP 14 and Ramsar wetlands catchment (about one per cent and 0.6 per cent respectively). The MUSIC modelling carried out in the water quality and watercourse assessment (GHD 2016a) indicates that such a minor increase in impervious area is unlikely to result in an appreciable change in pollutant loads reporting to the SEPP 14 and Ramsar wetlands.

Consequently, it is considered unlikely that the project would result in a '*real chance of a substantial and measurable change in the water quality of the wetland*' (DoE 2013), and is therefore considered to be consistent with *Significant impacts guidelines 1.1: Matters of National Environmental Significance* (DoE 2013) if the mitigation and management measures detailed in Section 9 are implemented.

8.5.5 Fragmentation of identified biodiversity links and habitat corridors

Fragmentation and connectivity of habitat

The project would result in the fragmentation of a large patch of existing isolated vegetation. The vegetation contained in the study area is largely intact however isolated from other remnant bushland by existing infrastructure and broad scale urban development (including the John Hunter Hospital precinct). The study area is located between a number of remnant vegetation areas, currently isolated by existing residential and transport infrastructure. The study area comprises the major proportion of remnant vegetation in the area and is identified as part of a local area biodiversity corridor (DECCW 2012) (Figure 1-4).

The project would result in fragmentation and a reduction in connectivity of vegetation within the study area by removing previously well-connected vegetation and creating a barrier for fauna movement between existing areas of vegetation to the east and west of the alignment. The project will also result in the isolation of previously connected remnant vegetation, particularly in south-eastern section of the project.

Lookout Road is a four lane carriageway with high traffic volumes which provides an existing barrier to terrestrial fauna species between the Rankin Park bushland and Blackbutt Reserve. The project will not result in an increase in traffic or corridor width on Lookout Road (north of McCaffrey Drive) and consequently, is unlikely to result in an increase in barrier effects to off-site areas, including Blackbutt Reserve.

A fauna connectivity strategy will be implemented as part of the project to maintain connectivity for terrestrial and arboreal fauna across the alignment (Section 7.3). The installation of dedicated fauna crossing infrastructure (eg culverts, pole and rope crossings) at several locations along the alignment will reduce the direct impact of the project on fauna connectivity. In conjunction with the dedicated fauna crossing points, the retention of two small areas of vegetation at the southern end of the study area will reduce the barrier effect to arboreal mammals and birds by providing stepping stones across the alignment.

A detailed assessment of other fauna crossing structures has been carried out and determined that they were not feasible as follows:

- Lookout Road - a rope bridge crossing of Lookout Road was determined to not be feasible due to the presence of overhead electrical wires. An underpass was also determined to not be feasible due to the significant costs and difficulty of construction under an existing high traffic volume four lane road. Further, the project would decrease the traffic volumes on Lookout Road north of McCaffrey Drive and reduce the likelihood of fauna mortality through road-strike.
- John Hunter Hospital precinct – an arboreal fauna rope bridge was considered near the existing hospital open air car park along the north-western extent of the hospital precinct. This option was determined to not be feasible due the following factors:
  - The large gap created by the existing car park (including lighting), construction compound and proposed bypass.
  - Lack of existing mature trees in the area linking the proposed crossing to remnant vegetation.
  - The existing presence of built infrastructure (including lighting) in the area.
- Potential for further development in this area as part of possible redevelopment of the John Hunter Hospital precinct. This would increase the extent of built infrastructure and roads (including lighting), further increasing the habitat gap and further decreasing favourable conditions for fauna utilisation.

The realignment of the project allowed for a wider vegetated corridor on the western side of alignment than the 2007 strategic design, which improves north-south connectivity between vegetation and associated habitat, increasing the potential for large and small fauna species to use habitats next to the project. It also improves connectivity to the west to Dangerfield Drive Reserve.

Existing movements of mobile fauna species and ecosystem processes through this area are likely to be affected by the project. Appropriate mitigation measures detailed in Section 9 will be implemented to reduce impacts wherever possible. The project is unlikely to significantly affect local or migratory movements of any native fauna species within and outside of the study area.

8.5.6 Edge effects on nearby native vegetation and habitat

‘Edge effects’ occur with increased noise and light, weed incursion or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may, in general, result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Removal of vegetation causes a number of new environmental conditions to develop along the edges of the cleared environments, in particular in environments that originally contain the upper strata levels (canopy and/or shrub layer) of vegetation. The removal of vegetation generally promotes the invasion of exotic species and/or disturbance tolerant native plants. With the invasion of these new species it often becomes difficult for the original plant species to recolonise once disturbed.

The project construction footprint and study area currently have a relatively low level of disturbance, with evidence of weed infestations around the perimeter of the study area, associated with cleared areas and residential disturbance. The project would increase the amount of vegetation cleared within the study area and result in areas that are currently not exposed to edge effects being exposed to possible detrimental impacts as a result of road construction. Edge effects would continue to affect remnant vegetation and habitats next to the alignment for the life of the project.

Potential edge effects resulting from the project include the introduction or spread of weed species, an increase of light, noise and dust to new areas of vegetation, which are currently less affected by these impacts. These impacts reduce flora and fauna habitat values in the newly exposed edge areas. Given the high habitat value of surrounding habitats, including the identified important populations of *Tetratheca juncea,* edge effects are a key management consideration for the project.

Edge effects will be managed through the implementation of mitigation and management measures detailed in Section 9. Indirect impacts have been calculated and will be offset in accordance with the project BOS to compensate for residual indirect impacts.

8.5.7 Injury and mortality of fauna

The project presents an inherent risk of injury and mortality to native fauna. Specific risks include:

- During construction when vegetation and habitats are being cleared.
- Through machinery and plant operating during construction.
- Operational traffic.

Native fauna injury and morality may occur during the construction and operation of the project. Risk of injury or mortality to native fauna is at its highest during construction of the project, particularly during vegetation clearing activities. More mobile species have a greater capacity to evade injury and/or seek alternative habitat within the extensive area of native vegetation surrounding the project. Small and hollow-dependent fauna such as reptiles or frogs which may be sheltering in dense vegetation or beneath woody debris during the project construction are more vulnerable to impact due to their decreased mobility.

There is the potential for adverse effects on smaller or less mobile terrestrial mammals, sheltering within the native vegetation as a result of clearing activities during construction. Particularly immobile fauna such as, fledglings, eggs and hollow dependent fauna species. Smaller species are known to sheltering in dense vegetation or beneath woody debris and are unlikely to avoid clearing disturbance.

Appropriate mitigation measures are provided in Section 9 to minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

Furthermore, operational fencing will be installed to exclude fauna and people from the road. Fauna escape points have also been incorporated into the operational fence design to allow entrapped fauna to escape in the unlikely event that fauna enter the fenced area.

8.5.8 Invasion and spread of weeds

The construction and operation of the project may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into nearby areas of native vegetation via erosion (wind and water), workers' shoes and clothing, or construction vehicles and machinery. The risk of weed introduction would continue during operation of the project through wind or water transmission of propagules from vehicles. Depending upon the weeds

introduced to the site, this could result in a decline in the condition of nearby native vegetation and associated native fauna habitats.

Some sections of the study area already support infestations of *Lantana camara,* a weed of national significance, however there is a possibility that additional, more invasive or otherwise damaging environmental weeds may be introduced to the remnant native vegetation, or that existing Lantana infestations may be further spread into areas that are currently free from infestations. Seven noxious weed species and numerous invasive species have been recorded within the study area (Section 2.1.10). These are currently abundant, particularly along the road verges, and watercourses within the study area. It is unlikely that any significant further introduction of weeds would occur as a result of the project with implementation of the mitigation and management measures in Section 9.

8.5.9 Invasion and spread of pests

The project has the potential to increase the presence of pest species such as the Fox (*Vulpes vulpes*) and Cat (*Felis catus*) within the study area as a result of clearing of native vegetation and dispersal of native fauna. Fox scats were observed within the study area during surveys and feral cats are likely to occur in the study area due to the high presence of residential areas surrounding the study area. Mitigation measures detailed in Section 9 will be implemented to minimise the potential for any impacts such as introduction and spread of pests a result of the project.

8.5.10 Invasion and spread of pathogens

The project has the potential to introduce pathogens such as Phytophthora (*Phytophthora cinnamomi*) and Myrtle Rust (*Uredo rangelii*) within the study area through vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Spread of Chytrid fungus (*Batrachochytrium dendrobatidis*) is also possible, given the presence of drainage lines in the study area but is unlikely as these drainage lines are relatively small and ephemeral. Where present, Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can wipe out entire populations once introduced into an area. Mitigation measures detailed in Section 9 will be implemented to minimise the potential for any impacts such as pathogen introduction as a result of the project.

8.5.11 Noise, light and vibration

Noise and vibration

The project would result in noise and vibration impacts during both the construction and operation of the project. These impacts would be as a result of vegetation clearing, vehicle movement, operation of plant and addition of traffic into the locality. Due to the topography of the site and staging of the proposed work, noise and vibration impacts would likely be limited to the areas immediately around the study area.

Raised levels of noise and vibration may deter native fauna from using the area surrounding the source of any noise or vibration. This may potentially interrupt dispersal within the locality if an individual is unwilling to travel through an area where increased levels of noise or vibration are detectable, or may cause some species to abandon an area in search of areas where these are not detectable.

The construction and operation of the project would expose new areas of habitat to increased noise and vibration levels, due to construction activities and ongoing vehicle traffic on the alignment. Although some parts of the study area are currently exposed to noise and vibration levels associated with existing roads, the project has the potential to result in additional impacts to native biota.

Mitigation measures to reduce noise and vibration generated by the project are outlined in Section 9 and will be implemented during the project. Indirect impacts have been calculated and will be offset in accordance with the project BOS to compensate for residual indirect impacts.

Artificial lighting

The remnant vegetation immediately next to the alignment would experience some artificial lighting impacts, including potential after-hours construction activities, street lights and security lighting. Night-time security or operational lighting could potentially discourage habitat use where diffuse light penetrates into nearby areas of vegetation. The foraging regimes of some nocturnal native mammals and birds can be disrupted by lighting and make them vulnerable to predation by cats, dogs and foxes. The eyesight of nocturnal species (such as owls, gliders and possums) is hindered by bright lights, and where they are affected by this, they may become more susceptible to predation.

The project would include the installation of lighting along the northern and southern interchanges and the hospital interchange sections of the alignment for road safety. Lighting would not be installed between the hospital interchange and McCaffrey Drive. Consequently, the project is likely to result in moderate light spill to vegetation immediately next to the alignment north of the hospital precinct and the southern interchange, and is likely to impact native biota within the study area.

Lighting used during construction and operation of the project would be designed as ‘down lights’ wherever practicable and be directed inwards so as to not spill into nearby areas of intact vegetation. Mitigation and management measures have been identified for the management of light spill have been provided in Section 9. Indirect impacts have been calculated and will be offset in accordance with the project BOS to compensate for residual indirect impacts.

8.5.12 Erosion, dust generation and sedimentation

Clearing of vegetation may increase erosion and sedimentation in the study area. Uncontrolled erosion of topsoil from excavated areas and exposed soils and corresponding deposition into native vegetation or freshwater creeks can cause weed problems, stifle plant growth and affect aquatic fauna. Sedimentation laden runoff to waterways from exposed soils due to riparian vegetation clearing and/or earthworks can adversely affect aquatic life in ephemeral creeks downslope by altering water quality and filling aquatic habitat with fine sediment. This reduces the habitat value of these areas for fauna such as frogs.

The topography of the site and the nature of the project means that there is potential for impacts resulting from erosion and sedimentation if adequate controls are not in place during the road construction, particularly during vegetation clearing activities. Mitigation and management measures are described in Section 9 and will be implemented to minimise potential impacts of erosion and sedimentation.

8.5.13 Soil and water pollution

The topography of the study area and nature of the project means that there is potential for soil and water pollution if appropriate controls are not adopted during road construction, particularly during vegetation clearing and soil disturbance activities.

The project has the potential to result in pollution and contaminated runoff within the project construction footprint and study area through soil disturbance and road construction activities. Potential sources of soil and water pollution include:

- Increased sedimentation and erosion potential in areas cleared of vegetation.
- Inappropriate management of soil and material stockpiles.
- Hydrocarbon leaks or spills from vehicles or equipment used in during road construction or vegetation clearance activities.
- Increased runoff from hardstand areas.

It is anticipated that provided mitigation measures outlined in Section 9 are implemented, including the use of erosion and sediment control devices and pollution control methods, the project would have a low risk of soil and water pollution.

8.5.14 Cumulative impacts

At time or writing there are no known significant projects or developments occurring within the locality that may exacerbate the project's potential impacts to biodiversity, particularly MNES. A number of nest boxes have been installed as part of an offset for the John Hunter Hospital precinct development. About twenty-seven of these nest boxes would be removed by the project (Section 4.3.3), however only one of these boxes was observed to be utilised by fauna during targeted surveys. While the John Hunter Hospital precinct is likely to expand its infrastructure, the timing and extent of this work is unknown. There is potential for additional clearing of native vegetation associated with these work, however the extent of these impacts are unknown. The impacts of the project will be appropriately managed and mitigated in accordance with the measures outlined in Section 9.

8.6 Impact summary

A summary of the standard impacts and the impact assessment carried out in this BAR are provided in Table 8-10.

8.6.1 Direct impacts

The project would result in direct impacts within the construction footprint, comprising:

- Disturbance of an overall construction footprint of about 50.1 hectares.
- Removal of about 39.2 hectares of native vegetation and associated habitat resources for threatened fauna and flora species and other native biota.
- Removal of about 4.1 hectares of an EEC listed under the TSC Act.
- Removal of about 846 clumps of Black-eyed Susan *(Tetratheca juncea).*
- Removal of 17 identified potential Powerful Owl roost trees and five identified Powerful Owl roost trees.
- Removal of about 4.4 hectares of Sydney Blue Gum – White Mahogany shrubby tall open forest GDE.
- Removal of about 320 identified habitat (hollow-bearing) trees.

8.6.2 Indirect impacts

Indirect impacts associated with the project include potential edge effects, introduction and/or spread of weeds, introduction and/or spread of pests and pathogens, effects of erosion and sedimentation, generation of dust, noise, light and vibration.

Despite the implementation of mitigation measures it is likely that there may still be some indirect impacts to surrounding vegetation and fauna habitat. It has been assumed that these impacts may extend up to 20 metres into the remnant vegetation from the construction footprint. Indirect impacts have been calculated for the project based on the assumption of a cleared 10 metre buffer surrounding the construction footprint to suitably capture indirect impacts. Consequently, an additional seven hectares of native vegetation surrounding the construction footprint has therefore been included in the credit calculations and will be offset as part of the BOS.

Table 8-10 Summary of impacts

Impact	Biodiversity values	Nature of Impact	Extent of Impact	Duration	Does the project constitute or exacerbate a key threatening process?
Clearing of vegetation	Removal of about 39.2 ha of native vegetation	Direct/ Consequential	Local/ Regional	Long-term/ Construction	• Clearing of native vegetation • Removal of hollow-bearing trees • Removal of dead wood and dead trees • Bushrock Removal
	Removal of about 4.1 ha EEC: Lower Hunter Spotted Gum - Ironbark Forest	Direct/ Consequential	Local/ Regional	Long-term/ Construction	• Clearing of native vegetation • Removal of hollow-bearing trees • Removal of dead wood and dead trees • Bushrock Removal
Removal of threatened fauna species habitat and habitat features	• Grey-headed Flying-fox (*Pteropus poliocephalus*) • Little Lorikeet (*Glossopsitta pusilla*) • Little Bentwing Bat (*Miniopterus australis*) • Powerful Owl (*Ninox strenua*) • Squirrel Glider (*Petaurus norfolcensis*) • Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) • Eastern Freetail Bat (*Micronomus norfolkensis (syn. Mormopterus norfolkensis*) • Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) • Greater Broad-nosed Bat (*Scoteanax rueppellii*) • Regent Honeyeater (*Anthochaera phrygia*) • Swift Parrot (*Lathamus discolor*) • Spotted-Tailed Quoll (Southern Subspecies) (*Dasyurus maculatus maculatus*) • Koala (*Phascolarctos cinereus*) • Large-eared Pied Bat (*Chalinolobus dwyeri*)	Direct/ Consequential	Site based/ Local/ Regional	Long-term/ Construction	• Clearing of native vegetation • Removal of hollow-bearing trees • Removal of dead wood and dead trees • Bushrock Removal
Removal of threatened plants	• Black-eyed Susan (*Tetratheca juncea)*	Direct/ Consequential	Site based/ Local	Long-term/ Construction	• Clearing of native vegetation
	• Small-flowered Grevillea (*Grevillea parviflora* subsp*. parviflora*) • Magenta Lily Pilly (*Syzygium paniculatum*)	Indirect/ Cumulative	Site based/ Local/ Regional	Long-term/ Construction	• Clearing of native vegetation

Impact	Biodiversity values	Nature of Impact	Extent of Impact	Duration	Does the project constitute or exacerbate a key threatening process?
Fragmentation of identified biodiversity links and habitat corridors	• Removal of a portion of locally significant biodiversity corridor (Figure 1-4)	Direct/ Consequential	Site based/ Local/ Regional	Long-term/ Pre & Post construction	• Clearing of native vegetation • Clearing of hollow-bearing trees • Removal of dead wood and dead trees • Predation by the feral cat (*Felis catus*) and European red fox (*Vulpes vulpes*)
Injury and mortality of fauna	• Incidental fauna injury and mortality during clearing activities and construction	Direct/ Consequential	Site based	Long-term/ During construction	• Clearing of native vegetation • Removal of hollow-bearing trees • Removal of dead wood and dead trees • Bushrock Removal
Invasion and spread of pests and pathogens	• Importation and spread of pests and pathogens during construction work	Indirect/ Cumulative	Site based/ Local/ Regional	Long-term/ During construction	• Introduction and establishment of pathogens *Phytophthora cinnamomi* (Phytophthora) and *Uredo rangelii* (Myrtle Rust) • Infection of frogs by spreading *Batrachochytrium dendrobatidis* (Chytrid fungus)
Invasion and spread of weeds	• Importation and spread of existing weeds during construction work	Indirect	Site based/ Local/ Regional	Long-term/ During & Post construction	• Invasion and establishment of exotic vines and scramblers • Invasion establishment and spread of *Lantana camara* • Invasion of plant communities by perennial exotic grasses
Degradation of aquatic habitats	• Disturbance to existing creek lines and waterways including: Blue Wren Creek, Dark Creek and Styx Creek	Direct	Site based/ Local	Long-term/ During construction	• Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands • Clearing of native vegetation
Contamination of groundwater dependant ecosystems (GDEs)	• Disturbance and clearing of GDEs	Direct/Indirect	Site based/ Local/ Regional	Long-term/ During construction	• Clearing of native vegetation • Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
Noise and vibration	• Disturbance of fauna from noise and vibrations	Direc t	Site based	Short-term/ During construction	N/A

Impact	Biodiversity values	Nature of Impact	Extent of Impact	Duration	Does the project constitute or exacerbate a key threatening process?
Artificial lighting	• Disturbance of nocturnal fauna from artificial lighting	Direct	Site based	Short-term/ During construction	• Predation by the feral cat (*Felis catus*) and European red fox (*Vulpes vulpes*)
Erosion, dust generation and sedimentation	• Disturbance and degradation of aquatic habitat through erosion and sedimentation	Indirect	Site based	Short-term/ Pre & During construction	N/A
Soil and water pollution	• Increased sedimentation and erosion potential in areas cleared of vegetation • Inappropriate management of soil and material stockpiles • Hydrocarbon leaks or spills from vehicles or equipment used in during road construction or vegetation clearance activities • Increased runoff from hardstand areas	Indirect	Site based/ Local	Long-term/ During construction	N/A
Aquatic habitat disturbance	• Disturbance and degradation of aquatic habitat through erosion and sedimentation • Development and removal of aquatic habitat within the construction footprint	Direct/Indirect	Site based/ local	Long-term/ During & Post construction	• Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
Edge effects on native vegetation	• Changes to vegetation type and structure • Increased growth of exotic plants • Increased predation of native fauna or avoidance of habitat by native fauna • Invasion of exotic species and/or disturbance tolerant native plants	Indirect	Site based/ local	Long-term/ During & Post construction	• Invasion and spread of *Lantana camera* • Invasion and establishment of exotic vines and scramblers Invasion of plant communities by perennial exotic grasses • Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae • Predation by the feral cat (*Felis catus*) and European red fox (*Vulpes vulpes*)

9. Mitigation

9.1 Introduction

The mitigation of adverse effects arising from the project has been presented according to the hierarchy of avoidance, mitigation and offsetting of impacts.

The project would result in direct impacts on native biota and their habitats within the construction footprint. There is also the potential for impacts on habitats outside the construction footprint through indirect impacts such as noise, light, vibration, sedimentation, runoff and edge effects, making habitat in these areas unsuitable for certain flora and fauna species. Specific mitigation measures are recommended to minimise such impacts on the remnant vegetation.

The project would result in some unavoidable impacts imposed upon some elements of the natural environment, including removal of native vegetation and imposition of edge effects on nearby areas of retained native vegetation, removal of EEC, removal of threatened flora and threatened species habitat.

9.2 Impact mitigation

In order to minimise the potential impacts of the project on biodiversity, the mitigation and management measures detailed in Table 9-1, in conjunction with the BOS, will be implemented to reduce residual impacts on biodiversity.

Table 9-1 Mitigation measures summary

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
General	Preparation of a Construction Environment Management Plan (CEMP) to include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures and relevant sub-management plans.	Pre-construction	Proven	None
	Ensure all workers are provided with an environmental induction before starting work on-site. This would include information on the ecological values of the subject site and study area and measures to be implemented to protect biodiversity.	Construction	Proven	None
Clearing of native vegetation	The Biodiversity Offsets Strategy will be finalised, in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014) as part of detailed design and required offsets secured.	Pre-construction and construction	Effective	None
Removal of native vegetation	Clearing of native vegetation and mature trees, particularly hollow-bearing trees, will be avoided and minimised where possible around aquatic habitats (creek lines and drainage lines), in Jesmond Park and near proposed fauna crossing structures. This is to assist with rehabilitation and habitat connectivity.	Detailed design and construction	Effective	Loss of native vegetation
	Pre-clearing surveys will be carried out in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 1: Pre-clearing process*) (RTA 2011).	Construction	Effective	
	Vegetation removal will be carried out in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 4: Clearing of vegetation and removal of bushrock)* (RTA 2011).	Construction	Effective	
	Native vegetation will be re-established in accordance with a re-vegetation management plan prepared in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Guide 3: Re-establishment of native vegetation)* (RTA 2011). The re-vegetation management plan will use suitable species from the indigenous vegetation communities present at the site to replace habitat for threatened species including Grey-headed Flying-fox.	Construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the construction footprint.	Construction	Proven	
Removal of threatened species habitat and habitat resources	Habitat removal will be carried out in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 4: Clearing of vegetation and removal of bushrock)* (RTA 2011).	Construction	Proven	Loss of threatened fauna habitat
	Habitat will be replaced or re-instated in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 5: Reuse of woody debris and bushrock* and *Guide 8: Nest boxes)* (RTA 2011).	Construction	Proven	
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the construction footprint.	Construction	Proven	
	Pre-clearing surveys will be carried out in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 1: Pre-clearing process*) (RTA 2011).	Construction	Effective	
	Clearing of native vegetation and mature trees, particularly hollow-bearing trees, will be avoided and minimised where possible around watercourses, in Jesmond Park, near proposed fauna crossing structures and those identified as known or likely to be used for breeding and roosting by Powerful Owl (*Ninox strenua*). This is to assist with rehabilitation and habitat connectivity.	Construction	Effective	
	Roads and Maritime will investigate opportunities to retain trees in construction compound A to provide an arboreal crossing for Squirrel Gliders and other arboreal fauna between vegetation to the east and west of the alignment.	Detailed design	Effective	
	The location of trees to be retained in the construction footprint would be confirmed during detailed design and incorporated in the flora and fauna management plan, landscape plan and re-vegetation management plan.	Detailed design	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
	Carry out clearing of hollow-bearing trees during periods which avoid breeding and hibernation seasons for threatened hollow-dependant fauna species (particularly the Powerful Owl (*Ninox strenua*) and Squirrel Glider (*Petaurus norfolcensis*)) where practicable.	Construction	Proven	
	A flora and fauna management plan (FFMP) will be prepared as a sub-plan to the CEMP for the project. The FFMP would identify environmental management measures to protect the natural environment (eg weed and pathogen controls) and detail site-specific and species-specific mitigation measures and management protocols to be implemented before, during and after all construction activities to further avoid or reduce impacts on threatened biodiversity.	Pre-construction	Effective	
Removal of threatened plants	A flora and fauna management plan (FFMP) will be prepared as a sub-plan to the CEMP for the project. The FFMP would include but not be restricted to key protocols for the protection of threatened flora and their habitats.	Construction	Proven	Loss of threatened plants
	Pre-clearing surveys will be carried out in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 1: Pre-clearing process*) (RTA 2011).	Construction	Proven	
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified in the construction footprint.	Construction	Proven	
	Exclusion zones will be set up at the limit of clearing in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 2: Exclusion zones)* (RTA 2011).	Construction	Effective	
Aquatic habitat impacts	Aquatic habitat will be protected in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 10: Aquatic habitats and riparian zones)* (RTA 2011), Section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013* (DPI (Fisheries NSW) 2013) and with reference to DPI Water Guidelines for Controlled Activities on Waterfront Land.	Construction	Proven	The project is unlikely to result in residual impacts to aquatic habitats.

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
	Preparation of a soil and water management plan and an erosion and sediment control plan as part of the CEMP to include appropriate control measures.	Pre-construction	Effective	
	The realignment of the northern branch of watercourse 2 will be designed to behave in a similar hydrologic and geomorphic manner as existing conditions and encourage native revegetation.	Detailed design	Effective	
	Native vegetation will be re-established around the realignment of the northern branch of watercourse 2 in accordance with a re-vegetation management plan prepared in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Guide 3: Re-establishment of native vegetation)* (RTA 2011).	Construction	Effective	
Groundwater dependent ecosystems	Minimise potential impacts to groundwater dependent ecosystems by implementation of management measures in accordance with the groundwater assessment (GHD 2016).	Construction	Effective	None
Changes to hydrology	Preparation of a soil and water management plan and an erosion and sediment control plan as part of the CEMP to include appropriate control measures.	Pre-construction	Effective	
	Changes to existing surface water flows will be minimised through detailed design as far as possible.	Pre-construction	Effective	
Fragmentation of identified biodiversity links and habitat corridors	Connectivity measures will be implemented in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (Roads and Maritime in preparation).	Construction	Effective	Loss of fauna connectivity for fauna species
	The fauna connectivity strategy will be finalised during detailed design to minimise impacts to fauna movement, in particular the Squirrel Glider.	Pre-construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
Edge effects on nearby native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 2: Exclusion zones)* (RTA 2011).	Construction	Effective	Loss of habitat in edge areas- this has been addressed through the application of a 10 m indirect impact assessment buffer around the construction footprint, comprising about 7 ha of native vegetation which will be offset in accordance with the BOS.
Injury and mortality of fauna	Fauna will be managed in accordance with Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (*Guide 9: Fauna handling)* (RTA 2011).	Construction	Effective	None
Invasion and spread of weeds	Protocols for preventing or minimising the spread of noxious and environmental weeds will be developed and implemented in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Guide 6: Weed Management)* (RTA 2011)	Construction	Effective	None
Invasion and spread of pathogens and	Protocols for preventing the introduction and/or spread of disease causing agents such as bacteria and fungi will be developed and implemented in accordance with the Roads and Maritime *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Guide 7: Pathogen Management)* (RTA 2011).	Construction	Effective	None
Noise, light and vibration	Design of all permanent lighting to minimise light spill as far as practicable and the associated secondary impact on nocturnal fauna species potentially utilising the area.	Detailed design	Effective	Loss of habitat in edge areas- this has been

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
	Using down-lights and motion sensor lighting where possible during construction in order to reduce light spill and the associated secondary impact on nocturnal fauna species potentially utilising the area.	Construction	Effective	addressed through the application of a 10 m indirect impact assessment buffer around the construction footprint, comprising about 7 ha of native vegetation which will be offset in accordance with the BOS.
Air quality	Manage air quality in accordance with the CEMP	Construction	Effective	Loss of habitat in edge areas- this has been addressed through the application of a 10 m indirect impact assessment buffer around the construction footprint, comprising about 7 ha of native vegetation which will be offset in accordance with the BOS.

Impact	Mitigation measures	Timing and duration	Likely efficiency of mitigation	Residual impacts anticipated
Soil and contamination	Manage soil and contamination in accordance with the CEMP	Construction	Effective	None

10. Offsetting required

This section presents the biodiversity credit impact calculations for the project. A BOS, which outlines how the proponent intends to offset the impacts of the project, has been prepared and is included as Appendix B. The BOS has been prepared in accordance with the requirements of the FBA. The credit calculator has been used in this BAR to determine the number and type of biodiversity credits required to offset impacts of the project. The biodiversity credit report is included in Appendix E with results summarised in Table 10-1 and Table 10-2. The BOS for the project would include the purchase and retirement of the following biodiversity credits as calculated in accordance with the FBA and provides offsets for relevant MNES.

10.1 Biodiversity credits

The data from the fieldwork and mapping was entered into Version v4.1 (linear module) of the BioBanking credit calculator as a 'Major Project' assessment to determine the number and type of biodiversity credits that would be required to offset impacts of the project. The Biodiversity credit report is included in Appendix E and summarised in the following sections.

10.2 Ecosystem credits

A total of 2972 ecosystem credits would be required to offset the impacts of the project as shown in Table 10-1.

Table 10-1 Ecosystem credit impact summary

Vegetation zone	Plant Community	Threatened species driving credit requirement	Loss in landscape value	Loss in site value	Credits required for threatened species	Area Impacted (ha)	Ecosystem credits required
VZ1	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands (HU833)	Powerful Owl and Barking Owl (TS score 3)	16.5	76.04	389	19.08	1167
VZ2	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (HU782)	Powerful Owl and Barking Owl (TS score 3)	16.5	86.98	111	4.8	333
VZ3	Spotted Gum – Red Ironbark –Grey Gum Shrub –grass open forest of the Lower Hunter (HU806)	Powerful Owl and Barking Owl (TS score 3)	16.5	68.23	94.3	5.12	283
VZ4	Spotted Gum – Broad-leaved Mahogany – Grey Gum grass- shrub open forest on Coastal Lowlands of the Central Coast (HU803)	Powerful Owl and Barking Owl (TS score 3)	16.5	88.54	352.3	14.98	1057
VZ5	Smooth-barked Apple – Turpentine –Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast (HU841)	Powerful Owl and Barking Owl (TS score 3)	16.5	73.44	44	2.23	132
	Total					**46.21**	**2972**

Note: Areas quoted include area of direct impact plus the area added to each vegetation zone in the credit calculator to account for indirect impacts.

10.2.1 Species credits

The credit calculator references geographic, vegetation and habitat data for the construction footprint to generate a list of the species credit-type threatened species predicted to occur and requiring targeted survey.

Three threatened flora species (Black-eyed Susan, Small-flowered Grevillea and Magenta Lilly Pilly) were recorded within the study area. Targeted surveys were carried out to accurately assess the extent of impacts on these species and determine the final number of species credits required.

The remainder of the species credit species predicted to occur in the construction footprint were either not recorded in the construction footprint during targeted surveys or determined to be unlikely to occur due to the absence of suitable habitat and/or nearby records.

A total of 12,690 species credits would be required to offset the impacts of the project for Black-eyed Susan (calculated using a threatened species multiplier of 1.5) as detailed in Table 10-2.

Table 10-2 Species credit impact summary

Species	Extent of impact	Species credit required
Black-eyed Susan *(Tetratheca juncea)*	846 clumps	12,690

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Appendices

Appendix A – Secretary's environmental assessment requirements

Secretary's environmental assessment requirements (SEARs)

This biodiversity assessment report (BAR) has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the Newcastle Inner City Bypass between Rankin Park and Jesmond (issued 3 March 2015) for the purpose of seeking project approval for state significant infrastructure under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Table 1 outlines the requirements relevant to this assessment and where they are addressed in this BAR.

Table 1 Secretary's Environmental Assessment Requirements

Agency	Requirements	Where addressed
Department of Planning and Environment	The environmental impact statement must include the following:	
	An assessment of the potential ecological impacts of the project, with specific reference to vegetation and habitat clearing, connectivity, edge effects, weed dispersal, riparian and aquatic habitat impacts, soil and water quality impacts and operational impacts. The assessment must:	
	• Make specific reference to impacts on landscape values, biodiversity values of native vegetation and threatened species or populations, including worst case estimates of vegetation clearing and operational impacts	Section 8
	• Demonstrate a design philosophy of impact avoidance on ecological values, and in particular, ecological values of high significance, and be consistent with the 'avoid, minimise or offset' principle	Section 5.2, Section 7 and Section 10
	• Be undertaken in accordance with the *Framework for Biodiversity Assessment* (Office of Environment and Heritage (OEH) 2014) and the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014e), and by a person accredited in accordance with section 142B(1)(c) of the *Threatened Species Conservation Act 1995.* Impacts on species, populations and ecological communities that will require further consideration and provision of information specified in section 9.2 of the *Framework for Biodiversity Assessment* include those identified by the OEH. Species specific surveys shall be undertaken for those species and in accordance with the survey requirements specified by the OEH (including during further consultation with the OEH)	Sections 1.2, Section 4.2, Section 8 (specifically Section 8.3), Section 10 and Appendix B
	• In relation to aquatic biodiversity be consistent with the draft *Policy and Guidelines for Fish Habitat Conservation and Management – Update* 2013 (DPI 2013)	Section 4.1.5 and Section 4.4

Agency	Requirements	Where addressed
	• Where there are potential impacts to the OEH estate reserved under the *National Parks and Wildlife Act 1974* or where the project is located upstream of OEH estate, an assessment of the matters to be considered outlined in the *Guidelines for developments adjoining land and water managed by DECCW* (DECCW 2010).	Section 2.1.7, Section 2.1.9, Section 5.1.3 and Section 8.4.5.
Commonwealth Department of the Environment (now the Commonwealth Department of the Environment and Energy)	These guidelines provide information on assessment requirements in relation to Matters of National Environmental Significance (MNES), if the project is being assessed under the NSW Assessment Bilateral Agreement (February 2015). It is a requirement of the Agreement that the project be assessed in the manner specified in Schedule 1 of that Agreement, including the matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth). These guidelines do not stand alone but should be considered in conjunction with the Department of Planning and Environment's Secretary's Environmental Assessment Requirements. The Guidelines are intended to ensure there is sufficient information in the Assessment Report relevant to MNES such that the Commonwealth decision-maker may make a determination on whether or not to approve the action.	Section 1.2, Section 5, and Section 8.4
	The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in paragraph 1 and Attachment A. <u>Paragraph 1</u> • Threatened species and communities • Ramsar wetlands <u>Attachment A – listed threatened species and communities:</u> The Department of the Environment considers impacts potentially arise in relation to the following matters: • Black-eyed Susan (*Tetratheca juncea*) – vulnerable • Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable The Department considers there is some risk there may be significant impacts on the following matters: • Leafless Tongue-orchid (*Cryptostylis hunteriana*) - vulnerable • Newcastle Doubletail (*Diuris praecox*) - vulnerable <u>Attachment A – Ramsar wetlands:</u> The Department of the Environment considers impacts potentially arise in relation to the following: • The Hunter Estuary Wetlands Ramsar site Resulting in: • A substantial and measurable change in the hydrological regime of the wetland	Section 8

Agency	Requirements	Where addressed
	• A substantial and measurable change in the water quality of the wetland	
	General requirements	
	The EIS must address the following issues: • The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on matters of national environmental significance (MNES). • An assessment of the likely impacts of the development on each EPBC Act-listed species and/or ecological community where there is likely to be a significant impact from the proposed development.	Section 1.1, Section 5 and Section 8.4 Section 8
	Key issues – biodiversity	
	The EIS must address the following issues in relation to Biodiversity including: • Identification of all EPBC Act listed threatened species and communities likely to be located in the Construction footprint or in the vicinity; and • Identification of all EPBC Act listed threatened species and communities likely to be significantly impacted by the development in accordance with the *Matters of National Environmental Significance - Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Significant Impact Guidelines).	Section 3 and Section 4 Section 5 and Section 8.4
	For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide: • a description of the environment (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans; • details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements.	Section 5, Section 8.3 and Section 8.4 EPBC Referral (GHD, 2015) Assessments of significance (Appendix M) Section 3.1, Section 4.2 and Parsons Brinckerhoff, 2015a (Appendix C)
	Impacts	
	For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide a description of the impacts of the action having regard to the full national extent of the species or community's range including:	Section 8.4

Agency	Requirements	Where addressed
	• A detailed assessment of the extent, nature and consequence of the likely direct, indirect and consequential impacts – refer to the Significant Impact Guidelines for guidance on the various types of impact that need to be considered; • A statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; and • A description of any likely cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity).	EPBC Referral Assessments of significance (Appendix M) Section 8.5.14
	Avoidance and mitigation	
	For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: • A description of proposed avoidance and mitigation measures to deal with relevant impacts of the action; • Assessment of the expected or predicted effectiveness of the mitigation measures, and • A description of the outcomes that the avoidance and mitigation measures will achieve.	Section 5.2 and Section 7 Section 9 (specifically Table 9-1)
	For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide reference to, and consideration of relevant Commonwealth guidelines and policy statements including conservation advice, recovery plans, threat abatement plans and wildlife conservation plans.	Section 5 Section 8.3 EPBC Referral Assessments of significance (Appendix M
	Residual impacts and offsets	
	For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide: • Identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts is taken into account. • Details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts. • Details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the development in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or	Section 5.2.3, Section 8.2 Section 6.1, Section 8.2, Section 10 Section 10 and Biodiversity Offset Strategy (Appendix B)

Agency	Requirements	Where addressed
	threatened communities occurring on proposed offset sites. *[Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. In applying the FBA, residual impacts on EPBC Act listed threatened ecological communities must be offset with Plant Community Type(s) (PCT) that are ascribed to the specific EPBC listed ecological community. PCTs from a different vegetation class will not generally be acceptable as offsets for EPBC listed communities.]*	
	Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offset Policy. http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy	Section 8.2, Section 8.5 and Section 10
	Environmental record of person proposing to take the action	
	The information provided must include 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 the person proposing to take the action; and for an action for which a person has applied for a permit, the person making the application.	Appendix L
	If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	Appendix L

Appendix B – Biodiversity Offset Strategy (BOS)

Aurecon Australasia Pty Ltd

Newcastle Inner City Bypass - Rankin Park to Jesmond
Biodiversity Offset Strategy

November 2016

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Appendices

1. Biodiversity Offset Strategy

Roads and Maritime Services (Roads and Maritime) is seeking approval to construct the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the Project).

The Newcastle Inner City Bypass is part of Roads and Maritimes' long-term strategy to provide an orbital road within Newcastle's road network to connect the Pacific Highway at Bennetts Green and the Pacific Highway at Sandgate.

An environmental impact statement (EIS) is required to assess the potential environmental impacts of the Project. A Biodiversity Assessment Report (BAR) has been prepared to assess the potential impacts on the Project on biodiversity to support the preparation of the EIS. This report presents the draft Biodiversity Offset Strategy (BOS), which supports the BAR and outlines how the proponent intends to offset the impacts of the Project. The BOS follows the BOS format required by the FBA.

The credit calculator has been used in the BAR to determine the number and type of biodiversity credits required to offset impacts of the Project. A copy of the biodiversity credit report is included in Appendix A.

The BOS for the Project would include the purchase and retirement of the following biodiversity credits as calculated in accordance with the FBA:

- 333 ecosystem credits for Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (HU782).
- 1167 ecosystem credits for Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands (HU833).
- 132 ecosystem credits for Smooth-barked Apple –Turpentine –Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast (HU841).
- 1057 ecosystem credits for Spotted Gum – Broad-leaved Mahogany – Grey Gum grass-shrub open forest on Coastal Lowlands of the Central Coast (HU803).
- 283 ecosystem credits for Spotted Gum – Red Ironbark –Grey Gum Shrub –grass open forest of the Lower Hunter (HU806).
- 12,690 species credits for Black-eyed Susan (*Tetratheca juncea*).

The above includes the number of species credits required to offset the impacts on threatened species and communities known or likely to occur in the disturbance footprint. A BOS developed in accordance with the FBA will satisfy the biodiversity offsetting requirements of the EPBC Act and associated policies.

The BOS for the Project aims to conserve an appropriate portion of land/s in a BioBanking agreement to suitably offset the impacts of the Project.

1.1 Requirement to offset

This BOS documents the process for identifying and evaluating offset options that will be required for the Project. Its describes several potential offset sites, including credit estimations for some of these sites. It sets out the pathway forward to securing and managing the final offset package.

Table 1-1 Offset requirements for the Project

Plant Community Type (PCT)	Veg Type Code	Number of credits required
Ecosystem credits		
Smooth-barked Apple – Red Bloodwood –Brown Stringybark – hairpin Banksia heathy open forest of coastal lowlands	HU833	1167
Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	HU782	333
Spotted Gum –Red Ironbark – Grey Gum shrub-grass open forest of the Lower Hunter (EEC)	HU806	283
Spotted Gum – Broad-leaved Mahogany – Grey-gum grass –shrub open forest on Coastal Lowlands of the Central Coast	HU803	1057
Smooth-barked Apple – Turpentine – Sydney Peppermint heathy woodland on sandstone ranges of Central Coast	HU841	132
Species credits		
Black-eyed Susan (*Tetratheca juncea)*		12,690

1.2 Offset investigations

Under the FBA, ecosystem and species credit requirements identified for the Project can be offset in a number of ways, including:

- Retiring credits via a BioBanking agreement.
- Contributing money to supplementary measures.
- Contributing money to a BioBanking fund.

The BioBanking Fund has not been established and was not an option for this Project at the time of writing.

Where possible, the BOS will aim to match ecosystem and species credits on a 'like for like' basis through the retirement of biodiversity credits, in accordance with the credit profiles provided in the Project's credit report (refer to Appendix A). Where this is not possible, the credit trading rules associated with major projects can be used to source suitable credits and/ or supplementary measures will be investigated in consultation with the consent authority.

The results of GHD's investigation into credits currently available, and biobank sites that have commenced their BioBanking agreement assessments, indicates the Project will be able to achieve the 'like for like' principle for the majority of the credit types requiring offsetting should Roads and Maritime secure the credits recommended in this BOS. This is the case for three of the vegetation types requiring offsetting, including the Lower Hunter Spotted Gum Ironbark Forest EEC.

The remaining two vegetation types will have a portion of the credits secured as 'like for like' and/ or will require the use of the trading rules. Details of the proposed credit trades are included in Table 1-2.

All credits for Black-eyed Susan (*Tetratheca juncea)* will be matched on a 'like for like' basis. The Project will not be using supplementary measures.

The Biodiversity Offsets Policy for Major Projects (OEH, 2014) outlines four key steps (refer to Table 1-2) that are to be considered by the proponent before the project can use the variation to the trading rules associated with major projects. The following table summarises the process carried out to date to secure offsets for the Project.

Table 1-2 Reasonable steps to secure offsets

Reasonable steps	Record of action taken
1. Check the BioBanking public register and place an expression of interest for credits wanted on it for at least six months	• GHD has undertaken a detailed review of properties currently available on the BioBanking public register for properties that meet the offsetting and biodiversity credit requirements of the Project. • GHD has reviewed the expression of interest (EOI) website associated with the BioBanking public register to determine if any properties listed would have the potential to provide suitable biodiversity credits for the Project. • Roads and Maritime Services also listed the Project's likely credit requirements on the EOI website for a period of over six (6) months.
2. Liaise with an OEH office and relevant local councils to obtain a list of potential sites that meet the requirements for offsetting	• GHD has contacted relevant local officers from the OEH to identify any potential property owners who may be interested in placing their property under a BioBanking agreement. The OEH indicated the only properties they were aware of were already being considered by GHD for the Project and that BioBanking assessments had commenced. • GHD have also carried out a detailed review of potentially suitable properties in the region for the establishment of a biobank site, using broad scale vegetation mapping (LHCCREMS 2006) and aerial photography. The Project is somewhat unique as it contains the eastern most distribution of the Lower Hunter Spotted Gum Ironbark Forest EEC as well as vegetation types influenced by sandstone. The analysis of the LHCCREMS suggested several properties would need to be purchased and secured via a BioBanking agreement to provide the necessary ecosystem credits for the Project. This analysis also does not provide any information regarding the likely

Reasonable steps	Record of action taken
	occurrence of *Tetratheca juncea* or otherwise. The Project contains a significant number of *Tetratheca juncea* species credits and it would be ideal if these credits could be sourced from a site which could also provide some of the ecosystem credits required. • Additionally, GHD have identified a number of privately owned properties in the region which GHD have previously, or are currently preparing BioBanking Assessments for, which would be suitable for utilisation as a Project biobank site/s and these have been included in our proposed credit trade approach accordingly.
3. Consider properties for sale in the required area	• GHD completed a review of properties listed for sale within the Hunter and surrounding areas. It was determined that there was no suitable property for sale and that several properties would need to be purchased to satisfy the Project's offset requirements. As mentioned, the Project site is unique in that it contains the eastern most distribution of Lower Hunter Spotted Gum Ironbark EEC.
4. Provide evidence of why offset sites are not feasible; suitable evidence may include: the unwillingness of a landowner to sell or establish a biobank site.	• Given the availability of credits that are generally suitable for the Project, the identification, purchase and establishment of additional biobank sites would be cost prohibitive in comparison to purchasing credits. • The nature of linear infrastructure means that impacts are often associated with many different vegetation types which is the case with the Project. This makes securing all ecosystems on a 'like for like' basis a difficult exercise. Achieving this would require the purchase of additional properties and/or sourcing additional potential biobank site owners, further increasing the costs associated with securing the offsets. This is considered unnecessary considering the trading options identified. • The size of the Project's impacts mean that large land holdings would be required for at least two of the vegetation types. A review of the properties for sale indicated there was no suitable properties available for sale of a sufficient size in the location where these vegetation types occur. • The need for a large quantity of *Tetratheca juncea* credits also adds a further layer of complexity associated with finding suitable offset sites. The project team has identified a suitable site during preparation of this BAR and the landowner has since completed and lodged a BioBanking agreement application with the OEH. It is likely that finding properties with the minimum number of *Tetratheca juncea* required would be difficult and may result in the purchase of several properties to offset this matter.

If insufficient credits are found, Roads and Maritime may be able to apply the FBA variation rules which state that the consent authority may approve:

a. *A variation of the offset rules for matching ecosystem credits by allowing ecosystem credits created for a PCT for the same vegetation formation as the PCT to which the required ecosystem credit relates to be proposed as an offset, or*

b. *A supplementary measure to be proposed as an offset for the PCT where the PCT is associated with an EEC or CEEC, or*

c. *A variation of the offset rules for matching specie credits by allowing a different species to that impacted by the proposed development to be used to meet the offset requirement, or*

d. *A supplementary measure to be proposed as an offset for the species impacted by the development.*

As mentioned above, the majority of the credit trades will occur within the 'like for like' parameters associated with the FBA. However, trades associated with two vegetation types (Smooth-barked apple Red bloodwood - Brown Stringybark (HU833) and Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest (HU782)) will require use of the variation to trading rules. These vegetation types are not associated with an EEC or CEEC.

1.3 Offset site identification

Based on preliminary estimation of the offset requirement, investigations into potential offset sites began early in the planning and assessment process. Initial investigations were focused on established biobank sites containing credits that are currently available on the open market. This review indicated there were three existing biobanks sites with the potential to provide credits for the Project.

Regional vegetation mapping (LHCCREMS 2006) and relevant literature were then used to identify potential offset sites. Roads and Maritime were also consulted to identify potential properties in their ownership likely to contain suitable credits. Roads and Maritime identified a site owned in the Lower Hunter which is likely to contain suitable credits, preliminary surveys and reporting has been carried out and is currently in review.

GHD through its involvement in BioBanking assessments and consultation in the region has also identified several additional properties which will contain suitable credits for offsetting the Project. These sites have had BioBanking Agreement assessments completed and have been lodged with the OEH for review and approval. GHD have included these sites in the proposed credit trades for the project as their approval is imminent. Roads and Maritime have indicated their support for the credit trades associated with this BOS.

A total of six separate biobank sites have been identified to provide biodiversity credits for this Project as summarised in Table 1-3.

Table 1-3 Table Biobank site summary

Site number	Brief description	Suitable Vegetation Types	Approximate area
1	An existing biobank site dominated by Spotted Gum Grey Ironbark Forest with Tallowwood - Brush Box - Sydney Blue Gum moist shrubby forest associated with moist gullies.	HU803, HU782	280 ha
2	An existing biobank site containing a mix of coastal vegetation types through to Spotted Gum - Grey Ironbark forest, Smooth-barked Apple - Red Bloodwood open forest and Tallowwood - Small-fruited Grey Gum dry grassy open forest.	HU803, HU833 and HU644	240 ha
3	An existing biobank site dominated by Spotted Gum - Red Ironbark - Grey Gum shrub grass open forest.	HU806	48 ha
4	A site which has lodged a BioBanking agreement application with OEH and is in the final stages of approval. The site contains a mix of vegetation types associated with estuarine environments through to Red Bloodwood – Smooth-barked Apple heathy woodland and Spotted Gum Broad-leaved Mahogany Red Ironbark shrubby open forest. The site also contains a large number of *Tetratheca juncea*.	HU861	42 ha
5	A site which has lodged a BioBanking agreement application and is in the final stages of approval. This site borders site 4. The site contains a mix of vegetation types associated with estuarine environments through to Red Bloodwood – Smooth-barked Apple heathy woodland and Spotted Gum Broad-leaved Mahogany Red Ironbark shrubby open forest. The site also contains a large number of *Tetratheca juncea*.	HU861	83 ha
6	A site currently owned by Roads and Maritime which is currently being the subject of a BioBanking agreement assessment. The site contains a mix of Smooth-barked Apple open forest and associated communities.	HU838, HU839, HU895.	20 ha

1.4 Proposed credit trades

The analysis of potential biobank sites available and potential biobank site owners who had expressed an interest in establishing a biobank site has enabled the Project to consider the credit trades outlined in Table 1-4 as the preferred approach to offsetting the projects income. Roads and Maritime will now undertake a process to secure the credits required via entering into 'take up' agreements or similar with the relevant biobank site owners and to complete the establishment of the biobank site (Site 6) on lands they currently own. The agreements would include a provision to purchase the credits required from the BioBanking scheme before clearing commences. With regard to the Roads and Maritime biobank site, the Project would be requesting a period of 12 months from approval to complete the BioBanking assessment, gain approval from OEH for the site.

The trades proposed have sought to match directly “like tor like” or with a PCT permitted by the BioBanking credit report where possible. This approach has led to three of the vegetation types being impacted by the Project (HU841, HU806 and HU803) being offset via a direct match or direct trade permitted under the BioBanking credit calculator results. This includes a direct trade for the only endangered ecological community (HU806) being impacted by the Project.

The vegetation type, HU833, will be partially offset via a direct match as well. The remaining credits trades have used the variation to the trading rules by trading with a PCT in the same formation with the same or greater percentage cleared. This approach was necessary as suitable credits are not currently available on the open market and won’t be available within the time frame required for the Projects approval. The use of this variation has led to a portion of HU833 and HU782 being offset with different PCTs. These vegetation types are not considered to be over cleared vegetation types in the catchment management authority (CMA) or endangered ecological communities.

The final trade for Black-eyed Susan (*Tetratheca juncea)* species credits is a direct match.

Table 1-4 Proposed credit trades

Vegetation type	Impact area (ha)	Credits required	Biobank site ID number	Credits available	Credit type being traded	Trading rules used
Smooth-barked apple Red bloodwood - Brown Stringybark (HU833)	19.08	1167	Site 2 (biobank approved)	279	Listed as HU621 now (HU833)*	Purchase and retire 279 credits (this portion of the credits required is a direct match)
			Site 2 (biobank approved)	376	HU803	Purchase and retire 376 credits (this trade uses the variation rules by trading with a PCT within the same formation with a higher percentage cleared)
			Site 4 & 5 (biobank pending approval)	554	HU861	Purchase and retire 418 credits (this trade uses the variation rules by trading with a PCT within the same formation with approx. the same percentage cleared)
			Site 6 (biobank assessment being completed)	94	HU838	Retire 94 credits (this trade uses the variation rules by trading with a PCT within the same formation and class with approx. the same percentage cleared)
Smooth-barked apple - Turpentine - Syd Peppermint heathy woodland (HU841)	2.23	132	Site 6 (biobank assessment being completed)	226	HU838	Retire 132 credits (direct trade permitted from the credit report)
Spotted Gum - Red Ironbark - Grey Gum shrub grass open forest (HU806) (EEC)	5.12	283	Site 3 (biobank approved)	350	Listed as HU629 now (HU806)*	Purchase and retire 283 credits (Direct match)
Spotted Gum - Broad-leaved Mahogany - Grey Gum shrub open forest (HU803)	14.98	1057	Site 1 (biobank approved)	842	Listed as HU630 now (HU803)*	Purchase and retire 842 credits (Direct match)
			Site 2 (biobank approved)	591	Listed as HU630 now (HU803)*	Purchase and retire 215 credits (Direct match)
Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest (HU782)	4.8	333	Site 1 (approved biobank)	259	Listed as HU642 now (HU782)*	Purchase and retire 259 credits (this trade uses the variation rules by trading with a PCT within the same formation and vegetation class with about the same percentage cleared)

Vegetation type	Impact area (ha)	Credits required	Biobank site ID number	Credits available	Credit type being traded	Trading rules used
			Site 2 (approved biobank)	219	HU644	Purchase and retire 74 credits (this trade uses the variation rules by trading with a PCT within the same formation with about the same percentage cleared)
Totals	**46.21**	**2,972**		**3,790**		
Tetratheca juncea	846 (individuals)	12,690	Site 5 (biobank pending approval)			Purchase and retire 12,690 credits (Direct match)

Note: The proposed trades using the variation trading rules generally include the same suite of ecosystem predicted threatened species as those vegetation types being impacted by the Project.

* Denotes new NSW Vegetation Type code for those biobanks sites established using the previous vegetation type codes.

1.5 Offsets for MNES

The offsets proposed have also considered the offset requirements for MNES. The Project includes direct impacts to about 39.2 hectares of foraging habitat for the Grey-headed Flying-fox. This equates to about 2566 credits. The biobank sites chosen all include suitable foraging habitat for this species and will achieve a 'like for like' outcome in terms of the offsets for this species. The biobank sites have an average credit generation rate of 7.5 credits per hectare which means approximately 342 hectares of suitable foraging habitat would be secured via a BioBanking agreement covenant and managed for conservation in perpetuity.

The Project also includes impacts to 846 clumps of Black-eyed Susan (*Tetratheca juncea)* which equates to 12,690 credits or 15 credits per individual. As one clump of *Tetratheca juncea* generates 7 credits according to the BBAM, at least 1812 individual clumps of *Tetratheca juncea* would be conserved via a BioBanking agreement with the population managed for conservation in perpetuity. The biobank proposed for this trade (Site 5) has a total of 2722 individuals present on site which equates to 19,326 credits. This is more than adequate to offset the Projects impact to this species.

1.6 Securing biodiversity credits – next steps

The majority of the credits required by the Project will be secured from existing biobank sites. However, Site 6, will require completion of the BioBanking agreement process to enable the credits the Project requires to be available. The actions required to secure and retire the necessary credits include:

1. For established biobank sites (sites 1, 2 and 3):
   - Negotiate a 'take-up' agreement (or similar) with each biobank site owner. This agreement will outline the number and type of credits to be purchased as well as the credit price.
   - Purchase and secure the credits.
   - Retire the credits for conservation as required by project approvals.
2. For biobank sites being assessed by OEH (sites 4 and 5):
   - Landowner to receive draft BioBanking Agreements for review and signing to confirm the number and type of credits available.
   - Negotiate a 'take-up' agreement (or similar) with each biobank site owner. This agreement will outline the number and type of credits to be purchased as well as the credit price.
   - Purchase and secure the credits.
   - Retire the credits for conservation as required by project approvals.
3. For biobank site being assessed (site 6):
   - BioBanking Agreement assessment to be completed and Roads and Maritime to review.
   - Roads and Maritime to complete the BioBanking agreement application process and lodge with OEH for approval.
   - Review draft BioBanking Agreement when issued and sign.
   - Retire the credits required by the Project as required by project approvals.

Completing the above listed activities in accordance with the details included in Table 1-4 would see the minimum number and type of credits retired to offset the Projects impacts.

1.6.1 Contingency

Should any of the proposed credit trades not be secured by Roads and Maritime (e.g. credits sold to a 3rd party as they are not secured, credit price could not be agreed etc.) Roads and Maritime would consider the following alternatives to secure any potential shortfall in credits:

- The purchase and retirement of biodiversity credits from alternative biobank sites that are not yet gazetted. It is anticipated that additional biobank sites may be added to the biobanking register prior to construction commencing. These would be reviewed by RMS to assess the potential suitability of credits available and credits would be secured if required.
- Investigate additional lands owned by Roads and Maritime for their ability to provide suitable credits for the project and place these lands under a BioBanking agreement. Credits would be retired if required.
- The use of supplementary measures. The FBA and the Offsets Policy for MNES both include the provision for the use of Supplementary Measures should there be a shortfall in securing direct offsets. The Offsets Policy for MNES dictates that supplementary measures can only be used to offset a maximum of 10% of a projects offset obligations and as the project is impacting on foraging habitat for the Grey-headed Flying-fox the use of supplementary measures would be limited to a maximum of 10% accordingly.

1.7 BioBanking Covenant and Management actions

1.7.1 Approach

Entering into a BioBanking agreement places a conservation covenant over the land, regardless of zoning. This covenant is the strongest conservation covenant available on private lands and extinguishes all land uses other than conservation. The following describes the actions that would be required for ongoing management of an offset site. A Management Actions Plan (MAP) (prepared in accordance with the BioBanking Methodology), detailing rehabilitation activities and an associated management program, would be prepared and included in the final BioBanking agreement. The MAP forms the basis of the funds required to be placed in the BioBanking Trust when purchasing the credits. The BioBanking Trust then funds the biobank site owner to implement the MAP.

Biobank sites may have two types of management actions applied:

- Standard Management Actions.
- Site Specific Management Actions.

Standard management actions are those actions required on an offset site to improve vegetation condition when entering into a BioBanking agreement. The standard management actions for all BioBanking properties are:

- Management of grazing for conservation.
- Weed control.
- Management of fire for conservation.
- Management of human disturbance.
- Retention of regrowth and remnant native vegetation.
- Replanting or supplementary planting where natural regeneration would not be sufficient (note: it is anticipated that natural regeneration would be sufficient for the proposed biobank sites and hence supplementary plantings are not required).

- Retention of dead timber.
- Erosion control.
- Retention of rocks.

Based on the habitat resources within the site and the suite of threatened species which are predicted to occur, the credit calculator nominates management actions that would be required to alleviate site-specific threats. Undertaking these actions is over and above the minimal requirements for a biobank site. Additional management actions that are likely to be required at the preferred biobank sites are summarised below:

- Feral animal control (pigs, horses).
- Exclude miscellaneous feral species.
- Control of feral and/or overabundant native herbivores (e.g. rabbit, goats, deer etc.).
- Maintain or reintroduce flow regimes (aquatic flora).

The MAP will identify site specific vegetation rehabilitation and management actions appropriate for the proposed offset site which would be completed during the preparation of the BioBanking agreement.

1.8 Monitoring of the offset site

The purchase of credits includes two components:

- Part A being the cost of rehabilitation and management.
- Part B being the 'profit' to the relevant landowner.

The Part A funds are the equivalent of all costs associated with the rehabilitation, management and monitoring of the biobank site/s in perpetuity.

The BioBanking methodology includes preparation of a MAP for each biobank site. The methodology also includes a credit pricing tool which places a commercial value for completing each of the actions listed in the MAP. These funds are held by the BioBanking Trust and managed by OEH. The funds are provided to the land owner on an annual basis for the amount equivalent to works required in that year. The biobank owner is then required to submit standard reports, outlining the works completed, their success and monitoring results. OEH then review the reports and, if works have been completed satisfactorily, provide the next payment for the following years work. The OEH also include site visits as part of their auditing process.

1.9 References

NSW OEH (2014), *NSW Biodiversity Offsets Policy for Major Projects*. http://www.environment.nsw.gov.au/resources/biodiversity/140672biopolicy.pdf

NSW OEH (2014), *Framework for Biodiversity Assessment.* http://www.environment.nsw.gov.au/resources/biodiversity/140675fba.pd

DSEWPaC (2012), *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy.* www.environment.gov.au/system/files/resources/12630bb4.../offsets-policy_2.pdf

Appendices

Appendix A – Credit Report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 12/04/2016 Time: 12:12:57PM Calculator version: v4.0

Major Project details

Proposal ID:	0082/2015/2218MP
Proposal name:	Newcastle Bypass V2
Proposal address:	Lookout Road New Lampton NSW
Proponent name:	RMS
Proponent address:	59 Darby Stree Newcastle NSW 2300
Proponent phone:	02 49240687
Assessor name:	Daniel Williams
Assessor address:	Level 1, 62 Clarence Street Port Macquarie NSW 2444
Assessor phone:	6586 8714
Assessor accreditation:	0082

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	4.80	333.00
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	19.08	1,167.00
Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	2.23	132.00
Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	14.98	1,057.00
Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	5.12	283.12
Total	46.21	2,972

Credit profiles

1. Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast, (HU782)

Number of ecosystem credits created	333
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast, (HU782) Flooded Gum - Brush Box - Tallowwood mesic tall open forest on ranges of the lower North Coast, (HU783)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803)

Number of ecosystem credits created	1,057
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter, (HU806)

Number of ecosystem credits created	283
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter, (HU806) Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast, (HU802) Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest, (HU804) Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter, (HU807) Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter, (HU814) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815) Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter, (HU816) Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter, (HU822)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833)

Number of ecosystem credits created	1,167
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833) Scribbly Gum - Smooth-barked Apple - Red Bloodwood shrubby forest of the Lower Hunter, Sydney Basin Bioregion, (HU715) Red Bloodwood - Sydney Peppermint - Podocarpus spinulosus shrubby open forest of the southern Central Coast, (HU839) Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast, (HU850) Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast, (HU852)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast, (HU841)

Number of ecosystem credits created	132
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast, (HU841) Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HU595) Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion, (HU622) Scribbly Gum - Smooth-barked Apple - Red Bloodwood shrubby forest of the Lower Hunter, Sydney Basin Bioregion, (HU715) Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833) Grey Ironbark - Broad-leaved Mahogany - Smooth-barked Apple coastal headland low open forest of the Central Coast, (HU834) Smooth-barked Apple open forest on coastal lowlands of the Central Coast, (HU835) Narrow-leaved Ironbark - Yellow bloodwood - Rough-barked Apple shrubby open forest on sandstone ranges of the Sydney Basin, (HU837) Smooth-barked Apple - Swamp Mahogany - Red Mahogany - Cabbage Palm open forest on lowlands of the Central Coast, (HU838) Red Bloodwood - Sydney Peppermint - Podocarpus spinulosus shrubby open forest of the southern Central Coast, (HU839) Sydney Peppermint - Silvertop Ash - Gymea Lilly ferny woodland on lowlands of the Central Coast, (HU846) Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast, (HU850) Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast, (HU852) Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast, (HU856) Red Bloodwood - Smooth-barked Apple - Scribbly Gum - Old Man Banksia heathy woodland on sandstone ranges of the Central Coast, (HU857) Smooth-barked Apple - Cabbage Palm - Broad-leaved Mahogany woodland on Wallarah Peninsular, (HU895)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Black-eyed Susan	Tetratheca juncea	846.00	12,690

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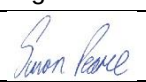
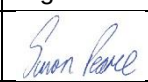
CRV01	D Williams	S Pearce		S Pearce		03/11/2016

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Appendix C – Parsons Brinckerhoff (2015a), Newcastle Inner City Bypass: Rankin Park to Jesmond – Biodiversity Survey Report

Roads & Maritime Services

Newcastle Inner City Bypass: Rankin Park to Jesmond

Biodiversity Survey Report

18 March 2015

PARSONS BRINCKERHOFF

Document information
Client: Roads & Maritime Services Title: Newcastle Inner City Bypass: Rankin Park to Jesmond Subtitle: Biodiversity Survey Report Document No: 2106581A-ENV-REP-001 RevA Date: 18 March 2015

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Glossary

AWS	All weather station.
BBAM	Biobanking Assessment Methodology as set out in the Biobanking Assessment Methodology (Office of Environment and Heritage 2014a)
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ Genetic diversity — the variety of genes (or units of heredity) in any population. ▪ Species diversity — the variety of species. ▪ Ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. The Study Area is in the Sydney Basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
CAMBA	China-Australia Migratory Bird Agreement.
CMA	Catchment Management Area.
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered Ecological Community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under either the TSC Act or the EPBC Act and both the state (Department of Environment, Climate Change and Water) and Federal (Department of the Sustainability, Environment, Water, Population and Communities) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant state and Commonwealth legislation
Department of the Environment (DoE)	The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the EPBC Act. The Commonwealth Department of the Environment was previously known as: ▪ Department of Sustainability, Environment, Water, Population and Communities (SEWPAC). ▪ Department of the Environment, Water, Heritage and the Arts (DEWHA). ▪ Department of Environment and Heritage (DEH). ▪ Department of the Environment and Water Resources (DEWR).
Ecological community	An assemblage of species occupying a particular area.
EEC	Ecologically Endangered Community.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
EP&A Act	*Environmental Planning and Assessment Act 1979.*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
Exotic	Introduced from outside the area (Ensbey & Johnson 2009). Used in the context of this report to refer to species introduced from overseas.
FM Act	*Fisheries Management Act 1994.*

GDEs	Groundwater dependant ecosystems.
GPS	Global Positioning System- a navigational tool which uses radio receivers to pick up signals from four or more special satellites to provide precise determination of location.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Highway 23	The proposed final stage of the Newcastle Inner City Bypass.
Indigenous	Native to the area: not introduced (Ensbey & Johnson 2009).
Introduced	Not native to the area: not indigenous (Ensbey & Johnson 2009). Refers to both exotic and non-indigenous Australian native species of plants and animals.
JAMBA	Japan-Australia Migratory Bird Agreement.
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the TSC Act, the FM Act and the EPBC Act. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
LGA	Local Government Area.
LHCCREMS	Lower Hunter and Central Coast Regional Environmental Management Strategy.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by Department of Environment and Climate Change (2007).
Locality	The area within a 10 km radius of the site.
Metapopulation of *Tetratheca juncea*	The distance between metapopulations of *Tetratheca juncea* is such that under no circumstances (other than human intervention) or any length of time would there be any transfer of genetic material between populations of *Tetratheca juncea*.
Migratory species	Species listed as Migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the EPBC Act.
MNES	Matters of National Environmental Significance.
Noxious weed	An introduced species listed under the Noxious Weeds Act 1993. Under the Act, noxious weeds have specific control measure and reporting requirements.
NSW	New South Wales.

Office of Environment and Heritage	Following the 2011 NSW elections, the Department of Environment, Climate Change and Water was abolished as a Division of the Government Service and was added to the NSW Department of Premier and Cabinet, as the Office of Environment and Heritage. Broadly, the Office of Environment works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making. Previously known as: ▪ Department of Environment, Climate Change and Water (DECCW). ▪ Department of Environment and Climate Change (DECC).
PEI	Preliminary Environmental Assessment
Plant clump (*Tetratheca juncea*)	A group of *Tetratheca juncea* stems separated from an adjacent group by greater than 30 cm. *Tetratheca juncea* grows in clumps of single or multiple stems arising from a single rootstock and it is therefore difficult to determine whether adjacent plants are joined or are separate without removing them from the soil.
Population of *Tetratheca juncea*	Groups of subpopulations of *Tetratheca juncea* separated from other groups by distances of greater than 500 m within suitable native vegetation or by greater than 100 m within unsuitable degraded/developed habitat or non-native vegetation. The distance between populations allows for the rare transfer of genetic material.
Proposal area	Is defined by a 20 m boundary from the proposed design alignment of the project footprint between Jesmond and Rankin Park (refer to (refer to).
Protected species	Those species defined as protected under the National Parks and Wildlife Act 1974. Includes all native animals, as well as all native plants listed on Schedule 13 of the National Parks and Wildlife Act 1974.
Recovery plan	A plan prepared under the TSC Act, FM Act or the EPBC Act to assist the recovery of a Threatened species, population or ecological community.
REF	Review of Environmental Factors.
Roads and Maritime	NSW Roads and Maritime Services.
RoKAMBA	Republic of Korea- Australia Migratory Bird Agreement.
RTA	Roads and Traffic Authority.
SAT	Spot Assessment Technique.
SEPP 44	State Environmental Planning Policy 44 – Koala habitat protection.
Significant	Important, weighty or more than ordinary as defined by Department of Environment, Climate Change and Water (2007).
Species richness	Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species (Office of Environment and Heritage 2012a).

Subpopulation of *Tetratheca juncea*	Plant clump groups separated by distances of less than 500 m within suitable habitat of native vegetation or by less than 100 m within unsuitable degraded/developed habitat or non-native vegetation. The distance between subpopulations allows for regular transfer of genetic material between subpopulations within a population.
Study area	Defined as the area of bushland contained between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital, Lookout Road and both northern and southern sides of McCaffrey Drive (refer to).
Threatened flora study area	The study area and included Blackbutt Reserve on the eastern side of Lookout Road.
The project	The proposed final stage of the Newcastle Inner City Bypass (Highway 23) from Jesmond roundabout to Rankin Park. It is proposed to construct approximately 3.4 km of dual lane carriageway highway between the intersection with McCaffrey Drive and Lookout Road, Rankin Park and the interchange with Newcastle Road at Jesmond.
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the TSC Act, FM Act or the EPBC Act.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the TSC Act, FM Act or the EPBC Act. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
TSC Act	NSW *Threatened Species Conservation Act 1995.*
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007).
Weed	A plant growing out of place or where it is not wanted: often characterized by high seed production and the ability to colonise disturbed ground quickly (Ensbey & Johnson 2009). Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

1. Introduction

Parsons Brinckerhoff has been engaged by Roads and Maritime Services (Roads and Maritime) to undertake a biodiversity survey (survey) for the proposed final stage of the Newcastle Inner City Bypass (Highway 23) from Jesmond roundabout to Rankin Park (the project). It is proposed to construct approximately 3.4 km of dual lane carriageway highway between the intersection with McCaffrey Drive and Lookout Road, Rankin Park and the interchange with Newcastle Road at Jesmond (the project). The locality of the project is provided in .

This biodiversity survey identifies potential ecological constraints and issues that may be associated with the project and it has informed the preliminary environmental investigation (PEI) and will form part of the Environmental Assessment.

1.1 Background

The project consists of a 3.4 km four lane dual carriage highway between Rankin Park and Jesmond which would complete the final stage of the Newcastle Inner City Bypass. The project will provide traffic relief for the existing road network, in particular Lookout Road, Croudace Street and Newcastle Road.

The key features of the project include:

- a grade-separated interchange at the northern connection with the existing Newcastle Road to Shortland section of the bypass
- potential for a connection to the rear of John Hunter Hospital
- bridge structures along the route to provide drainage, fauna movements and bushwalker access
- a grade-separated interchange with Lookout road and McCaffrey Drive at the southern connection.

The Newcastle Inner City Bypass has been a long-term strategy to provide an orbital road to link Newcastle's road network. The bypass was first planned in the 1950's and incorporated into the Northumberland County Planning Scheme in 1957. Since this time numerous studies have been undertaken within the Rankin Park to Jesmond study area.

This Biodiversity Survey Report provides details of the ecological characteristics of the study area, therefore providing the ecological constraints that are associated with the project. The ecological information has been gathered from a number of ecological surveys conducted for this assessment and from previous surveys conducted within the vicinity of the project.

1.2 Study objectives

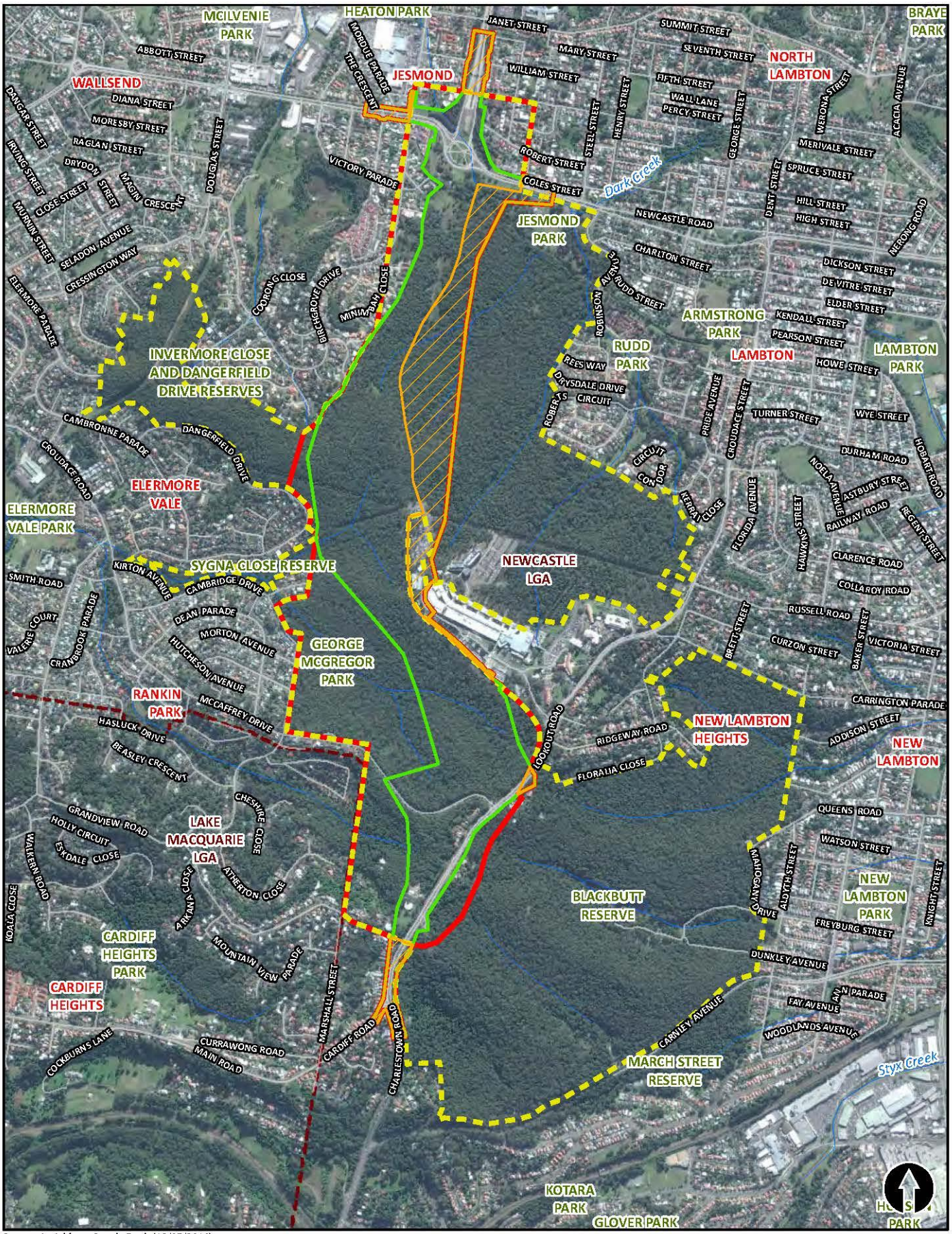
The objectives of this biodiversity survey report are to:

- describe the existing environment and identify the significance of biodiversity within the study area
- identify flora and fauna habitats and Threatened ecological communities, populations and species listed under the TSC Act and/or the EPBC Act within the study area
- develop maps detailing the locations of threatened flora and fauna, potential habitat features such as hollow bearing trees (HBTs) and any significant vegetation within the study area
- provide recommendations regarding further detailed ecological studies.

The report has been prepared according to the requirements of the Roads and Maritime Environmental Impact Assessment Practice Note: Biodiversity Assessment (NSW Roads and Maritime Services 2012). The Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (NSW Roads and Maritime Services 2011) have also guided biodiversity management outcomes where appropriate. Vegetation surveys have also been undertaken with BioBanking Assessment Methodology (BBAM) plot and transect survey requirements (Office of Environment and Heritage 2014a).

Major road
Road
Proposal area
Study area
Threatened flora study area
Newcastle Inner City Bypass
Local government area
National Parks and Wildlife Service Estate and bushland reserves

Figure 1.1
Project locality



Source: Aerial from Google Earth (16/05/2014)

- Local roads
- Creek lines
- Proposal area
- Extended proposal area
- Study area
- Threatened flora study area
- Local government area

Figure 1.2
Project boundaries

2. Methodology

2.1 Definitions

For the purpose of this report the following definitions apply:

- **Proposal area** is defined by a 20 m boundary from the proposed design alignment of the project footprint between Jesmond and Rankin Park (refer to (refer to).
- **Extended proposal area** is defined as an extension of proposal area to the east of the original proposal area () as a result of design changes. Targeted seasonal surveys had been completed before the change in design occurred, therefore a shaded area has been added to the figures where surveys have not been conducted within the extended proposal area (this area is hereafter referred to as 'extended proposal area').
- **Study area** is the area of bushland contained between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital, Lookout Road and both northern and southern sides of McCaffrey Drive (refer to). The study area was amended to include the extended proposal area and not all surveys have been conducted in this area. Figures throughout the report have shown where no surveys have occurred.
- **Threatened Flora Study area** is the study area used to identify threatened flora species and included Blackbutt Reserve on the eastern side of Lookout Road.
- **Locality** is defined as an approximate 10 km radius around the proposal area.
- **Region** is a bioregion defined in a national system of bioregionalisation. For this study this is the Sydney Basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).

2.2 Personnel

The contributors to the preparation of this report, their qualification and roles are provided in Table 2.1.

Table 2.1 Contributors and their roles

Name	Qualifications	Role
Alex Cockerill	BSc (Hons)	Lead ecologist – Project manager
Toby Lambert	BEnvSc	Principal ecologist – Report review
Allan Richardson	BEnvSc (Hons)	Senior ecologist – Fauna survey, report preparation
Nathan Cooper	BEnvSc, Grad Dip Ornith	Senior ecologist – Fauna survey, Anabat analysis
Deborah Landenberger	BSc (Hons)	Senior ecologist – Flora surveys and reporting
Tanya Bangel	BSc (Hons)	Ecologist – Fauna and flora survey, report preparation
Kim Lentz	BSc	Ecologist – Fauna and flora survey, report preparation
Emily Mitchell	BDvptSt, Cert 4 SIS	Mapping and data management – GIS operator

All work was carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the National Parks and Wildlife Regulations 2002 and Section 132C of the *National Parks and Wildlife Act 1974*, Animal Research Authority issued by the Department of Industries and Investment NSW (Agriculture).

2.3 Nomenclature

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with updates from PlantNet (Royal Botanic Gardens 2014). Scientific names are used in this report for species of plant followed by the common names in brackets. Scientific and common names of plants are listed in Appendix A and C. Introduced species are identified within the text with an asterisk following the name, for example *Lantana camara**.

Vegetation community names have followed that of the Office of Environment and Heritage vegetation types database (Office of Environment and Heritage 2012b). Corresponding vegetation community names from the local broad scale vegetation mapping projects (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) has been provided in section 3.2.

Names of vertebrates follow the Australian Faunal Directory (Department of the Environment 2014) maintained by the Commonwealth Department of the Environment (DoE). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendix B and C.

2.4 Literature and database assessment

2.4.1 Database searches

Records of threatened species known or predicted to occur in the locality of the project were obtained from a range of databases as detailed in Table 2.2.

Table 2.2 Database searches

Database	Searches	Area searched	Reference
Atlas of NSW Wildlife (BioNet)	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	10 km buffer around the project[1]	Office of Environment and Heritage (2014b)
NSW Department of Primary Industries (Fishing and Aquaculture) threatened Aquatic Fauna Database	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	Hunter/Central Rivers and Catchment Management Authority area	NSW Department of Primary Industries (2014)
PlantNet	25 July 2014 7 October 2014	10 km buffer around project[1]	Royal Botanical Gardens, Sydney (2014)
Protected Matters Search Tool	25 July 2014 (flora and fauna) 7 October 2014 (flora and fauna)	10 km buffer around project[1]	Department of Environment (2014b)
Noxious Weeds Database	29 October 2014	Newcastle City Council	Department of Trade and Investment Regional Infrastructure and Services (2014)

(1) coordinates used -32.86, 151.64, -32.96, 151.74

2.4.2 Previous survey and assessments

Due to the site's long history for potential infrastructure development, a number of previous ecological and environmental studies have been undertaken within the study area, including:

- Fauna Survey of Rankin Park Area for Proposed Route of State Highway 23 (Mount King Ecological Surveys 1984).
- Rankin Park Highway Development Vegetation Description and Assessment (T. J. Fatchen & Associates 1984).
- Flora survey of remnant bushland patches in Newcastle Local Government Area – part of the 'Save the Bush' Program (Anne Clements & Associates 1994).
- Flora and Fauna survey and threatened species assessment for a proposal to construct a new access road to John Hunter Hospital, an extension to the Hospital building including a new car park and a relocated helipad (Ecotone Ecological Consultants Pty Ltd 2002).
- Ecological Constraints Analysis for a Proposed New Route for State Highway 23 between Rankin Park and Jesmond (Umwelt Environmental Consultants 2006).
- Newcastle Inner City Bypass, Rankin Park to Jesmond, Preliminary Environmental Investigation (Parsons Brinckerhoff 2014).
- Survey of *Tetratheca juncea* Sm. In Blackbutt Reserve and Rankin Park Bushland (Winning 2000).

Furthermore, staff experience and knowledge in the locality in addition to field surveys completed by Parsons Brinckerhoff that inform other projects in the locality, provide important knowledge of species distribution and habitat occurrence, particularly as it applies to threatened communities and species of plant and animal.

2.5 Field survey

Flora and fauna surveys were undertaken during optimal periods for flowering for plant species and fauna activity ranging from July-October 2014. Survey times are outlined below:

- Fauna survey and trapping – undertaken during late October 2014.
- Powerful Owl breeding habitat survey – undertaken during the breeding period 21–28 July 2014.
- Targeted threatened flora surveys – undertaken during optimum flowering periods between early August, September, October and early November 2014.
- Vegetation survey (mapping) – late September and early October 2014
- Vegetation survey (mapping) – extended proposal area 17 February 2015 ().

Survey methodology and effort for flora and fauna survey is described below and illustrated in to . The field survey conducted in February 2015 was conducted due to change in the study area. Targeted flora surveys for *Tetratheca juncea* were conducted during the flowering period in 2014 within the extended study area, however no other targeted seasonal surveys for threatened flora or fauna were conducted in the extended area as part of these reporting works. Figures throughout this report show where surveys have not been conducted as part of this report.

2.5.1 Weather conditions

The weather conditions during the surveying period varied from cool to hot temperatures (7.4–32°C), dry to slight rainfall (0–14.6 mm) and from calm to strong windy (calm–28 km/ph) weather (refer to Table 2.3).

Table 2.3 Weather conditions

Date	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/ph)/direction)[1]
17 July 2014	8.2	18.3	1.8	4/NE
18 July 2014	8.2	16.4	0	19/NW
21 July 2014	8.7	17.6	0	Calm
22 July 2014	8.5	17.9	0	4/W
23 July 2014	5.2	18.2	0.2	Calm
24 July 2014	–	18.2	0.1	–
26 July 2014	10.0	19.2	10.8	4/N
28 July 2014	7.8	19.2	0	4/SW
29 July 2014	8.7	20.8	0.1	19/NW
30 July 2014	10.4	22.5	0	28/NW
31 July 2014	13.2	24.5	0	28/NW
5 August 2014	5.9	21.2	0.2	9/SE
6 August 2014	4.4	20.2	0	4/NW
13 August 2014	6.0	17.3	18.2	19/SE
20 August 2014	10.6	17.2	7.6	28/SW
22 August 2014	11.4	18.6	8.6	Calm
29 August 2014	9.9	18.0	2.4	4/SE
17 September 2014	11.7	23.5	0	4/NW
18 September 2014	9.2	20.0	0	Calm
19 September 2014	9.4	19.8	0	Calm
22 September 2014	9.0	20.8	0	Calm
23 September 2014	7.5	21.7	0	Calm
24 September 2014	9.2	25.2	0	Calm
25 September 2014	14.4	21.2	0	Calm
26 September 2014	14.2	21.2	0	Calm
2 October 2014	7.4	23.8	0	4/NW
8 October 2014	15.2	19.0	0.2	4/S
9 October 2014	13.4	22.4	9.4	Calm
10 October 2014	11.5	26.0	0	Calm
13 October 2014	15.0	30.0	0	4/NW
14 October 2014	12.9	19.9	14.6	4/S
27 October 2014	17.2	32.0	0	9/NE
28 October 2014	14.1	30.8	0	4/NE

Date	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/ph)/direction)[1]
29 October 2014	15.0	25.0	0	9/SW
30 October 2014	12.8	29.8	0	9/SE
31 October 2014	13.0	33.0	0	9/SE
13 November 2014	16.9	26.0	0.2	19/SE
17 February 2015	19.0	29.2	0	37/E

[1] Data obtained from Bureau of Meteorology Newcastle University NSW AWS Station (Station 061390).

2.5.2 Fauna survey

Terrestrial vertebrate surveys completed within the study area were carried out as described below and where applicable, consider the methodology detailed in the *NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation 2004), the Survey Guidelines for Australia's Threatened Birds (Department of Environment Water Heritage and the Arts 2010), the *Threatened Species survey and assessment guidelines: field survey and methods for fauna-Amphibians* (NSW Department of Environment 2009) and the *Survey guidelines for Australia's threatened frogs* (Department of the Environment Water Heritage and the Arts 2010).

The fauna survey methodology involved surveys at 'standard fauna survey sites' and supplementary sites. Standard trapping sites were established to survey broad habitat types within the study area and consisted of standard fauna survey sites (Site 1–3) and supplementary survey sites (refer to).

At each standard fauna survey site the following methodologies were used:

- arboreal mammal trapping
- remote camera trapping
- diurnal bird surveys
- microchiropteran bat surveys (harp trap and Anabat surveys)
- spotlighting
- call playback
- herpetofauna active searches
- targeted Koala habitat searches
- fauna habitat assessment.

Supplementary sites were selected to target specific habitat features likely to be used by threatened species of fauna. Supplementary surveys included:

- targeted Powerful Owl breeding roost stag watching at all identified potential Powerful Owl breeding hollows within the proposal area (), these surveys excluded the extended proposal area
- targeted bird surveys
- herpetofauna active searches
- spotlighting
- call playback
- Anabat
- harp trap.

A summary of the total fauna survey effort for threatened species is provided in Table 2.4. All fauna species observed during field surveys were documented and combined into a total species list (refer to Table 3.14 and Appendix B).

Table 2.4 Summary of threatened fauna survey effort

Species targeted	Survey type	Survey effort and type	Dates surveyed	Habitat searched in study area
Threatened arboreal mammals	Arboreal mammal trapping Spotlight surveys Camera traps	4 nights 3 trap lines 6 traps each (72 trap nights)	27–31 October 2014	Dry forest and wet forest.
Hollow bearing tree surveys	Parallel transects at 50 m intervals	8 days	18–23 July 2014	Within the proposal area excluding the extended proposal area as shown in .
Large forest owls	Call playback Spotlight surveys	2 hours 8 person hours	27–30 October 2014	Open Forest and wet gully forest.
	Powerful Owl habitat tree stag watch	2 hours x 1–4 persons x 12 nights 64 person hours	21–24, 26 & 28–31 July 5, 6 & 8 August 2014	All identified potential Powerful Owl hollow bearing trees with large hollows.
Threatened diurnal birds	Standard 20 minute, 2 ha area search	3.3 person hours	27-31 October 2014	Open Forest and wet gully forest.
Regent Honeyeater and Swift Parrot	20 hrs over 5 days (Regent Honeyeater) 20 hrs over 8 days (Swift Parrot)	20 persons hours	17–28 July 2014	Open forest.
Threatened microchiropteran bats	Active ultrasonic bat detection Passive ultrasonic bat detection	8 hours during spotlight events 2 nights full recording	27–30 October 2014	Open Forest and wet gully forest.
	Harp trapping	4 trap nights over 2 consecutive nights	27°30 October 2014	Wet gully forest
Koala	(SPOT assessment) Scat searches Spotlight surveys	3 person hours	29–30 October 2014	Habitat and woodlands containing Koala feed tree species
All threatened species	Opportunistic sightings	5 days	27–31 October 2014	Within entirety of the study area

Note: Full details of fauna survey effort is provided below

2.5.2.1 Fauna habitats

Fauna habitat assessments were completed to assess the likelihood of threatened species of animal occurring in the study area. Habitat assessments included the assessment and identification of habitat features through targeted meander surveys.

During habitat assessments and targeted meander surveys, opportunistic recordings of species were made through incidental sightings, aural recognition of calls and observations of indirect evidence of species' presence (such as Glossy-black Cockatoo chewed cones, nests/dreys, whitewash, burrows and scats). This provided supplementary information on faunal species presence.

Fauna habitats were assessed generally by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, shelter roosting and breeding. The following criteria were used to evaluate habitat values:

- **Good:** A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate:** Some fauna habitat components are missing (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
- **Poor:** Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

Specific fauna habitat features were assessed at each standard fauna survey site (refer to) in the study area.

2.5.2.2 Hollow-bearing trees

A comprehensive hollow bearing tree (HBT) survey was undertaken within the proposal area, this survey excluded the extended survey area which was added after the surveys were completed () to identify all potential habitat trees, due to their importance to a diversity of threatened fauna species. Parallel transects at 50 m intervals were completed within the proposal area over 8 days of survey effort (Table 2.4). This was to ensure all hollow-bearing trees were recorded within the proposal area.

Special consideration was given to the locations of large hollows, due to their importance as potential breeding resources for large forest owls, in particular Powerful Owls in this locality. Three hollow size ranges were recorded during the survey to encompass a range of fauna size guilds, including; small hollows (<10 cm) suited to bats, small arboreal mammals and small birds, medium hollows (10–20 cm) for larger arboreal mammals and medium sized birds, and large hollows (> 20 cm) suitable for large birds like cockatoos and large forest owls including the Powerful Owl.

The location and type of hollow was also recorded, including crown branch, trunk, fire scar and decorticating bark. All tree locations were identified with a GPS and locations are shown in whilst the hollow-bearing tree data is provided in section 3.6 and Appendix G.

2.5.2.3 Microchiropteran bat surveys

Ultrasonic Anabat bat detection (Anabat SD1 CF Bat Detector – Titley Electronics, Ballina) was used to record and identify the echolocation calls of microchiropterans foraging across five locations in the study area (refer). Passive monitoring of these survey sites was achieved by setting Anabat bat detectors to record throughout the night. Bat call analysis was completed by Nathan Cooper of Parsons Brinckerhoff, with the presentation of data (refer Appendix F) considering the guidelines of the Australasian Bat Society. Bat call of New South Wales Sydney Basin region (Pennay *et al.* 2004) was used as a reference collection for bat call identification.

Harp traps were used to trap foraging microchiropterans, with traps located at sites within the study area that had potential to be used as fly-ways. Four locations were targeted therein with harp traps set in each location for two consecutive nights (refer). Harp traps were checked every evening following spotlighting events and again the following day during morning hours. Microchiropteran species caught by harp traps were identified to species level, sexed and forearm measurement recorded. Microchiropterans caught before evening harp

trap checks were released the same night, while those caught after the evening check were contained until the following evening for release.

2.5.2.4 Powerful Owl surveys

Powerful Owl surveys were undertaken during the breeding period between 21 July and 13 August 2014. All 84 potential Powerful Owl roost trees identified within the study area during hollow-bearing tree surveys (refer to) were stag watched for a three hour period during dusk to determine if the hollows were utilised by breeding Powerful Owls. The hollow size, tree species and tree diameter at breast height was recorded for all potential Powerful Owl breeding trees identified. Trees were also inspected for the presence of Powerful Owl pellets, scratchings and white wash to determine if the identified hollow trees were being utilised for Powerful Owl breeding.

2.5.2.5 Diurnal bird surveys

Three formal diurnal bird surveys were completed at standard fauna survey locations (site 1 to site 3) within the study area (refer to) and a further two formal surveys were conducted at supplementary sites. Bird surveys were completed by actively walking through the nominated site (transect) over a period of 20 minutes. All birds were identified to the species level, either through direct observation or identification of calls. Bird surveys were completed during different times of the day, but generally occurred in the morning. Birds were also recorded opportunistically during all other surveys.

2.5.2.6 Threatened bird surveys

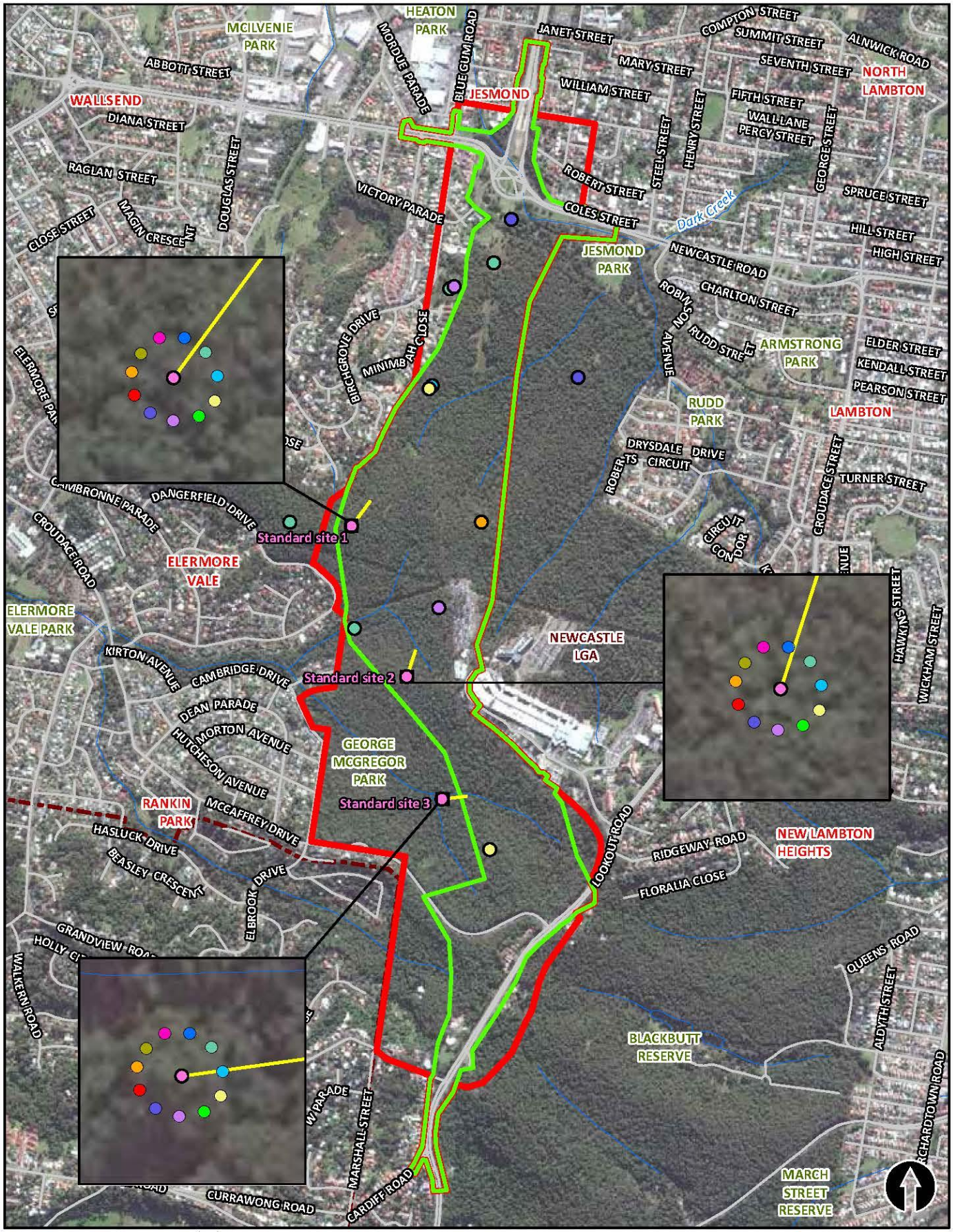
In addition to standard diurnal bird surveys, targeted surveys were conducted for threatened birds including endangered blossom nomads such as the Regent Honeyeater and Swift Parrot. The presence of these species is dependent upon the distribution of blossom resources at regional and sometimes national levels, therefore they may be absent from some areas containing suitable habitat for a number of years. As a consequence, where these species were absent on the site, habitat assessments were conducted for threatened bird species, to determine the likelihood that habitats contained within the study area might support those species that are known to occur in the Lower Hunter Region.

2.5.2.7 Targeted Koala surveys – SEPP 44

Targeted searches for the Koala were completed at four locations in the study area (refer to) and consisted of inspecting feed trees for signs of usage including scratching and scat searches. Koala feed tree species identified in the study area that are consistent with State Environmental Planning Policy 44 – Koala habitat protection (SEPP 44) included, Grey Gum (*Eucalyptus punctata*). At each survey location the Spot Assessment Technique (SAT) methodology was employed, which involved actively searching the ground between the drip-line of the canopy and the trunk of 30 trees; specifically targeting feed tree species where possible.

2.5.2.8 Spotlighting

Spotlighting was used to target arboreal, flying and ground-dwelling mammals, as well as, nocturnal birds, reptiles and amphibians. Spotlighting was completed after dusk on four consecutive nights generally following the targeted nocturnal search transects, as shown in . Surveys were completed on foot using high-powered headlamps. Sighted animals were identified to the species level.



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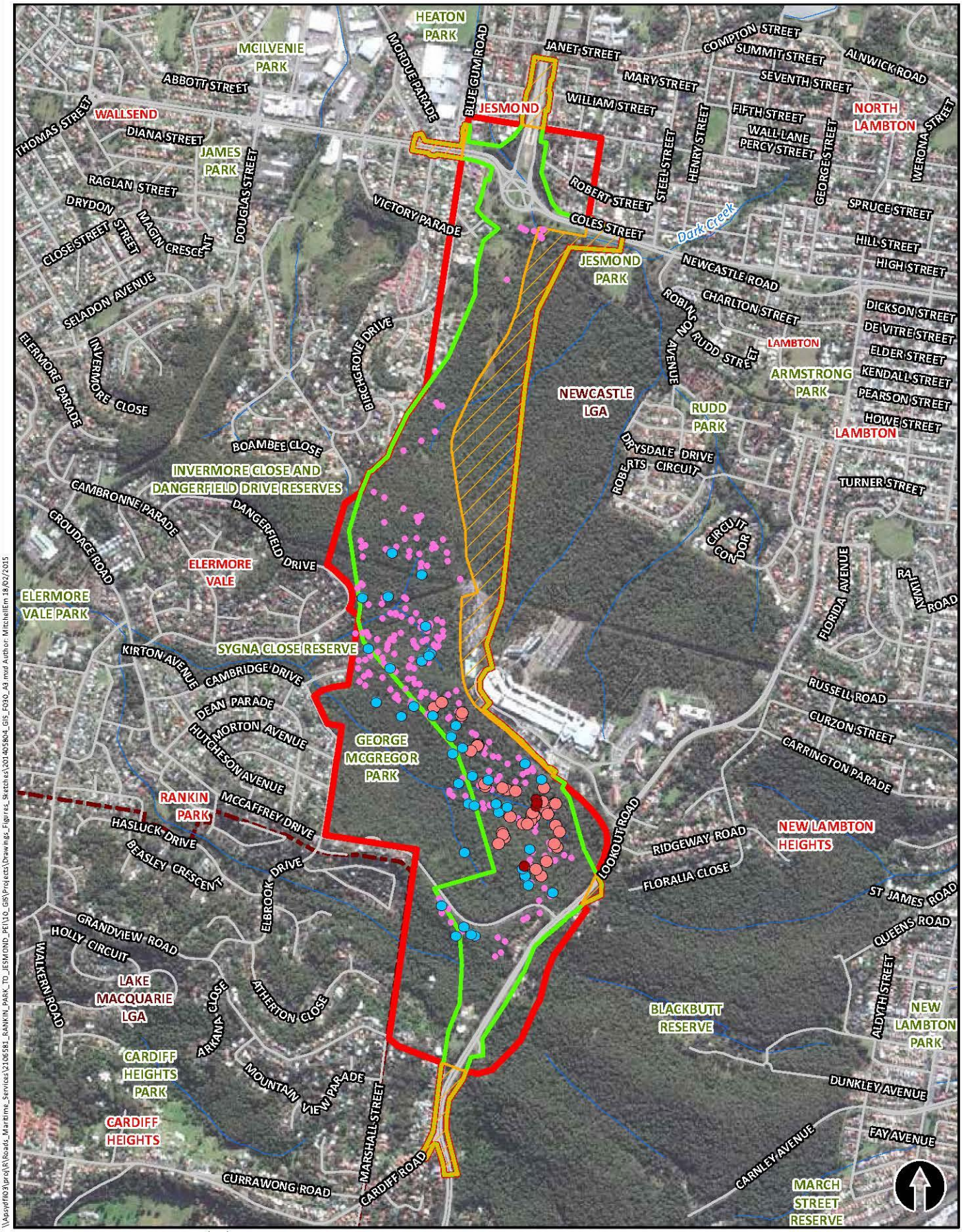
Source: Aerial from Google Earth (16/05/2014)

- Local roads
- Creek lines
- Proposal area
- Study area
- Local government area
- Arboreal trap line
- Standard site
- Anabat
- Arboreal trap line
- Bird survey
- Call playback
- Habitat assessment
- Harp trap
- Herpetofauna search
- Koala habitat search
- Remote camera trapping
- Spotlighting
- Stag watch

0 200 400 600 m

Figure 2.1
Fauna survey effort
(Parsons Brinckerhoff)



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Source: Aerial from Google Earth (16/05/2014)

- Local roads
- Creek lines
- Proposal area
- Proposal area not part of original survey
- Study area
- Local government area
- Powerful Owl roost trees
- Stag watch
- Hollow-bearing tree (potentially suitable for Powerful Owl)
- Hollow-bearing tree

0 200 400 600 m

Figure 2.2
Powerful Owl targeted survey effort (Parsons Brinckerhoff July-Aug 2014)

2.5.2.9 Call playback

Call playback was used to survey for the Barking Owl, Masked Owl, and Sooty Owl using standard methods (Debus 1995; Kavanagh & Debus 1994). No call playback was used for Powerful Owl, to prevent disturbance of potential breeding cycle behaviour, as their presence has already been established within the Study Area. Call playback was completed after dusk at four locations in the study area (refer to).

For each survey, an initial listening period of 10 to 15 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animals in the immediate vicinity. The calls of the target species were then played intermittently for five minutes followed by a 10 minute listening period. After the calls were played, another 10 minutes of spotlighting was done in the vicinity to check for animals attracted by the calls, but not vocalising. Calls from Stewart and Pennay (Pennay *et al.* 2004; Stewart 1998) were broadcast using a portable media player.

Call playback was also used for the Koala and Squirrel Glider during nocturnal surveys.

2.5.2.10 Herpetofauna active searches

Herpetofauna active searches involved looking for active specimens and eye shine, turning over suitable ground shelter, such as fallen timber, sheets of iron and exposed rocks, racking debris, and peeling decorticating bark. Specimens were either identified visually, by aural recognition of call (frogs only) or were collected and identified using nomenclature outlined in *A Field Guide to Reptiles of New South Wales* (Swan *et al.* 2004).

Herpetofauna surveys were completed by two persons over a 30 minute period with all ground shelter returned to their original position. Herpetofauna active searches were completed in conjunction with diurnal and nocturnal surveys. Frogs and reptiles were also surveyed opportunistically across the study area. Reptiles were surveyed in reference to *Threatened species survey and assessment guidelines: field survey methods for fauna (reptiles)* (Department of Environment and Climate Change 2009). Herpetofauna was also recorded opportunistically during all other surveys.

2.5.2.11 Arboreal trapping

Medium to large sized arboreal mammals were surveyed using arboreally set Elliott Type B trapping methods. Live capture/release Elliott Type B traps were set in three transects of six traps for four nights per transect to target Squirrel Gliders. Each trap was baited with a suitable food source containing honey, and each trap and immediate location was sprayed with an attractant of honey water mix. Traps were checked at dawn each morning with captured animals identified to species level and released. All live trapping followed guidelines and policies for wildlife research in accordance with animal ethics protocols.

2.5.2.12 Remote camera

A remote motion sensing infra-red camera was utilised at each standard fauna survey site (site 1 to site 3) with a bait to survey for terrestrial mammals. Suitable meat bait was used as an attractant for the target species Spotted-tailed Quoll in appropriate micro-habitats at each site in the study area (refer to). These cameras were also used to identify any other animal recorded.

2.5.3 Flora survey

The floristic diversity and possible presence of threatened species was assessed using a combination of random meander and plot-based (quadrat) surveys in accordance with the NSW *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft*) (Department of Environment and Conservation 2004). The plot based surveys were conducted in accordance with the

BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014a). This methodology was followed to allow for potential BioBanking calculations to be performed for any potential offsets that maybe required. This methodology is explained further in section 2.5.3.4 below.

Random meander surveys were completed along the entire length of the study area, these surveys included the extended proposal area. Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random meander throughout the site recording all species observed, boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

2.5.3.1 Desktop analysis of vegetation

The vegetation community boundaries were assessed using aerial photo interpretation. Analysis of the aerial photographs identified past land use practices, disturbance and native vegetation regrowth, changes in vegetation structure and floristics throughout the study area. This provided an initial split of vegetation communities into simple structural and disturbance classifications.

2.5.3.2 Field verification of existing vegetation mapping

Vegetation within the study area and locality has been previously mapped at a regional scale by the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (2003) and refined by previous vegetation mapping of the study area by Umwelt (2006).

Field validation (ground-truthing) of the initial vegetation classification identified from aerial photograph interpretation and existing vegetation mapping (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003; Umwelt Environmental Consultants 2006) was undertaken to determine the site specific classification of the vegetation structure, dominant canopy species, native diversity and condition. The ground-truthing included the extended proposal area as outlined in .

2.5.3.3 Targeted surveys for threatened flora

Targeted threatened flora surveys were undertaken over three different survey periods to ensure that the flowering period that the survey were conducted in the specific flowering period for each species. These surveys were undertaken for threatened plants that were assessed as having a moderate or greater chance of occurrence, based on known distributions and habitat types present within the study area. Targeted surveys were undertaken for eight threatened plants (Table 2.5) for which potential habitat occur within the study area. The methodologies used were a combination of random meander technique and parallel transects as described by Cropper (1993). Table 2.5 below outlines the flowering period for each species targeted and the survey dates that the current surveys were undertaken.

Table 2.5 Summary of targeted threatened flora searches

Threatened species	Flowering period	Dates surveyed	TSC Act status[1]	EPBC Act status[2]
Caladenia tessellata	September	17, 18, 19, 22, 23, 24, 25, 26 September 2014, 2 October 2014, 13 November 2014	E	V
Callistemon linearifolius	September	18, 19, 22, 23, 24, 25, 26 September 2014, 2 October 2014	V	-
Corybas dowlingii	June to August	20, 22, 29 August 2014	E	-
Cryptostylis hunteriana	November to December	14 October 2014 13 November 2014	V	V

Threatened species	Flowering period	Dates surveyed	TSC Act status[1]	EPBC Act status[2]
Diuris praecox	August to September	20, 22, 29 August 2014	V	V
Grevillea parviflora subsp. *parviflora*	August to September	20, 22, 29 August 2014 17, 18, 19, 22, 23, 24, 25, 26 September 2014, 2 October 2014	V	V
Rutidosis heterogama	September	18, 19, 22, 23, 24, 25, 26 September 2014, 2 October 2014	V	V
Syzygium paniculatum	August to September	18, 19, 22, 24, 25, 26 September 2014 27, 28, 29, 30, 31 October 2014	E	V
Tetratheca juncea	Peak flowering Mid-September to October	17, 18, 19, 22, 23, 24, 25 September 2014 2, 8, 9, 13, 14 October 2014, 13 November 2014	V	V

(1) Listed as vulnerable (V), endangered (E) under the TSC Act.
(2) Listed as vulnerable (V), endangered (E) under the EPBC Act.

Corybas dowlingii and *Diuris praecox* targeted surveys

Random meander surveys were completed along the entire length of the study area for these species during the flowering period of August 2014. These surveys excluded the additional proposal area (Figure 2.1) and therefore additional targeted surveys for these two species will be required in the extended proposal area. Random meander surveys were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random meander throughout the site searching for the targeted species and recording other common species that are in flower. For these species the entire study area was surveyed in a random manner. Included in searches for *Diuris praecox, Corybas dowlingii* was searched for as the flowering period for this species overlaps. The survey effort is outlined in Table 2.5 and Table 2.6 whilst the locations of the random searches are shown in .

Cryptostylis hunteriana targeted surveys

Random meander surveys were completed along the entire length of the study area for this species during the flowering period of October and November 2014. This survey excluded the extended proposal area (Figure 2.1) and further targeted surveys will be required for this species within the extended proposal area. Random meander surveys were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random meander throughout the site searching for the targeted species and recording other common species that are in flower. For this species habitat for this species in the form HU621 Smooth-barked Apple – Red Bloodwood open forest and HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest vegetation community types within the study area was surveyed in using random meander surveys. The survey effort is outlined in Table 2.5 and Table 2.6 whilst the locations of the random searches are shown in .

Tetratheca juncea targeted surveys

The survey methodology for this species followed the Commonwealth of Australia referral guidelines for *Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011). The Lake Macquarie Planning and Management Guidelines for *Tetratheca juncea* (Lake Macquarie City Council 2014) was also considered when conducting these current targeted surveys.

Determination of peak flowering for *Tetratheca juncea*

The survey methodology for determination of peak flowering for *Tetratheca juncea* followed the guidelines outlined in the federal species profile for *Tetratheca juncea* (Department of the Environment 2013) This

survey methodology was conducted throughout the study area within the peak flowering period for this species, being from 1 September to 31 October outlined in the referral guidelines for *Tetratheca juncea* Department of Sustainability Environment Water Population and Communities 2011). The targeted surveys of this species included the extended proposal area and therefore no further targeted surveys for this species will be required.

Prior to the detailed field survey, on 17 September 2014 random meander surveys were conducted to determine the extent of the *Tetratheca juncea* population and 36 plant clumps were chosen to be sampled at nine locations to determine if peak flowering was occurring. At each of the 36 plant clumps one stem was chosen in which all buds, flowers and seed capsules were counted and recorded. Peak flowering is defined as a minimum average of 75% of the plant stems sampled should be in flower before conducting further detailed surveys (Department of the Environment 2013). Nine locations for the stem counts were chosen representing the sub populations of *Tetratheca juncea* within the study area. The locations of the stem counts are shown in . Four plant clumps were selected at each of the nine locations, giving a total of 36 stems counted. At each of the nine locations plant clumps were selected at a minimum of 10 m apart, whereby a single stem was selected on each clump and the number of buds, flowers and seed capsules was counted.

Parallel transect and random meander surveys for *Tetratheca juncea*

The survey consisted of 5–10 m spaced parallel transects being traversed in potential habitat of HU621 Smooth-barked Apple – Red Bloodwood open forest and HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest within the study area. Random meander searches were undertaken in the remaining vegetation communities which contained sub-optimal habitat. If the species was detected during the random meander searches then parallel transects of 5–10 m apart were conducted in the immediate vicinity to detect any outlier plant clumps. Table 2.6 below outlines the survey effort and shows the location of parallel transects and random meander searches throughout the Threatened flora study area.

All clumps of *Tetratheca juncea* were recorded by GPS and clumps were counted in accordance with the requirements of the Commonwealth of Australia referral guidelines for *Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011). These guidelines refer to Payne et al (2002) which defines an individual clump as being a distance of at least 30 cm apart. Each GPS point may refer to more than one *Tetratheca juncea* plant clump; in this case all plant clumps within a 5 m radius were counted and added to each GPS point.

The above methodology was repeated within Blackbutt Reserve and the surrounding bushland to the west and east of the study area. The communities of Coastal Narrabeen Moist Forest and Subtropical Rainforest were not recorded within the study area and random meander searches were undertaken throughout these vegetation community types.

The above methodology has followed the guidelines outlined in Figure 2 in Section 4 of the Commonwealth of Australia referral guidelines for *Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011) for detailed targeted surveys.

Other threatened flora species

The remaining five threatened flora species these include *Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora, Caladenia tesselata, Rutidosis heterogama*, *Syzygium paniculatum* that have been identified as having potential habitat within the study area, all have the same flowering period as *Tetratheca juncea*. Therefore these species were targeted during the same survey period. Targeted surveys for these five threatened species have been completed within the extended proposal area and therefore no additional targeted surveys are required.

If a species was detected during the random searches then parallel searches were conducted to detect all species within the vicinity of the detected species. Table 2.6 below outlines the survey effort conducted for

these threatened flora species. shows the location of the random meander and parallel transect searches conducted for these threatened flora species throughout the study area.

The above methodology was repeated within Blackbutt Reserve (refer) and the surrounding bushland to the west and east of the study area. The communities of Coastal Narrabeen Moist Forest and Subtropical Rainforest were not recorded within the study area and random meander searches were undertaken throughout these vegetation community types.

Table 2.6 Summary of threatened flora survey effort

Species Targeted/ survey area	Flowering period of target species/ optimal survey time	Dates of targeted survey	Plant community type searched within study area	Type of survey effort	Total survey effort (person hours)
***Tetratheca juncea* survey effort**					
Within study area and adjoining bushland to the west of Lookout Road[1] Includes extended proposal area	September to October	17, 18, 19, 22, 23, 24, 25, 26 September 2014 2 October 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Parallel transects and quadrats	174 hours
		17, 22, September 2014 2 October 2014 13 November 2014	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Parallel transects and quadrats	19 hours
		18, 19, 24, September 2014	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Random meanders and quadrats	10.0 hours
		18, 22, 25, 26 September 2014 2 October 2014	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – Syncarpia glomulifera variant	Random meanders and quadrats	17 hours
		18, 19, 22, 24, 25, 26 September 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders and quadrats	18 hours
		18, 19, 23, 24, 25, 26 September 2014 2 October 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders and quadrats	36 hours
		19, 22, 25 September 2014 2 October 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders and quadrats	10 hours
		23, 24 September 2014	Coastal Narrabeen Moist Forest (Blackbutt Apple Forest) Note: this community occurs outside the study area and within the threatened species study area.	Random Meander	6 hours

Species Targeted/ survey area	Flowering period of target species/ optimal survey time	Dates of targeted survey	Plant community type searched within study area	Type of survey effort	Total survey effort (person hours)
Blackbutt Reserve	September to October	8, 9, 13, 14 October 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Parallel transects	34.0 hours
		9, 13, October 2014	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Parallel transects	6 hours
		9, 13, October 2014	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – Syncarpia glomulifera variant	Random meanders	3 hours
		8 October 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders	1.0 hours
		8, 9, 13, October 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders	7.0 hours
		8, 9, October 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders	7.0 hours
		13, 14 October 2014	Coastal Narrabeen Moist Forest (Blackbutt Apple Forest)	Random Meander	4 hours
		9 October 2014	Subtropical Rainforest	Random Meander	2 hours
Other threatened flora species targeted					
Callistemon linearifolius[2] Same as survey area *Tetratheca juncea*	September	18, 19, 22, 24, 25, 26 September 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders and quadrats	18 hours
		18, 19, 23, 24, 25, 26 September 2014 2 October 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders and quadrats	36 hours
		19, 22, 25 September 2014 2 October 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders and quadrats	10 hours
Cryptostylis hunteriana	November to December	14 October 2014 13 November 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Random meanders	12 hours

Species Targeted/ survey area	Flowering period of target species/ optimal survey time	Dates of targeted survey	Plant community type searched within study area	Type of survey effort	Total survey effort (person hours)
Within proposal area Excludes extended proposal area		14 October 2014 13 November 2014	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Random meanders	18 hours
Caladenia tesselata[2] Same as survey area *Tetratheca juncea*	September	18, 19, 22, 24, 25, 26 September 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders and quadrats	18 hours
		18, 19, 23, 24, 25, 26 September 2014 2 October 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders and quadrats	36 hours
		17, 18, 19, 22, 23, 24, 25, 26 September 2014 2 October 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Parallel transects and quadrats	174 hours
		17, 22, September 2014 2 October 2014 13 November 2014	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Parallel transects and quadrats	19 hours
		19, 22, 25 September 2014 2 October 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders and quadrats	10 hours
		23, 24 September 2014	Coastal Narrabeen Moist Forest (Blackbutt Apple Forest) Note: this community occurs outside the study area and within the threatened species study area.	Random meanders	6 hours
Diuris praecox Within proposal area Excludes extended proposal area	August	20, 22 August 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders	2 hours
		20, 22, August 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders	10 hours
		29 August 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders	4 hours
		20, 22 August 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Random meanders	7.0 hours

Species Targeted/ survey area	Flowering period of target species/ optimal survey time	Dates of targeted survey	Plant community type searched within study area	Type of survey effort	Total survey effort (person hours)
		20 August 2014	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Random meanders	1 hour
Corybas dowlingii[3] Within proposal area Excludes extended proposal area	August	20, 22 August 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders	2 hours
		20, 22, August 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders	10 hours
		29 August 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders	4 hours
		20, 22 August 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Random meanders	7.0 hours
		20 August 2014	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Random meanders	1 hour
Grevillea parviflora subsp. parviflora[2] Same as survey area *Tetratheca juncea*	August – September	20, 22 August 2014 18, 19, 22, 24, 25, 26 September 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders	20 hours
		20, 22, August 2014 18, 19, 23, 24, 25, 26 September 2014 2 October 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders and quadrats	38 hours
		29 August 2014 19, 22, 25 September 2014 2 October 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders and quadrats	14 hours
		20, 22 August 2014 17, 18, 19, 22, 23, 24, 25, 26 September 2014 2 October 2014	HU621 Smooth-barked Apple – Red Bloodwood open forest	Parallel transects and quadrats	181 hours
Rutidosis heterogama[2]	September	18, 19, 22, 24, 25, 26 September 2014	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	Random meanders and quadrats	18 hours

Species Targeted/ survey area	Flowering period of target species/ optimal survey time	Dates of targeted survey	Plant community type searched within study area	Type of survey effort	Total survey effort (person hours)
Same as survey area *Tetratheca juncea*		18, 19, 23, 24, 25, 26 September 2014 2 October 2014	HU631 Spotted Gum – Grey Ironbark open forest – Eucalyptus fergusonii variant	Random meanders and quadrats	36 hours
		19, 22, 25 September 2014, 2 October 2014	HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	Random meanders and quadrats	10 hours
Syzygium paniculatum[2] Same as survey area *Tetratheca juncea*	September - December	18, 22, 25, 26 September 2014 2, 27, 28 October 2014	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – Syncarpia glomulifera variant	Random meanders and quadrats	19 hours
		18, 19, 24, September 2014 29, 30 October 2014	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Random meanders and quadrats	14.0 hours

Notes: 1 = Hours are quoted in person hours with four staff undertaking targeted surveys for 3 days, three staff for 2 days for the targeted parallel *Tetratheca juncea* searches in September. Two staff for four days undertook the quadrat surveys
2 = These threatened flora species were targeted during the surveys for *Tetratheca juncea* as they flower at the same time.
3 = *Corybas dowlingii* was surveyed at the same time as *Diuris praecox* as they have co-occurring flowering periods.

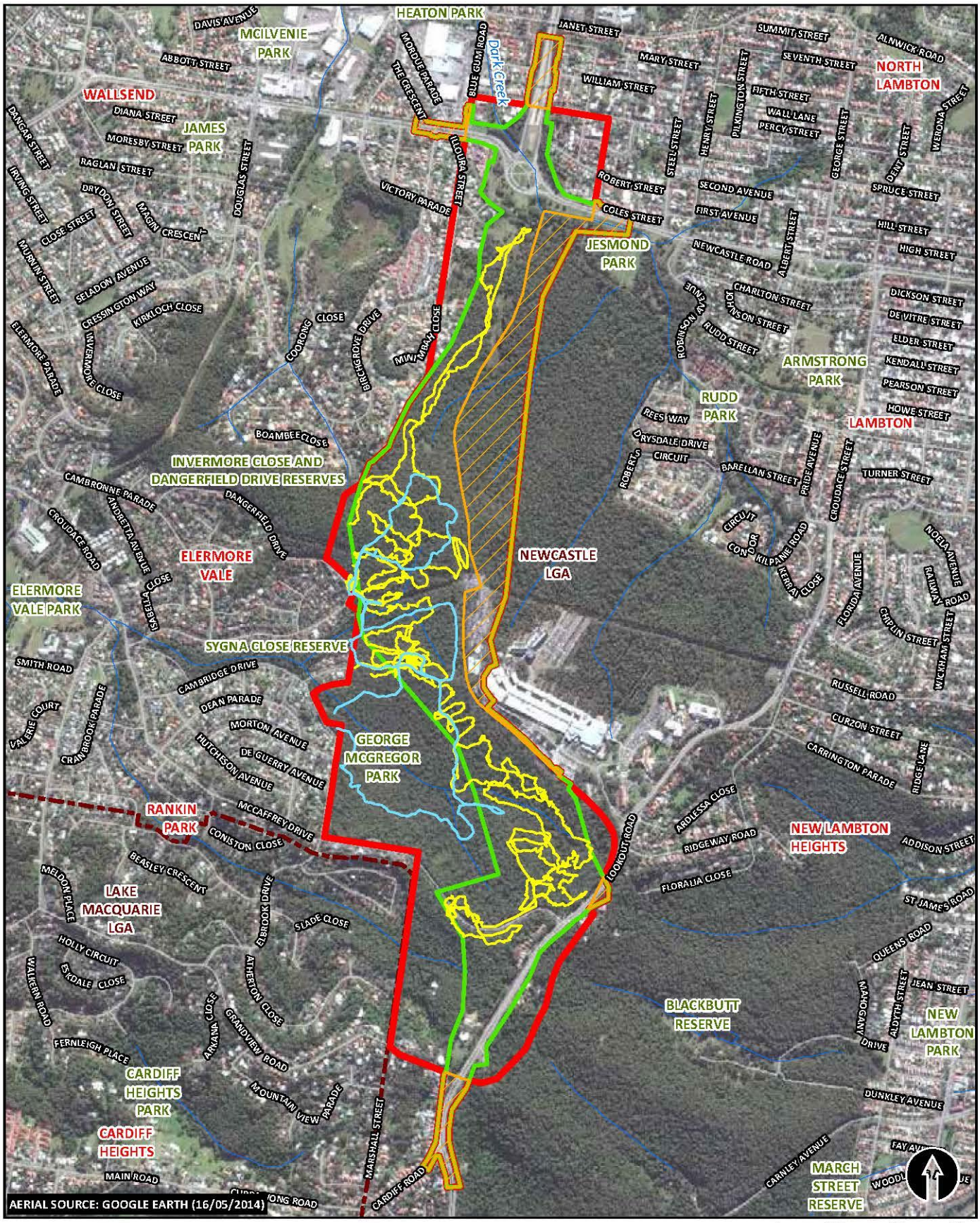
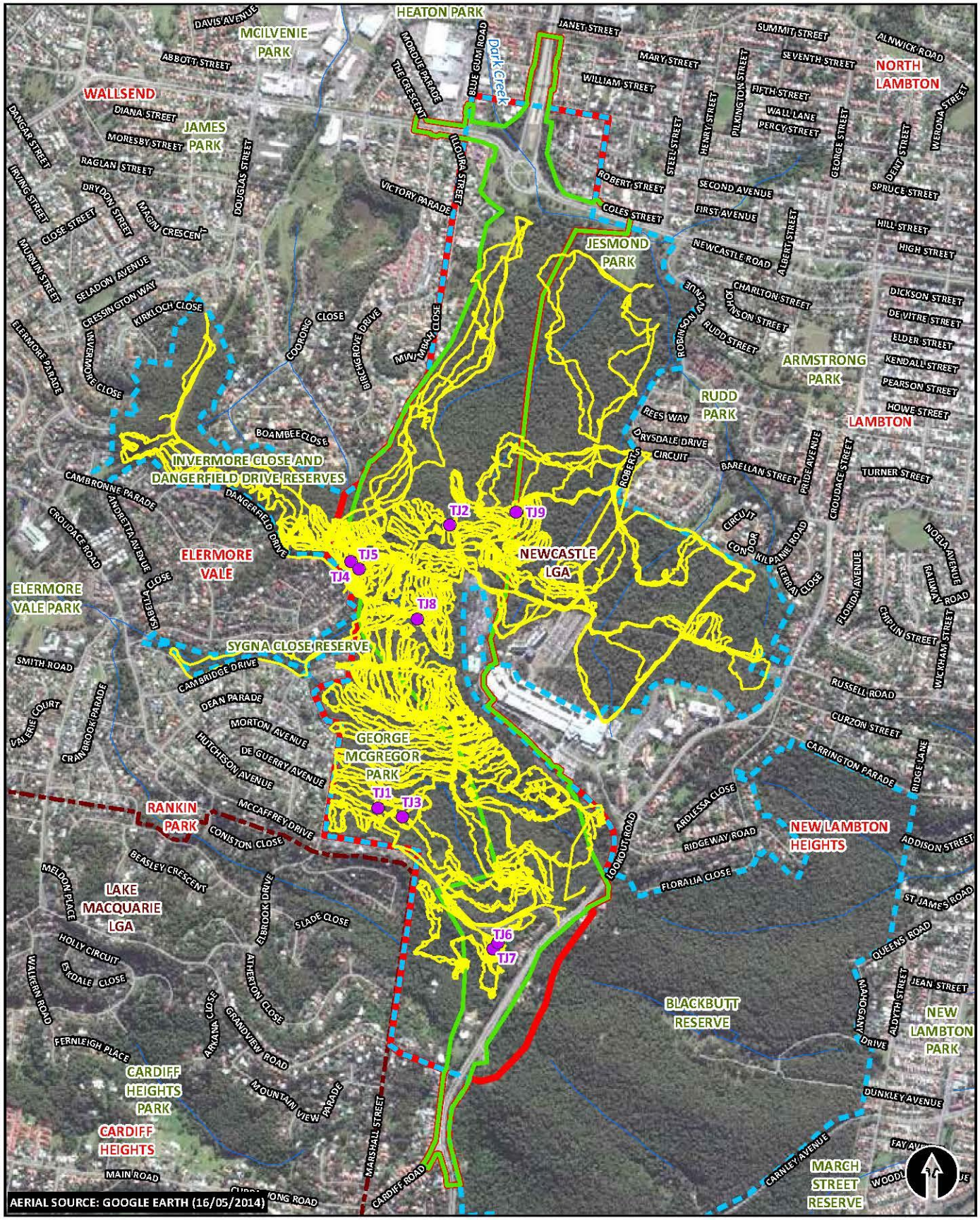
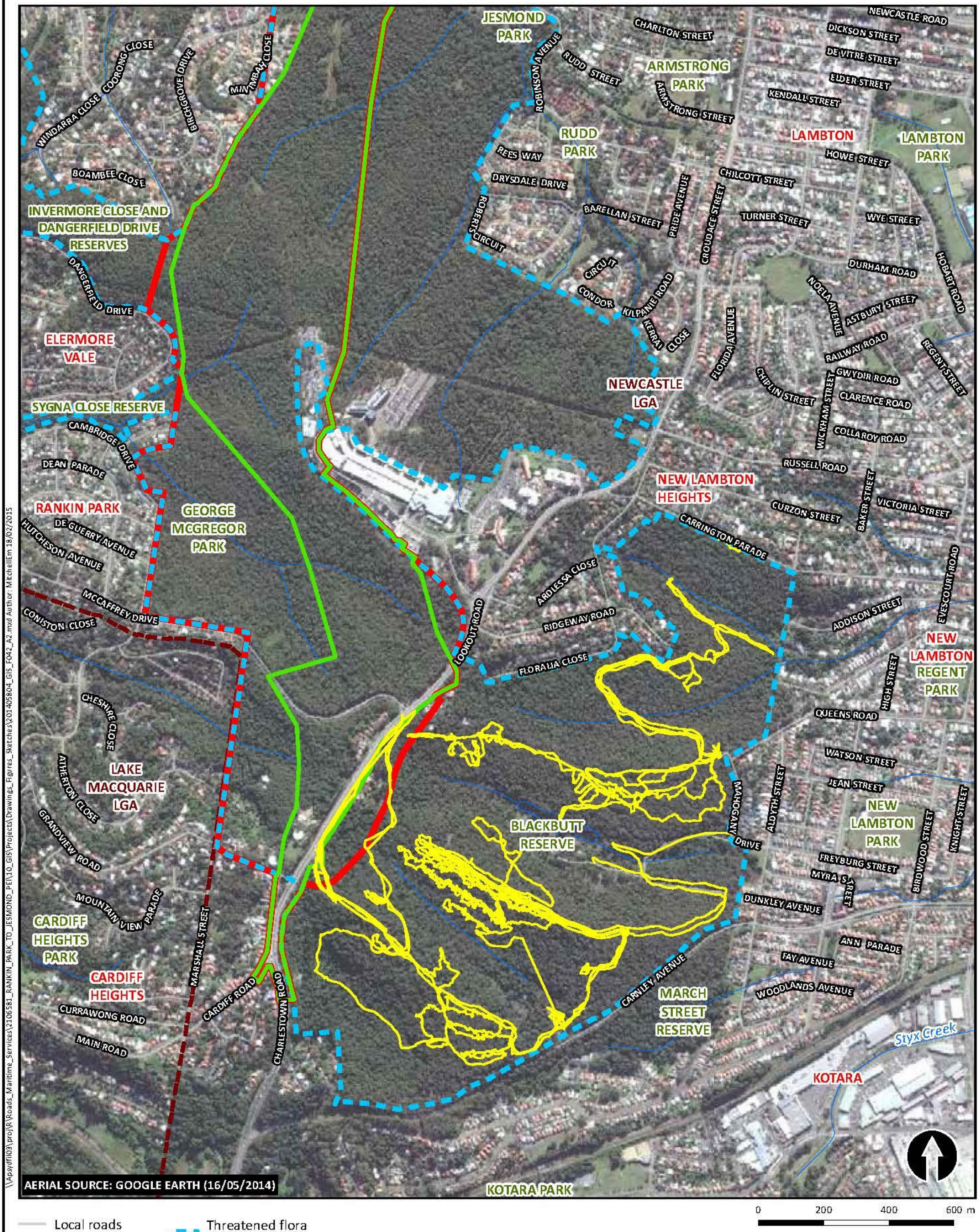


Figure 2.3
Corybas dowlingii, *Cryptosylis hunteriana* and *Diuris praecox* survey tracks



Local roads
Creek lines
Proposal area
Study area
Local government area
Threatened flora study area
Targeted *Tetratheca juncea*, *Syzigium paniculatum*, *Rutidosis heterogama*, *Caladenia tessellata* and *Grevillea parviflora subsp. parviflora* survey tracks
Tetratheca juncea stem count locations

Figure 2.4
Tetratheca juncea, *Syzygium paniculatum*, *Rutidosis heterogama*, *Caladenia tessellata* and *Grevillea parviflora subsp. parviflora* targeted survey effort - western side of Lookout Road



- Local roads
- Creek lines
- Proposal area
- Study area
- Local government area
- Threatened flora study area
- Targeted *Tetratheca juncea* survey tracks

Figure 2.5
Targeted *Tetratheca juncea* survey effort in Blackbutt Reserve

2.5.3.4 Quadrats site surveys

Thirty quantitative (quadrat/transect) site surveys (refer Table 2.7 and) were completed within the study area as outlined in the methodology contained in the BioBanking Assessment Methodology (Office of Environment and Heritage 2014a) and described below Figure 2.1 illustrates the plot layout that was used at each site.

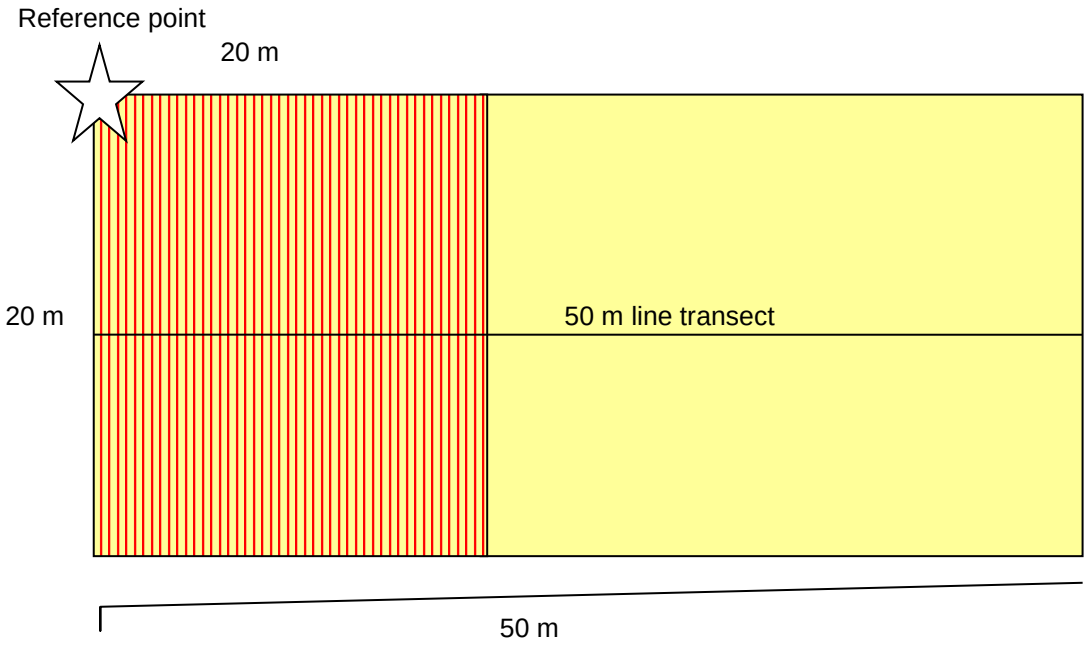


Figure 2.1 Schematic diagram illustrating the layout of the nested 20 m x 50 m and 20 m x 20 m quadrats used for the assessment of condition attributes at each site

The following site attributes were recorded at each site:

- Location (easting – northing grid type MGA 94, Zone 56).
- Vegetation structure and dominant species and vegetation condition.
- Native and exotic species richness (within a 400 m^2 quadrat): this consisted of recording all species by systematically walking through each 20 m x 20 m quadrat. The cover abundance of each species was estimated.
- Number of trees with hollows (1,000 m^2 quadrat): this was the frequency of hollows within living and dead trees within each 50 m x 20 m quadrat. A hollow was only recorded if:
  - the entrance could be seen
  - the estimated entrance width was at least 5 cm across
  - the hollow appeared to have depth
  - the hollow was at least 1 m above the ground
  - the centre of the tree was located within the sampled quadrat.
- Total length of fallen logs (1,000 m^2 quadrat): this was the cumulative total of logs within each 50 m x 20 m quadrat with a diameter of at least 10 cm and a length of at least 0.5 m.
- Native over-storey cover: this consisted of estimating the percentage cover of the tallest woody stratum present (>1 m and including emergents). The woody stratum included species that were native to NSW and not necessarily those that were locally endemic.
- Native mid-storey cover: this involved estimating the cover of vegetation between the over-storey stratum and a height of one m (i.e. tall shrubs, under-storey trees and tree regeneration).

- Ground cover: this comprised estimating the cover of plants below 1 m in height. The following categories of plants were recorded:
  - native ground cover (grasses): native grasses (Poaceae family native to NSW)
  - native ground cover (shrubs): all woody vegetation below one m in height and native to NSW
  - native ground cover (other): non-woody vegetation (i.e. vascular plants–ferns and herbs) below one m in height and native to NSW
  - exotic plant cover: vascular plants not native to Australia.
- Evaluation of regeneration: this was estimated as the proportion of over-storey species present at the site that was regenerating (i.e. saplings with a diameter at breast height ≤5 cm). The maximum value for this measure was one.

Table 2.7 Location of flora quadrats

BioBanking quadrat/transect ID	Plant community type (vegetation condition class)	Easting[1]	Northing[1]
Q1	HU637 Sydney Blue Gum – White Mahogany tall open forest –*Syncarpia glomulifera* variant (Moderate-Good)	377292	6356879
Q2	HU629 Spotted Gum – Broad-leaved grassy open forest – Canopy only (Moderate-Good)	377570	6357891
Q3	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest (Moderate-Good)	377602	6357989
Q4	HU631 Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant (Moderate-Good)	377869	635590
Q5	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377986	6356200
Q6	HU631 Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant (Moderate-Good)	377833	6356240
Q7	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant (Moderate-Good)	377777	6356301
Q8	HU637 Sydney Blue Gum – White Mahogany tall open forest –*Syncarpia glomulifera* variant (Moderate-Good)	377541	6356286
Q9	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377242	6356672
Q10	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377351	6356731
Q11	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377447	6856686
Q12	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest (Moderate-Good)	377465	6356569
Q13	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377145	6356371
Q14	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377134	6356239
Q15	HU631 Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant (Moderate-Good)	377444	6355808
Q16	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant (Moderate-Good)	377418	6355738
Q17	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant (Moderate-Good)	377522	6355704
Q18	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant (Moderate-Good)	377611	6355621

BioBanking quadrat/transect ID	Plant community type (vegetation condition class)	Easting[1]	Northing[1]
Q19	HU631 Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant (Moderate-Good)	377625	6355690
Q20	HU621 Smooth-barked Apple – Red Bloodwood open forest (Moderate-Good)	377634	6355701
Q21	HU631 Spotted Gum – Grey Ironbark open forest - atypical variant (Moderate-Good)	377535	6355896
Q22	HU631 Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant (Moderate-Good)	377453	6356070
Q23	HU637 Sydney Blue Gum – White Mahogany tall open forest –*Syncarpia glomulifera* variant (Moderate-Good)	377097	6356585
Q24	Planted and parkland vegetation (Moderate-Good)	377738	6358232
Q25	HU629 Spotted Gum – Broad-leaved grassy open forest – (Moderate-Good)	377752	6358112
Q26	HU629 Spotted Gum – Broad-leaved grassy open forest (Moderate-Good)	377576	6357763
Q27	HU631 Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant (Moderate-Good)	377490	6357587
Q28	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant (Moderate-Good)	377121	6357215
Q29	HU629 Spotted Gum – Broad-leaved grassy open forest (Moderate-Good)	377442	6357280
Q30	HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest (Moderate-Good)	377236	6357095

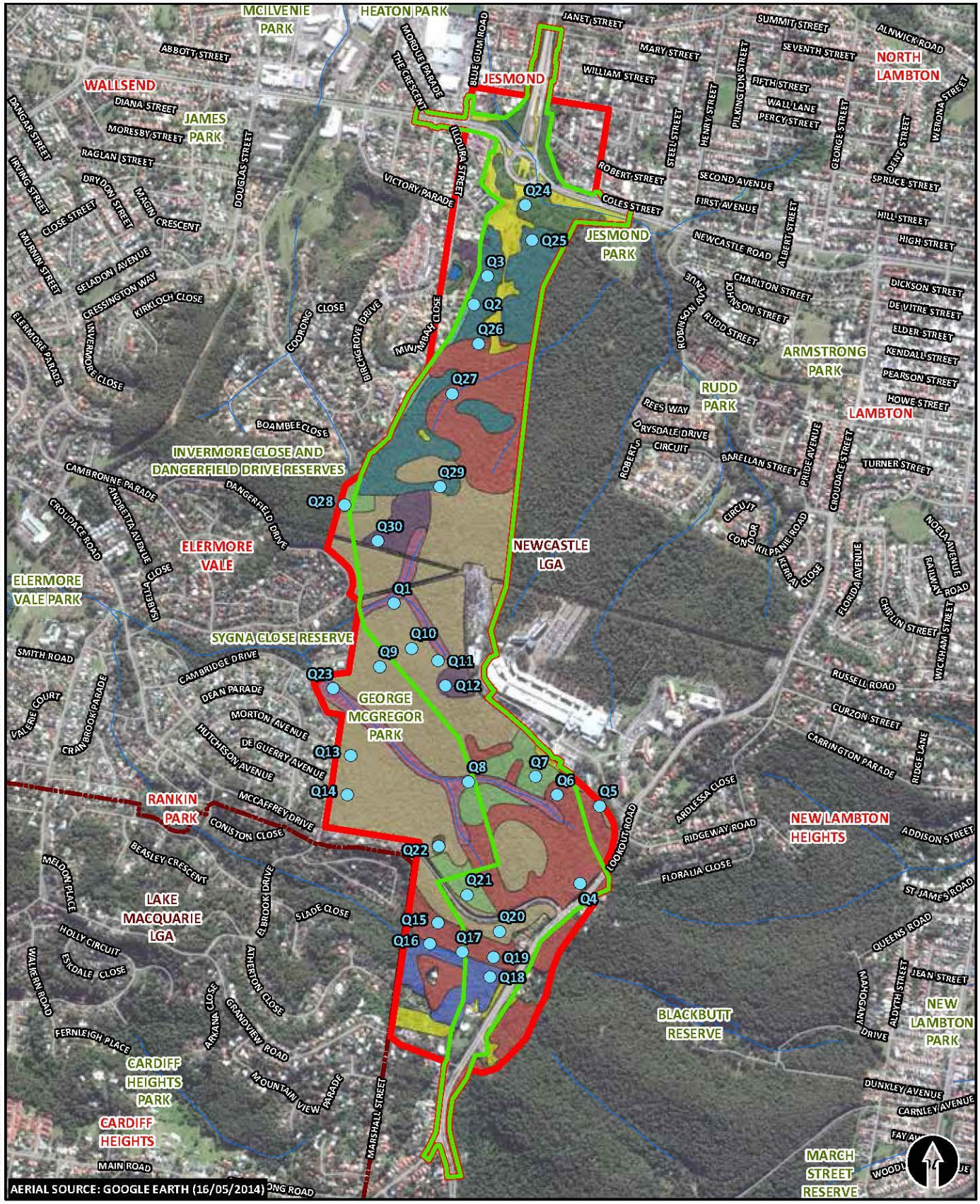
(1) GDA 94: Zone 56.

2.5.3.5 Biobanking quadrat/transect survey effort

Table 2.8 below outlines the survey effort for the BioBanking plots in each plant community type and their condition.

Table 2.8 BioBanking quadrat/transect survey effort

Plant community type (vegetation condition class)	Number of quadrats	Survey effort (person hours)
HU631 Spotted Gum – Grey Ironbark open forest – atypical variant	3	4.5
HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	6	4.5
HU629 Spotted Gum – Broad-leaved Ironbark grassy open woodland	4	6
HU621 Smooth-barked Apple – Red Bloodwood open forest	7	10.5
HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	3	4
HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant	3	10.5
HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	3	3
Planted and parkland vegetation	1	1.5
Totals	**30**	**44.5**



Local roads
Creek lines
Proposal area
Study area
Local government area
Quadrats

Vegetation communities

- Dam
- Exotic vegetation
- HU621 - Smooth-barked Apple - Red Bloodwood open forest
- HU621 - Smooth-barked Apple - Red Bloodwood open forest - Gahnia clarkei variant
- HU622 - Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest
- HU629 - Spotted Gum - Broad-leaved Ironbark grassy open forest (EEC)
- HU629 - Spotted Gum - Broad-leaved Ironbark grassy open forest - Canopy only (EEC)
- HU631 - Spotted Gum - Grey Ironbark open forest - atypical variant
- HU631 - Spotted Gum Grey Ironbark open forest - Eucalyptus fergusonii variant
- HU631 - Spotted Gum Grey Ironbark open forest - Eucalyptus fergusonii variant - Canopy only
- HU637 - Sydney Blue Gum - White Mahogany shrubby tall open forest - atypical variant
- HU637 - Sydney Blue Gum - White Mahogany tall open forest - Syncarpia glomulifera variant
- Planted and parkland vegetation

Figure 2.7
Vegetation and BioBanking plot survey effort (Parsons Brinckerhoff 2014)

2.5.3.6 Condition and quality assessment of vegetation communities

The overall condition of vegetation was assessed through general observation and comparison against the BioBanking benchmark data (Office of Environment and Heritage 2014c) and the vegetation condition definition as set out in the BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014a). The moderate to good condition classes as outlined in the BBAM methodology have been separated as the parts of the native vegetation within the study area retains the native canopy floristic characteristics with the shrub and groundlayer being disturbed from maintenance such as mowing or weed incursions.

Three categories were used to describe the condition of the vegetation communities are set out below:

- **Good condition:** vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers. This vegetation will be at or above the BioBanking benchmarks (Office of Environment and Heritage 2014c). This condition equates to BBAM Moderate to Good condition (Office of Environment and Heritage 2014a).
- **Moderate condition:** vegetation has retained a native canopy and has a native understorey of greater than 50%. This condition class can include derived native grasslands and can have minor weed incursions with some patches being subject to grazing. This condition equates to BBAM moderate to good condition (Office of Environment and Heritage 2014a).
- **Low condition:** vegetation has a native canopy less than 50% of the lower benchmark. The understorey is generally dominated by exotic species being greater than 50% exotic cover. The shrub layer was generally absent from this condition class. Weed invasion can be significant in such remnants. This condition class equates to BBAM low condition (Office of Environment and Heritage 2014a).

Following the BioBanking methodology (Office of Environment and Heritage 2014a), woody vegetation, is considered as low condition vegetation when:

- Over-storey per cent foliage cover is <25% of the lower values of the over-storey per cent foliage cover benchmark for that vegetation type, and either:
  - less than 50% of vegetation in the ground layer is indigenous species
  - greater than 90% is cleared.

2.6 Likelihood of occurrence

For this study, likelihood of occurrence of threatened species within the study area for species recorded or predicted to occur in the locality is defined in Table 2.9.

Table 2.9 Likelihood of occurrence of threatened species

Likelihood	Description
Low	Species considered to have a low likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: ■ have not been recorded previously in the study area and surrounds and for which the study area is beyond the current distribution range ■ rely on specific habitat types or resources that are not present in the study area ■ are considered locally extinct ■ are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.

Likelihood	Description
Moderate	Species considered to have a moderate likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: ■ have infrequently been recorded previously in the study area and surrounds ■ use habitat types or resources that are present in the study area, although generally in a poor or modified condition ■ are unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically during variable seasons or migration ■ are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
High	Species considered to have a high likelihood of occurrence include species not recorded that fit one or more of the following criteria: ■ have frequently been recorded previously in the study area and surrounds ■ use habitat types or resources that are present in the study area, that are abundant and/or in good condition within the study area ■ are known or likely to maintain resident populations surrounding the study area ■ are known or likely to visit the site during regular seasonal movements or migration.
Recorded	Any threatened species recorded during field surveys.

2.7 Limitations

2.7.1 Reliance on externally supplied information

In preparing this study, Parsons Brinckerhoff has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations. Except as otherwise stated in the study, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this study (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

2.7.2 Study for benefit of client

This BIA has been prepared for the exclusive benefit of the client and no other party. Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this study (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this study). Other parties should not rely upon the study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

2.7.3 Field survey limitations

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely

indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.

Fieldwork for this study was completed during mid-winter and spring with cool to moderate overnight temperatures and occasional rainfall recorded. This may have impacted the activity (and therefore detectability) of some nocturnal species of frogs, reptiles, and small mammals. However, if suitable habitat for locally occurring threatened fauna was observed, a precautionary approach was taken and it was assumed that the species was likely to be present on at least an intermittent basis**.** Large Spotted Gum trees were present within the site and this winter-flowering species is a known feed tree for both Swift Parrots and Regent Honeyeaters in the Lower Hunter Region. However, Spotted Gum does not flower annually, due to long-bud setting periods, and this species was not flowering during the survey periods.

Targeted flora surveys have been conducted over three survey periods to detect cryptic threatened flora species that may occur within the study area. These survey periods were conducted in August, September, October and November 2014. Methodologies for these surveys are outlined in section 2.5.3, whilst the results are summarised in section 4.3.1.1.

2.7.4 Other limitations

To the best of Parsons Brinckerhoff's knowledge, the project presented and the facts and matters described in this study reasonably represent the client's intentions at the time of preparation of the study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the project and of its possible environmental impact.

Parsons Brinckerhoff will not be liable to update or revise this BIA to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the BIA.

3. Existing environment

3.1 Landscape context

The study area occurs within relatively undisturbed bushland contained between Jesmond, John Hunter Hospital and Rankin Park. The study area is largely undisturbed native bushland with some historical agricultural disturbance in the northern sections, near Jesmond Roundabout. The surrounding areas have been extensively developed for predominantly residential and infrastructure developments. The soils and vegetation in the study area is in relatively intact with minimal disturbance. The study area is one of few remaining intact parcels of remnant vegetation within the Newcastle LGA and is provides habitat for a range of native fauna and fauna species. The area is also regularly used by the public for recreational purposes such as bushwalking and bird watching.

A summary of the study area locality is provided in Table 3.1.

Table 3.1 Study area locality

Criteria	Location
Council	Newcastle City Council
Bioregion	Sydney Basin, Hunter Subregion
Catchment management area (CMA)	Hunter Central Rivers CMA, Hunter Sub-catchment
Botanical subdivision	North Coast
Mitchell Landscape	Gosford – Cooranbong Coastal Slopes
Noxious Weed Control Area	Newcastle City Council

3.1.1 Bioregion

The study area is within the Sydney Basin bioregion. This region covers about 3,624,008.00 ha (4.53% of NSW). The bioregion is on the coast and extends from just north of Batemans Bay to Nelson Bay on the central coast, and almost as far west as Mudgee. As well as Sydney itself, the Sydney Basin bioregion encompasses the towns of Wollongong, Nowra, Newcastle, Cessnock, Muswellbrook and Blue Mountains towns such as Katoomba and Mt. Victoria.

It includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems, all of the smaller catchments of Lake Macquarie, Lake Illawarra, Hacking, Georges and Parramatta Rivers, and smaller portions of the headwaters of the Clyde and Macquarie rivers.

The Sydney Basin bioregion has the third highest area of conservation-oriented tenures of the NSW bioregions, with conservation areas occupying about 1,384,418.33 ha (equivalent to 38.2% of the bioregion). This includes the Greater Blue Mountains, which is one of four World Heritage areas within NSW.

It is a highly variable region with variation in geology, topography and climate resulting in one of the most species diverse areas in Australia.

The study area is within the Hunter subregion, characterised by:

- rolling hills, wide valleys, with a meandering river system on a wide flood plain and river terraces
- a complex of Permian shales, sandstones, conglomerates, volcanic and coal measures, bounded on the north by the Hunter Thrust fault and on the south by cliffs of Narrabeen Sandstone
- a variety of harsh texture contrast soils on slopes and deep sandy loam alluvium on the valley floors
- dunes on the southern tributaries of the Hunter and deep sands in dunes on the barrier, saline, organic muds in the estuary
- soil salinity commonly occurs on some bedrocks in the upper catchment
- streams that are brackish or saline at low flow
- numerous small swamps in upper catchment, extensive estuarine swamps behind the coastal barrier of beach and dunes
- a variety of vegetation types including:
  - rainforest brush in the lower valley
  - forest and open woodland of white box, forest red gum, narrow-leaved ironbark, grey box, grey gum spotted gum, rough-barked apple and extensive of stands of swamp oak in upper reaches and foothills
  - river oak and river red gum along the streams
  - coastal dune vegetation of blackbutt, smooth-barked apple, coast banksias and swamp mahogany
  - mangroves, salt marsh and freshwater reed swamps in the estuary (NSW National Parks and Wildlife Service 2003).

3.1.2 Landscape

Landscapes (Mitchell) of NSW (NSW National Parks and Wildlife Service 2002) outlines a system of ecosystem classification mapped at the 1:250,000 scale, based on a combination of soils, topography and vegetation.

The study area falls predominantly within the Gosford – Cooranbong Coastal Slopes landscape. The following description have been taken from the Landscapes (Mitchell) of NSW (NSW National Parks and Wildlife Service 2002) to describe the landscape that has been mapped within the study area.

3.1.2.1 The Gosford – Cooranbong Coastal Slopes

The Gosford – Cooranbong Coastal Slopes landscape is consistent with the coastal region of the Sydney Basin, rolling hills and sandstone plateau outliers of the Triassic Narrabeen sandstones. The Narrabeen sandstone contain extensive rock outcrops, low cliffs along ridge margins, which have a general elevation of 0 to 75 m. This landscape comprises texture-contrast soils on lithic sandstones and shales, loamy sand alluvium along creeks and organic sand and mud in lagoons and swamps.

Open forest and woodland of Scribbly Gum Smooth-barked Apple Forest occur on the hills whilst Spotted Gum Ironbark Moist forests occur on the slopes. Dominant species that are associated with these communities include; smooth-barked apple (*Angophora costata*), red bloodwood (*Corymbia gummifera*), brown stringybark (*Eucalyptus capitellata*), Sydney peppermint (*Eucalyptus piperita*), spotted gum (*Corymbia maculata*), bastard mahogany (*Eucalyptus carnea*), northern grey ironbark (*Eucalyptus siderophloia*) and grey gum (*Eucalyptus punctata*).

Small areas of tall closed forest are located within the gullies under cliff lines at higher elevations. Dominant species that occur within these forests are; turpentine (*Syncarpia glomulifera*), lilly pilly (*Acmena smithii*),

mountain cedar wattle (*Acacia elata*), coachwood (*Ceratopetalum apetalum*), sassafras (*Doryphora sassafras*) and water gum (*Tristaniopsis laurina*).

Prickly-leaved tea-tree (*Melaleuca styphelioides*), Broad-leaved Paperbark (*Melaleuca quinquenervia*) and other paperbarks with swamp mahogany (*Eucalyptus robusta*), swamp oak (*Casuarina glauca*), sedges and common reed (*Phragmites australis*) are located on swampy creek flats.

3.1.3 Surrounding land uses

The surrounding area has been extensively disturbed, predominantly consisting of residential and infrastructure developments. The city of Newcastle lies to the east of the project, with major arterial suburbs of Kotara, Charlestown and Jesmond to the south-east, south and north, respectively. The John Hunter Hospital and its associated infrastructure are located immediately adjacent to the study area, along the eastern boundary. The Jesmond Park recreational area is located in the east of the study area and the locally significant Blackbutt Reserve is adjacent to the study area, on the southern boundary. The study area represents one of few large intact remnant native vegetation areas remaining within the Newcastle LGA and provides suitable habitat for a range of threatened flora and fauna species.

3.1.4 Wildlife corridors

Wildlife corridors are generally links of native vegetation that join two or more areas of similar habitat and are critical for sustaining ecological processes, such as provision for animal movement and the maintenance of viable populations.

Habitat in the study area is largely intact and forms part of a large isolated patch of remnant bushland surrounded by broad scale urban development, including the John Hunter Hospital complex. This remnant patch includes Blackbutt Reserve, which is encroached on by the study area's eastern boundary. Lookout Road in the Study area's south-east occurs as an existing barrier between George McGregor Park and Blackbutt Reserve.

Within George McGregor Park, development of the proposal area would result in a key barrier to wildlife movement; impacting a primary corridor link (). Without appropriate mitigation, the project would restrict movement in an approximate north-east to south-west direction, effectively limiting fauna connectivity at a bottleneck within George McGregor Park (approximate 400 m width) between John Hunter Hospital complex in the east and Sygna Close Reserve in the west.

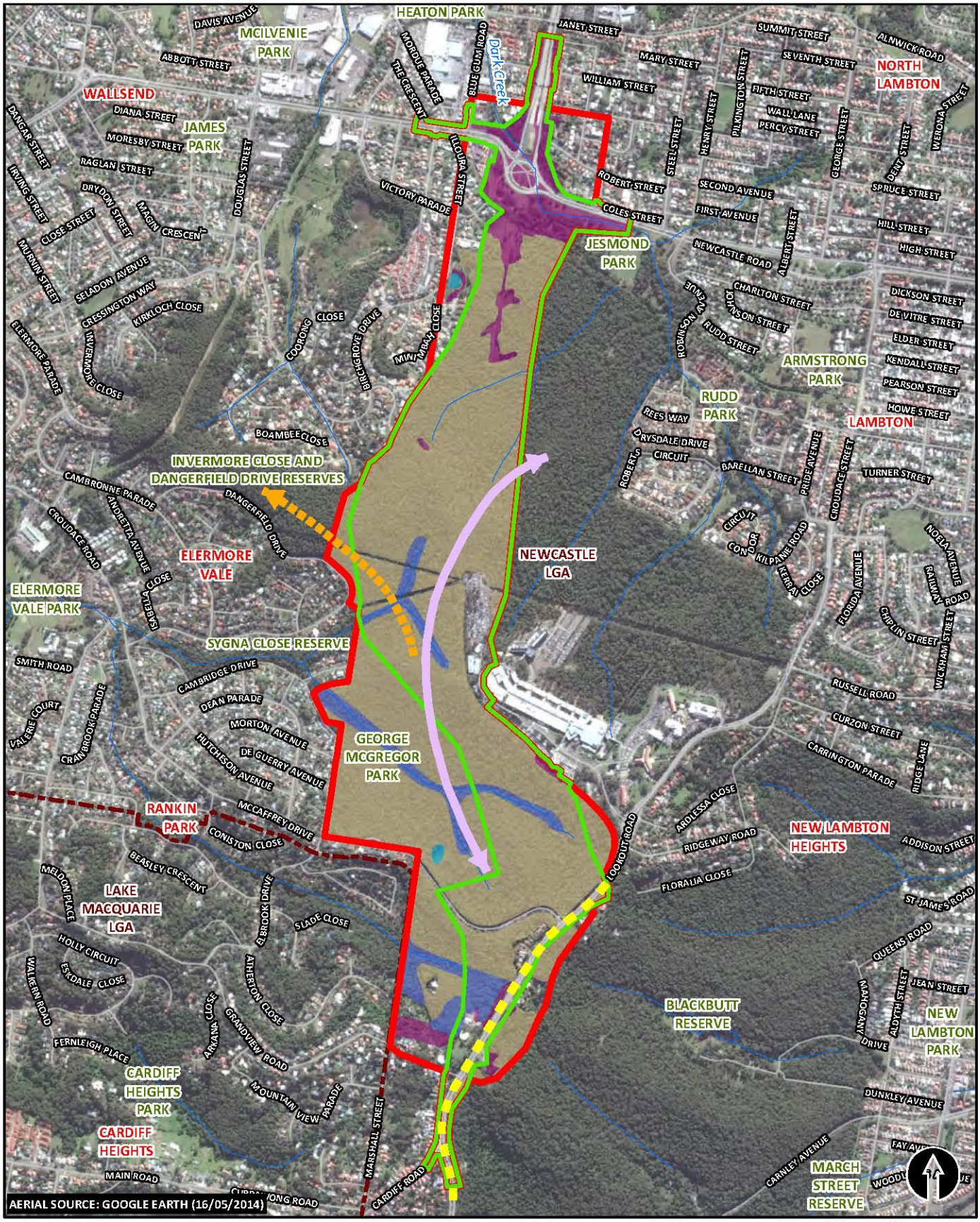


Figure 3.1
Local wildlife corridors

3.2 Vegetation communities

Desktop analysis of the vegetation mapping for and ground-truthing during surveys found nine vegetation communities present within the study area (refer to Table 3.2 and).

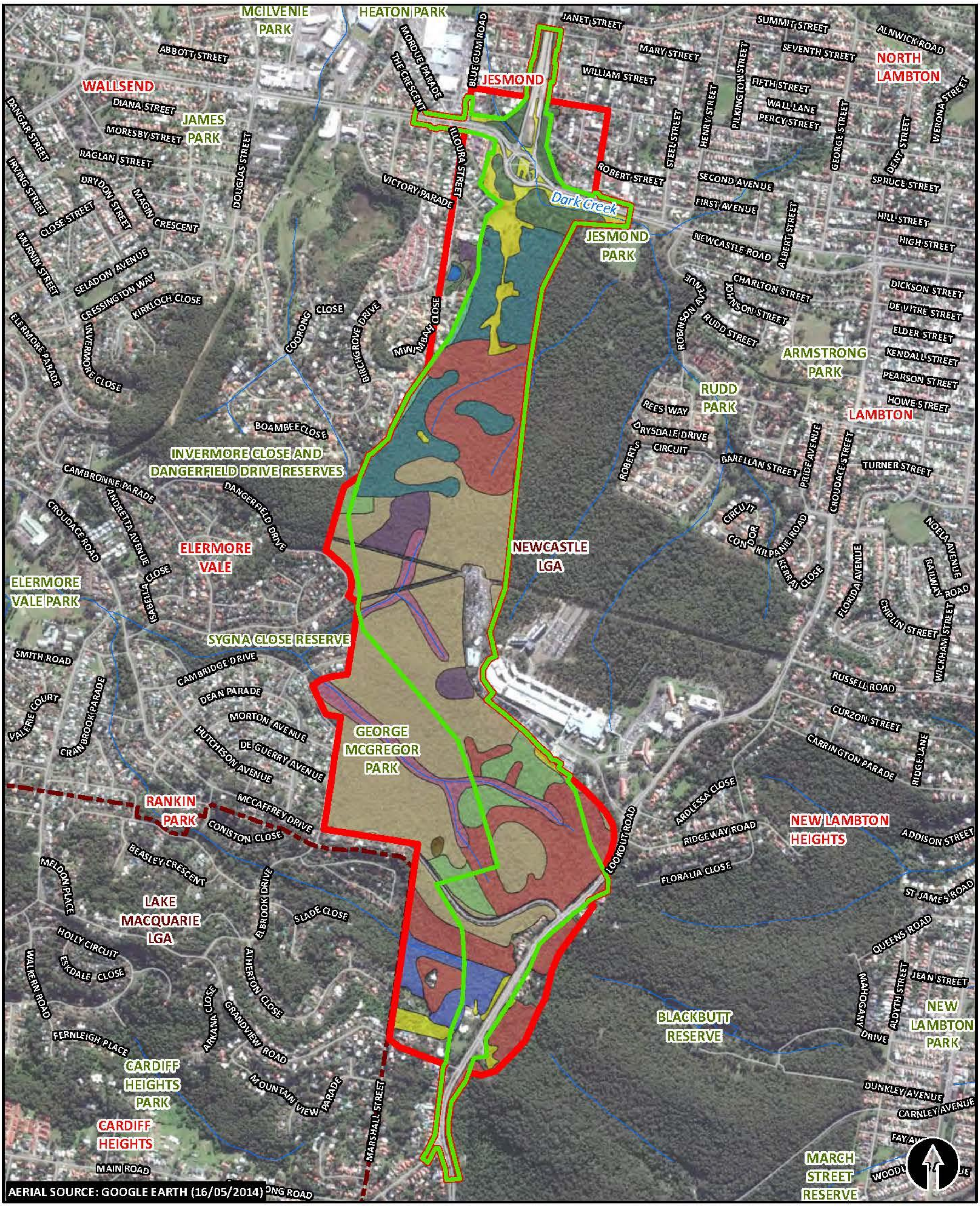
Table 3.2 Vegetation communities identified in the study area

Plant Community Type[1]	LHCCREMS Broad Scale Vegetation Mapping[2]	Threatened Ecological Community on the TSC Act
HU 629 Spotted Gum – Broad-leaved Ironbark grassy open forest	Lower Hunter Spotted Gum Ironbark Forest	Yes – Lower Hunter Spotted Gum Ironbark Forest[3]
HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant	Coastal Foothills Spotted Gum – Ironbark Forest	No
HU 631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	Hunter Valley Moist Forest	No
HU 621 Smooth-barked Apple – Red Bloodwood open forest	Coastal Plains Smooth-barked Apple Woodland	No
HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Coastal Sheltered Apple – Peppermint Forest	No
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant[1]	Alluvial Tall Moist Forest	No
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Alluvial Tall Moist Forest	No
Planted and parkland vegetation	–	No
Exotic Vegetation	–	No
Dam	–	No

(1) Office of Environment and Heritage vegetation types database (Office of Environment and Heritage 2012b) as used in BioMetric 2.0 (Office of Environment and Heritage 2015a).

(2) Lower Hunter and Central Coast Regional Environmental Management Strategy (2003).

(3) Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion listed as endangered under the TSC Act.



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- Local roads
- Creek lines
- Proposal area
- Study area
- Local government area

Vegetation communities

- Dam
- Exotic vegetation
- HU621 - Smooth-barked Apple - Red Bloodwood open forest
- HU621 - Smooth-barked Apple - Red Bloodwood open forest - Gahnia clarkei variant
- HU622 - Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest
- HU629 - Spotted Gum - Broad-leaved Ironbark grassy open forest (EEC)
- HU629 - Spotted Gum - Broad-leaved Ironbark grassy open forest - Canopy only (EEC)
- HU631 - Spotted Gum - Grey Ironbark open forest - atypical variant
- HU631 - Spotted Gum Grey Ironbark open forest - Eucalyptus fergusonii variant
- HU631 - Spotted Gum Grey Ironbark open forest - Eucalyptus fergusonii variant - Canopy only
- HU637 - Sydney Blue Gum - White Mahogany shrubby tall open forest - atypical variant
- HU637 - Sydney Blue Gum - White Mahogany tall open forest - Syncarpia glomulifera variant
- Planted and parkland vegetation

0 200 400 600 m

Figure 3.2
Vegetation communities
(Parsons Brinckerhoff 2014)

3.2.1 HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest

The broad scale vegetation mapping of the study area did not identify the presence of HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest within the study area. This community was previously mapped as Coastal Foothills Spotted Gum – Ironbark Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). This community covered 16.4 ha equivalent to 12% of the study area. This community occurred in the north of the study area between Dangerfield Drive Reserve and Newcastle Road within the study area.

This community was mapped as two condition classes good (15.6 ha) (Photo 3.1 and Photo 3.2) and moderate (0.80 ha) (Photo 3.3). The majority of the community was in good condition occurring generally within the northern section of the study area in areas of minimal disturbance (). The moderate condition occurred as a narrow linear patch of vegetation immediately behind houses on Minimbah Close, Wallsend. The moderate condition patch occurred as canopy only with minimal shrub or groundcover species as a result of vegetation clearance. Both the good and moderate conditions contained native canopy shrub and groundcover species representative of this community. The vegetation characteristics of this community are summarised in Table 3.3.

The community differed from the other two spotted gum communities within the study area as the canopy was dominated by *Eucalyptus fibrosa* (Broad-leaved Ironbark) and the understorey was dominated by shrubs and grasses that prefer dryer environments. This community occurred on the tops of ridges and on the drier north facing slopes.

Table 3.3 Characteristics of HU629 Spotted Gum – Broad–leaved Ironbark grassy open forest

HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest	
Conservation significance	High: This community consisted of native species characteristic with the HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest native vegetation community. This community is consistent with Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion which is listed as endangered under the TSC Act. This community is not consistent with any threatened ecological community listed under the EPBC Act.
Condition	This vegetation community occurred as two variants within the study area and as such has two condition classes, as follows: ■ **Good –** The type variant of this community is in good condition with high diversity of native species recorded, with little weed incursions. This condition class generally occurred as the dominant vegetation community within the northern section of the Study Area where no vegetation clearing has occurred. This community had grassy patches dominated by *Joycea pallida* (Photo 3.1) and shrubby areas dominated by prickly shrub species such as *Bursaria spinosa* (Photo 3.2). This condition class encompassed 15.6 ha. ■ **Moderate –** This condition class occurred immediately adjacent behind housing east of Minmibah Close, Wallsend. This variant contained an intact canopy of tree species characteristic of this community however, was almost entirely void of shrub and groundcover species as a result of vegetation clearance and recreational use. This condition class encompassed 0.80 ha.
Location	This community occurred throughout the northern section of the study area just south of Jesmond Park.

HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest			
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	10–18	0–40	*Eucalyptus fibrosa, Corymbia maculata, Eucalyptus umbra, and the occasional Eucalyptus punctata* and *Angophora costata*
Sub-canopy	3–8	0–30	*Syncarpia glomulifera*
Shrub	0.4–3	0–50	*Daviesia ulicifolia, Breynia oblongifolia, Bursaria spinosa, Acacia ulicifolia, Pultenaea villosa, Acacia falcata, Notelaea longifolia, Maytenus silvestris,* and the occasional *Dodonaea triquetra*
Ground cover	0.1–1	0–90	*Joycea pallida, Entolasia stricta, Imperata cylindrica, Lomandra multiflora, Macrozamia producta, Lepidosperma laterale, Hardenbergia violacea, Pratia purpurascens, Digitaria parviflora, Phyllanthus hirtellus, Dianella revoluta* and *Pandorea pandorana*

Photo 3.1 **Good Condition HU629 Spotted Gum – Broad-leaved – Ironbark grassy open woodland with grassy understory of *Joycea pallida***

Photo 3.2 **Good Condition HU629 Spotted Gum – Broad-leaved – Ironbark grassy open woodland with shrubby midstorey of prickly shrubs such as *Bursaria spinosa***

Photo 3.3 **Moderate Condition HU629 Spotted Gum – Broad-leaved – Ironbark grassy open woodland (Canopy Only)**

3.2.2 HU631 Spotted Gum – Grey Ironbark open forest – atypical variant

The broad scale vegetation mapping of the study area mapped this community as Coastal Foothills Spotted Gum – Ironbark Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. This was confirmed during the field survey which this community was identified as covering 7.22 ha equivalent to 5% of the study area. This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of this community (and Photo 3.4). The vegetation characteristics of this community are summarised in Table 3.4.

This community differed from the other two spotted gum communities in the study area as it was dominated by *Eucalyptus paniculata* (Grey Ironbark) and occurred on more sheltered slopes and contained moister species in the understorey.

Table 3.4 HU631 Spotted Gum – Grey Ironbark open forest – atypical variant

HU631 Spotted Gum – Grey Ironbark open forest – atypical variant			
Conservation significance	High: Whilst this community is not consistent with any threatened ecological community, it does contain a high diversity of density of native species providing habitat for a number of threatened flora and fauna species.		
Condition	▪ Good – This community occurred predominantly within the south of the study area which has been subjected to moderate weed infestations, particularly near existing infrastructure such as roads, paths and John Hunter Hospital. This community had a sparse to dense canopy, shrub and ground cover with a high density of native species with areas.		
Location	This community occurred behind John Hunter Hospital and along McCaffreys drive to the south of the study area.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	14–25	0–40	*Eucalyptus paniculata, Corymbia maculata, Angophora costata, Eucalyptus fergusonii subsp. dorsiventralis* X *paniculata, Eucalyptus punctata, Eucalyptus acmenoides, Eucalyptus umbra*
Sub-canopy	1–6	0–20	*Juvenile Eucalyptus sp.* and *Allocasuarina torulosa*
Shrub	0.4–2	0–10	*Daviesia ulicifolia, Pultenaea villosa, Acacia ulicifolia, Dodonaea triquetra, Epacris pulchella,* juvenile *Allocasuarina torulosa* and the occasional *Banksia spinulosa*
Ground cover	0.1–1	0–70	*Entolasia stricta, Imperata cylindrica, Lomandra longifolia, Billardiera scandens, Lepidosperma laterale, Macrozamia communis, Microlaena stipoides, Glycine tabacina, Lomandra multiflora subsp. multiflora, Eustrephus latifolius, Pseuderanthemum variabile*

Photo 3.4 HU631 Spotted Gum – Grey Ironbark open forest – atypical variant

3.2.3 HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant

The broad scale vegetation mapping of the study area mapped this community as Hunter Valley Moist Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. This was confirmed during the field survey which was identified as covering 34.40 ha equivalent to 24% of the study area (and Photo 3.5). This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of this community. The vegetation characteristics of this community are summarised in Table 3.5.

This community differs from the HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant and other spotted gum communities as it is dominated by *Eucalyptus fergusonii subsp. dorsiventralis* instead of *Eucalyptus paniculata*. In addition this community occurred generally on sheltered slopes and gullies and contained a ferny understorey with species that grow in moist environments such as sedges, ferns.

Table 3.5 HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant

HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant			
Conservation significance	High: Whilst this community is not consistent with any threatened ecological community, listed on the TSC Act or the EPBC Act, it does contain a high diversity of density of native species providing habitat for a number of threatened flora and fauna species		
Condition	▪ Good – This community occurred predominantly within gullys to the south and north of the study area which have been subjected to moderate weed infestations, particularly within the creeks, as a result of run off from Lookout Road. This community had a dense canopy, shrub and ground cover with a high density of native species with areas.		
Location	This community occurred predominantly within the south of the study area immediately adjacent Lookout Road and McCaffreys Drive. Additional patches were also recorded within the northern section of the study area near Dangerfield Drive Reserve.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	12–24	0–40	*Eucalyptus fergusonii subsp. dorsiventralis, Eucalyptus punctata, Corymbia maculata, Eucalyptus acmenoides, Eucalyptus umbra* and the occasional *Angophora costata*
Sub-canopy	3–10	0–40	*Syncarpia glomulifera, Glochidion ferdinandi* and *Allocasuarina torulosa*
Shrub	0.4–3	0–80	*Acacia linearis, Persoonia linearis, Pomaderris aspera, Notelaea longifolia, Dodonaea triquetra, Pultenaea euchila* and the occasional *Leucopogon lanceolatus, Breynia oblongifolia , Podolobium ilicifolium, Bursaria spinosa* and *Acacia ulicifolia*
Ground cover	0.1–1	0–40	*Calochlaena dubia, Pteridium esculentum, Microlaena stipoides, Poa affinis, Lepidosperma laterale Entolasia stricta, Imperata cylindrica, Lomandra longifolia, Smilax australis, Blechnum cartilagineum, Doodia aspera, Hibbertia dentata, Desmodium rhytidophyllum, Cheilanthes sieberi subsp. sieberi, Dichondra repens, Eustrephus latifolius, Billardiera scandens, Polyscias sambucifolia*

Photo 3.5 **HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant within the study area**

3.2.4 HU621 Smooth-barked Apple – Red Bloodwood open forest

The broad scale vegetation mapping of the study area mapped this community as Coastal Plains Smooth-barked Apple Woodland (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. This was confirmed during the field surveys which identified it as being the most abundant community covering 55.06 ha equivalent to 38% of the study area (and Photo 3.6). This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of this community. The vegetation characteristics of this community are summarised in Table 3.6.

This community contained a *Gahnia clarkei* variant that occurred within a potential groundwater seep or as a result of the construction of McCaffrey Drive from a culvert. However, it was difficult to determine if a culvert was present due to the access constraints from dense bushland. This variant occurred within George McGregor Park to the north of McCaffrey Drive () and is outside of the proposal area. The groundwater seep appeared to have heavily influenced the vegetation composition which was dominated by *Pteridium esculentum, Gahnia clarkei, Leptospermum polygalifolium, Calochlaena dubia, Glochidion ferdinandi, Lantana camara** and dead stags (refer to Photo 3.7). The stags observed appeared to have been *Eucalyptus acmenoides* and *Angophora costata* representative of HU621 Smooth-barked Apple – Red Bloodwood open forest and has therefore been included in this community.

Table 3.6 HU621 Smooth-barked Apple – Red Bloodwood open forest

HU621 Smooth-barked Apple – Red Bloodwood open forest			
Conservation significance	High: Whilst this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of density of native species providing habitat for a number of threatened flora and fauna species, including a large population of *Tetratheca juncea.*		
Condition	▪ Good – HU621 Smooth-barked Apple – Red Bloodwood open forest was the most abundant vegetation community recorded within the study area. In some areas the community occurred adjacent to previously disturbed areas that have been subjected to land clearance and weed invasion. This community had a sparse to dense canopy, shrub and ground cover with a high density of native species representative of this community.		
Location	This community occurred immediately south of McCaffrey Drive to north of Dangerfield Drive Reserve. HU621 Smooth-barked Apple – Red Bloodwood open forest was the dominant vegetation community within the study area.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	10–23	0–40	*Angophora costata, Corymbia gummifera, Eucalyptus capitellata* and the occasional *Eucalyptus punctata* and *Eucalyptus globoidea*
Sub-canopy	1–6	0–20	*Allocasuarina torulosa, Syncarpia glomulifera, Persoonia linearis* and juvenile Eucalypt spp.
Shrub	0.5–3	0–60	*Leptospermum trinervium, Banksia spinulosa, Persoonia levis, Acacia ulicifolia, Acacia terminalis, Pittosporum undulatum, Lomatia salicifolia, Pultenaea euchila* and *Tetratheca juncea*
Ground cover	0.1–1.5	0–80	*Pteridium esculentum, Imperata cylindrica, Lomandra oblique, Themeda australis, Entolasia stricta, Cassytha pubescens, Ptilothrix deusta, Xanthorrhoea latifolia* and *Lindsaea linearis*

Photo 3.6 HU621 Smooth-barked Apple – Red Bloodwood open forest within the study area

Photo 3.7 HU621 Smooth-barked Apple – Red Bloodwood open forest groundwater seep

3.2.5 HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest

The broad scale vegetation mapping of the study area has not mapped this community as occurring within the study area (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). The field surveys identified this community as being equivalent to the vegetation description of Coastal Sheltered Apple – Peppermint Forest as described by LCCREMS (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). This community encompasses 4.40 ha equivalent to 3% of the study area (and Photo 3.8). This community occurred in good condition with a high density of native canopy, shrub and groundcover species representative of this community. The northern patch of this community has been subjected to moderate weed infestation by exotic species such as *Lantana camara** which has been improved as a result of bush regeneration efforts. The vegetation characteristics of this community are summarised in Table 3.7.

Table 3.7 HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest

HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest			
Conservation significance	High: Whilst this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of density of native species providing habitat for a number of threatened flora and fauna species.		
Condition	▪ Good – This community occurred as two small isolated patches which have been subjected to low to moderate weed infestations, particularly within areas close to vegetation clearing, paths, roads and private residences. This community had a dense canopy, shrub and ground cover with a high density of native species.		
Location	This community occurred as three patches; immediately behind John Hunter Hospital and within the centre of the study area (behind John Hunter Hospital and residential properties east of Illoura Street).		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	10–20	0–40	*Eucalyptus piperita, Eucalyptus globoidea, Angophora costata, Corymbia gummifera* and *Syncarpia glomulifera*
Sub-canopy	4–10	0–30	*Allocasuarina torulosa* and juvenile Eucalypt spp.
Shrub	1–4	20–80	*Breynia oblongifolia, Banksia spinulosa, Leptospermum polygalifolium, Acacia myrtifolia, Dodonaea triquetra, Daviesia ulicifolia, Zieria smithii subsp smithii* and *Leucopogon lanceolatus*
Ground cover	0.1–1	0–90	*Entolasia stricta, Imperata cylindrica, Pteridium esculatum, Gonocarpus spp., Xanthorrhoea latifolia, Pratia purpurascens, Dichondra repens, Cassytha pubescens, Viola hederacea, Microlaena stipoides* and *Dianella caerulea var. producta*

Photo 3.8 **HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest within the study area**

3.2.6 HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant

The broad scale vegetation mapping of the study area mapped this community as a variety of native vegetation communities including Coastal Foothills Spotted Gum – Ironbark Forest, Coastal Wet Gully Forest, Hunter Valley Moist Forest, Coastal Plains Smooth-barked Apple Woodland, Coastal Narrabeen Forest and Alluvial Tall Moist Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). This community is equivalent to Alluvial Tall Moist Forest as described by the broad scale vegetation mapping for the study area (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). The field surveys identified areas of HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant along the creek lines within the study area covering 7.05 ha equivalent to 5% of the study area (and Photo 3.9). This community occurred in good condition with a high density of native canopy, shrub and ground cover species representative of this community. Some areas within this community, predominantly along the creeks, did contain moderate weed infestations (i.e. *Lantana camara**). The vegetation characteristics of this community are summarised in Table 3.8.

This community differs from the HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant as *Eucalyptus saligna* were absent from the canopy layer. Alternatively, the community had a higher density of *Syncarpia glomulifera* present within the community.

Table 3.8 HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant

HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant			
Conservation significance	High: Whilst this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of density of native species providing habitat for a number of threatened flora and fauna species. The threatened flora species *Syzygium paniculatum* was recorded within this community. Powerful Owl was recorded roosting in the dense vegetation in the south east of the study area in this community.		
Condition	▪ Good – This community occurred within the centre of the study area (behind John Hunter Hospital and Lookout Road through to Sygna Close Reserve). This community has been subjected to moderate weed infestations, particularly within the creeks, as a result of run off from Lookout Road. This community had a dense canopy, shrub and ground cover with a high density of native species.		
Location	This community occurred along Ironbark Creek lines within the study area that flow into Sygna Close Reserve.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	14–24	0–40	*Eucalyptus acmenoides, Syncarpia glomulifera, Eucalyptus paniculata, Eucalyptus siderophloia, Eucalyptus resinifera* and *Eucalyptus piperita* with the occasional *Angophora costata*
Sub-canopy	3–6	10–40	*Syncarpia glomulifera, Melaleuca linariifolia, Glochidion ferdinandi* and *Allocasuarina torulosa*
Shrub	0.4–3	0–40	*Dodonaea triquetra, Zieria smithii* subsp. *smithii, Leucopogon lanceolatus, Notelaea ovata, Acmena smithii* and *Syzygium paniculatum*
Ground cover	0.1–1	0–90	*Juncus usitatus, Carex appressa, Oplismenus aemulus, Entolasia marginata, Smilax australis, Gahnia erythrocarpa, Adiantum aethiopicum, Calochlaena dubia* and *Morinda jasminoides*

Photo 3.9 **HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant within the study area**

3.2.7 HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant

The broad scale vegetation mapping of the study area mapped this community as Coastal Foothills Spotted Gum – Ironbark Forest (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) within the study area. The field surveys identified this community as HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant covering 4.61 ha equivalent to 3% of the study area. This community occurred in moderate condition with a high density of native canopy species and moderate density of native shrub and ground cover species representative of this community (and Photo 3.10). Along the creek line this community was dominantly by exotic species such as *Lantana camara**. The vegetation characteristics of this community are summarised in Table 3.9.

Table 3.9 HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant

HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant			
Conservation significance	High: Whilst this community is not consistent with any threatened ecological community listed on either the TSC Act or the EPBC Act, it does contain a high diversity of density of native species providing habitat for a number of threatened flora and fauna species.		
Condition	▪ Moderate – This community occurred as remnant vegetation surrounded by residential development and urban infrastructure (such as roads). Previous and current land uses have resulted in this community being moderately to highly disturbed as a result of weed invasion. Some areas within this community have received bush regeneration efforts to remove areas of woody weeds. This community had a dense canopy and shrub cover however in areas contained a sparse or completely void ground cover.		
Location	This community occurred to the south of the study area immediately west of Lookout Road and south of McCaffreys Drive.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	18–26	0–40	*Eucalyptus saligna, Eucalyptus acmenoides, Eucalyptus paniculata, Syncarpia glomulifera, Eucalyptus siderophloia* and *Corymbia maculata*
Sub-canopy	3–6	0–30	*Allocasuarina torulosa* and *Glochidion ferdinandi*
Shrub	0.4–3	30–60	*Dominated by Lantana camara*, Ligustrum sinense*, Pittosporum undulatum, Breynia oblongifolia, Eupomatia laurina, Ochna serrulata**
Ground cover	0.1–1	050	*Cynodon dactylon, Entolasia marginata, Dichondra repens, Sarcopetalum harveyanum, Lomandra sp., Gahnia melanocarpa, Smilax australis* and *Cissus antarctica*

Photo 3.10 **HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant within the study area**

3.2.8 Planted and parkland vegetation

The planted and parkland vegetation was a highly disturbed vegetation community that occurred within Jesmond Park and along Newcastle Road to the north of the study area (refer to Table 3.10). The community was generally associated with areas that had been subjected to land clearance and weed invasion as a result of parkland and infrastructure (such as walking tracks and roads) (and Photo 3.11). The community covered 5.9 ha equivalent to 4% of the study area. Due to previous and current land uses this community no longer resembles any local native remnant vegetation communities. The vegetation characteristics of this community are summarised in Table 3.3.

Table 3.10 Planted and parkland vegetation

Planted and parkland vegetation			
Conservation significance	Moderate: This community consisted of planted and the occasional remnant native tree species. This community was not consistent with any vegetation community or any threatened ecological communities.		
Condition	▪ Moderate – This community generally occurred adjacent to previously disturbed areas that have been subjected to land clearance and weed invasion. This community had a sparse to dense remnant and/or planted canopy and ground cover however generally lacked a shrub layer with a moderate density of native species. Within Jesmond Park numerous planted exotic and native species occurred whereas to the north of the roundabout dense stands of *Casuarina glauca* have been planted along the road verges.		
Location	This community occurred in the northern section of the study area along Newcastle Road, the existing areas of the Inner City Bypass to Sandgate and within Jesmond Park.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	8–30	0–40	*Eucalyptus punctata, Corymbia maculata, Eucalyptus acmenoides, Eucalyptus fergusonii, Syncarpia glomulifera, Brachychiton acerifolius,* and *Casuarina glauca*
Ground cover	0.1–1	0–90	*Cynodon dactylon, Dichondra repens, Ehrharta erecta*, Trifolium repens*, Sporobolus africanus*, Avena fatua*, Poa annua*, Sonchus oleraceus*, Conyza sp*, Hypochaeris spp.*

Photo 3.11 Planted and parkland vegetation to the north of the study area

3.2.9 Exotic vegetation

The exotic vegetation was a highly disturbed vegetation community that occurred predominantly to the north and south of the study area (refer to and Photo 3.12). The community covered 7.85 ha equivalent to 5% of the study area. The community was generally associated with areas that had been subjected to land clearance and weed invasion as a result of residential development, recreation (parks) and infrastructure (such as walking tracks, roads and power easements). Due to previous and current land uses this community no longer resembles any local native remnant vegetation communities. The vegetation characteristics of this community are summarised in Table 3.11).

Table 3.11 Exotic vegetation

Exotic vegetation			
Conservation significance	Low: This community is not consistent with any native vegetation community or any threatened ecological communities.		
Condition	▪ Low – This community generally occurred adjacent to previously disturbed areas that have been subjected to land clearance and weed invasion. This community generally lacked a canopy layer and had a high density of groundlayer exotic species and in some of the gullies a high density of *Lantana camara** was recorded.		
Location	This community occurred adjacent to Lookout Road to the south and Newcastle Road to the north of the study area.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	6–20	0–20	Occasional isolated *Eucalyptus sp.*
Shrub	1–2.5	0–100	*Lantana camara**
Ground cover	0.1–2	0–100	*Hyparrhenia hirta*, Chloris gayana*, Ehrharta erecta*, Trifolium repens*, Sporobolus africanus*, Avena fatua*, Poa annua*, Sonchus oleraceus*, Conyza sp*, Hypochaeris spp.* and the occasional native species such as *Imperata cylindrica* and *Pteridium esculentum*

Photo 3.12 Exotic vegetation to the north of the study area

3.2.10 Dam

There is one dam within the study area and this dam has been constructed to collect runoff from the surrounding urban development (and Photo 3.13). This community encompasses 0.17 ha, equivalent to 0.11% of the study area. This vegetation is not consistent with a native vegetation community, although it does contain native emergent aquatic flora species which would provide habitat for commonly occurring waterfowl and herpetofauna (Photo 3.12). The vegetation characteristics of this community are summarised in Table 3.12.

Table 3.12 Characteristics of dam

Dams			
Conservation significance	Low: The dam was man made to collect runoff from the surrounding urban development. The dam does provide habitat for commonly occurring fauna species such as waterfowl and herpetofauna.		
Condition	Low – The general condition of the dams is low due to high sediment build up and the poor quality of the water. The vegetation would provide habitat for commonly occurring fauna species.		
Location	There is one dam to the east of Illora Street in the north west of the study area.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Floating Aquatic	-	-	*Spirodela punctata* and *Nymphaea sp.*
Emergent Aquatic	0.9–2	0–20	*Persicaria decipiens, Paspalum distichum* and *Juncus usitatus*
Terrestrial ground layer	0.1–0.8	0–40	*Rumex crispus*, Pennisetum clandestinum** and *Cynodon dactylon*

Photo 3.13 Manmade dam

3.3 Plant species recorded

A total of 312 plant species were recorded in the study area during field surveys of which 256 species (82%) were native and 56 species (18%) were exotic (refer to Appendix A). The most diverse families recorded were the Poaceae both with 38 species, Fabaceae with 36 species, followed by Myrtaceae with 30 species and Asteraceae with 17 species (refer to Appendix A).

Three threatened species of plant were recorded, these included *Tetratheca juncea, Grevillea parviflora subsp. parviflora* and *Syzygium paniculatum.* These species are discussed further in section 4.3.1.

3.3.1 Noxious weeds

Of the 56 exotic species that were recorded in the study area, seven species of plant are listed under the *Noxious Weeds Act 1993* for the Newcastle City Council noxious weed control area (refer to Table 3.13). Of these five species, *Rubus fruticosus* Senecio madagascariensis*, Asparagus officinalis*, Asparagus aethiopicus** and *Chrysanthemoides monilifera subsp. rotundata** and one additional weed *Lantana camara** are listed as a Weeds of National Significance (Australian Weeds Committee 2014). Other highly invasive species occurred abundantly, particularly along the road verges and water bodies within the study area and included: *Hyparrhenia hirta *, Chloris gayana*, Bidens pilosa*, Sida rhombifolia*, Senna pendula*, Ligustrum sp*, Olea europaea subsp. Cuspidata** and *Setaria palmifolia*.*

Table 3.13 Noxious weeds recorded within the study area

Name	Noxious Weeds Act 1993 control category[1]	Weed of National Significance[2]
*Asparagus aethiopicus** (Asparagus Fern)	The plant must be eradicated from the land and that land must be kept free of the plant	Yes
Cortaderia selloana (Pampas Grass)	Class 3 – The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.	–
*Ageratina adenophora** (Crofton Weed)	Class 4 – The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.	–
*Asparagus officinalis** (Asparagus)		Yes
*Rubus fruiticosus** (Blackberry)		Yes
*Senecio madagascariensis** (Fireweed)		Yes
*Chrysanthemoides monilifera subsp. rotundata** (Bitou Bush)		Yes
*Lantana camara** (Lantana)	–	Yes

(1) Classes of noxious weed and control requirements under the *Noxious Weed Act 1993*; * - denotes an introduced species

(2) Weed of National Significance as listed by the (Australian Weeds Committee 2014)

3.4 Animal species recorded

A total of 79 species of animal were recorded during field surveys (refer to Table 3.14 and Appendix B), including five threatened species; Little Lorikeet (*Glossopsitta pusilla*), Powerful Owl (*Ninox strenua*), Squirrel Glider (*Petaurus norfolcensis*), Little Bentwing Bat (*Miniopterus australis*) and Grey-headed Flying-fox (*Pteropus poliocephalus*) (refer to Table 3.14). A total of twelve native mammal species were recorded. One introduced species of bird being Spotted Turtle-dove was recorded.

Table 3.14 Species of animal recorded

Group	Introduced	Native	Total
Birds	1	62	63
Mammals	–	12	12
Frogs	–	2	2
Reptiles	–	2	2
Total	**1**	**78**	**79**

3.5 Fauna habitats

The suitability, size and configuration of the fauna habitats correlated broadly with the vegetation communities, as summarised in Table 3.15 and illustrated in and . These areas provided habitat for a range of birds, herpetofauna and mammals, and native vegetation communities were in good condition.

Habitat features recorded in the study area generally included those associated with dry open forests associated with ridgelines in the Lower Hunter Valley and wet sclerophyll forests occurring in sheltered gullies of the ranges, constructed dams, managed and planted vegetation. Specific habitat attributes of each habitat type are described in further detail in the sections below with condition of each of the fauna habitats and their attributes are described in Table 3.16.

Table 3.15 Fauna habitat with corresponding habitat description

Fauna habitat description	Corresponding vegetation community (refer to Section 3.2)
Dry forest	HU631 Spotted Gum – Grey Ironbark open forest – atypical variant HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant HU629 Spotted Gum – Broad-leaved Ironbark Grassy Open Forest HU621 Smooth-barked Apple – Red Bloodwood open forest HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest
Wet forest	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant
Aquatic habitat	Constructed dams
Cleared land with scattered trees	Exotic vegetation and planted vegetation

3.5.1 Dry forest

The study area contained several forms of dry open forest, including HU631 Spotted Gum – Grey Ironbark open forest – atypical variant, and HU631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant, occurring on sheltered mid to lower slopes; HU629 Spotted Gum – Broad-leaved Ironbark Grassy Open Forest occurring on upper west facing slopes;HU621 Smooth-barked Apple – Red Bloodwood open forest on dry ridges and HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest on south-facing upper ridges (refer to and Table 3.15). Large canopy species such as Smooth-barked Apple, Red Bloodwood and Spotted Gum within the study area's dry forests often contained a range of hollow sizes, including large hollows, which are important breeding habitats for large forest owls, cockatoos and arboreal mammals. Spotted Gum is an important winter-flowering tree during years when it flowers and is

supplemented by Ferguson's Ironbark during the winter period. Both trees are used by Swift Parrots, Little Lorikeets, Grey-headed Flying-foxes, Regent Honeyeaters and Squirrel Gliders in the Lower Hunter Region, with good Spotted Gum flowering events important to nectivorous species. Bloodwood is a strong flowerer and is important for nectivorous fauna during autumn.

Dry forest within the study area provided a range of other fauna microhabitats, including shrubby ground-covers, leaf litter, fallen timber and loose surface rocks that would support a potentially diverse fauna.

3.5.2 Wet forest

Wet forest types represented across the study area by HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant, and HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant, were well represented in deep gullies (refer to and Table 3.15). Trees within this habitat type were very tall and large in girth suggesting medium to old age cohorts with many trees containing large hollow cavities. A mid-understorey of mesic broad-leaf tree species provided cover and foraging habitats for wet forest birds and other small mammals and roosting sites for arboreal mammals and forest owls. The wet forest habitat contained dense patches of understorey vegetation dominated by ferns and vines, which provided cover for small terrestrial animals.

3.5.3 Aquatic

The study area contained restricted areas of aquatic habitat in the form of constructed dams, ephemeral freshwater creek lines and drainage lines largely in the southern parts of the study area (refer to and Table 3.15). This habitat was in good condition, due to the intact vegetation communities surrounding it, although the ephemeral nature of the habitat restricted the number of aquatic animals using it.

3.5.4 Cleared land with scattered trees

In the northern sections of the study area some patches of vegetation were reduced to open areas with retained trees. Such habitat included a portion of the western section of Jesmond Park characterised by manicured lawns, garden beds and both retained and planted trees. Other areas to the south of Jesmond Park showed evidence of historic clearing with groundcover vegetation dominated by exotic grasses and herbaceous weeds. A fenced area in this vicinity was used to contain horses during the survey period otherwise fauna was limited to common native species of fauna. Species recorded within this habitat included Spangled Drongo, Superb Fairy-wren and Willie Wagtail.

3.6 Fauna microhabitats

Table 3.16 describes fauna microhabitats recorded during habitat assessments in each fauna stratification unit.

Table 3.16 Fauna microhabitats

Microhabitat attributes	Fauna habitat stratification			
	Dry forest	Wet forest	Aquatic habitat	Cleared land with scattered trees
Upper canopy	Included *Eucalyptus fergusonii, E. paniculata, Corymbia gummifera, Corymbia maculata, Angophora costata, Eucalyptus capitellata, Syncarpia glomulifera*	*Eucalyptus saligna, E. acmenoides, Corymbia maculata, Syncarpia glomulifera, Allocasuarina torulosa*	Absent	*Eucalyptus saligna, E. umbra, Corymbia maculata, Syncarpia glomulifera*
Shrub layer	*Dodonaea triquetra, Banksia spinulosa, Bursaria spinosa, Daviesia ulicifolia, Acacia ulicifolia*	Absent	Absent	Absent
Grasses, herbs, forbs, sedges, and rushes	*Themeda australis, Entolasia stricta, Hardenbergia violacea, Pteridium esculentum*	*Calochlaena dubia, Doodia aspera, Smilax australis, Gymnostachys anceps*	Absent	*Pennisetum clandestinum** and *Trifolium repens**.
Leaf litter	50–75%	30–50%	Absent	Absent
Fallen timber	Present	Present	Over creeklines	Absent
Tree hollows and stags	Present	Present	Absent	Present
Rocks and rock shelves	Scattered surface rocks	Scattered surface rocks	Creekline rocks	Absent
Drainage lines and water bodies	Absent	Generally occurred as ephemeral freshwater creeks and a dam.	Ephemeral creekline pool and dam	Absent
Overall condition	**Good**	**Good**	**Poor to moderate**	**Poor**

3.6.1 Hollow tree resources

Eleven of the 22 threatened fauna species that are considered to have potential habitat in the study area use hollow tree resources for breeding and roosting. While many attributes of tree hollows may be selected by hollow using species, such as hollow depth, entrance size and hollow type (Goldingay 2009), hollows are more likely to occur and be used by wildlife in large trees that are many decades or even centuries old (Goldingay 2009).

A total of 289 hollow-bearing trees were located within existing proposal area (). These numbers excluded the shaded area (refer to) which is the extended proposal area. A small number of trees were surveyed to the west of the proposal area to ensure all trees were included within the survey area. The hollow-bearing tree data is provided in Appendix G. Three hollow size ranges were recorded during the survey, including; small hollows (<10 cm), medium hollows (10–20 cm) and large (> 20 cm).

Across 12 tree species, and dead stags, a total of 689 hollows were recorded encompassing 320 small hollows, 264 medium hollows and 105 large hollows. The most important tree species for hollow occurrence within the surveyed area were Smooth-barked Apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), dead trees (Stag), Grey Gum (*Eucalyptus punctata*) and Spotted Gum (*Corymbia maculata*) in order of numerical magnitude, with a further three species, Red Mahogany (*E. resinifera*), Broad-leaved Mahogany (*E. umbra*) and Red Bloodwood (*C. gummifera*), recording more than 20 hollow-bearing individuals (refer Figure 3.1). Due to the height of forest trees across the proposal area there was great difficulty in observing small hollows, therefore it is likely that there was a number of small hollows overlooked during the survey.

The hollow-bearing tree survey returned a high density of trees with hollows in the proposal area. Small to medium sized hollows on site may be used as roosting or maternity sites by hollow-dwelling microchiropteran bats, possums and birds. However, of most importance was the relatively high density of large hollows (105 hollows in 84 trees) exceeding 20 cm in diameter (refer Figure 3.1). Large hollows are important requirements for the breeding cycles of large forest owls, such as the Powerful Owl, which were recorded within the proposal area and the surrounding study area.

3.6.2 Feeding resources

Fauna occurring in the locality are likely to use a range of foraging resources. Flora species in the study area provided a variety of foraging resources from a range of species that together would flower throughout much of the year. However, at the time of the survey, few species showed significant flowering. Given the relatively large tracts of native vegetation adjacent to the study area, feeding resources contained within the study area would only provide a small proportion of that available to fauna in the wider locality.

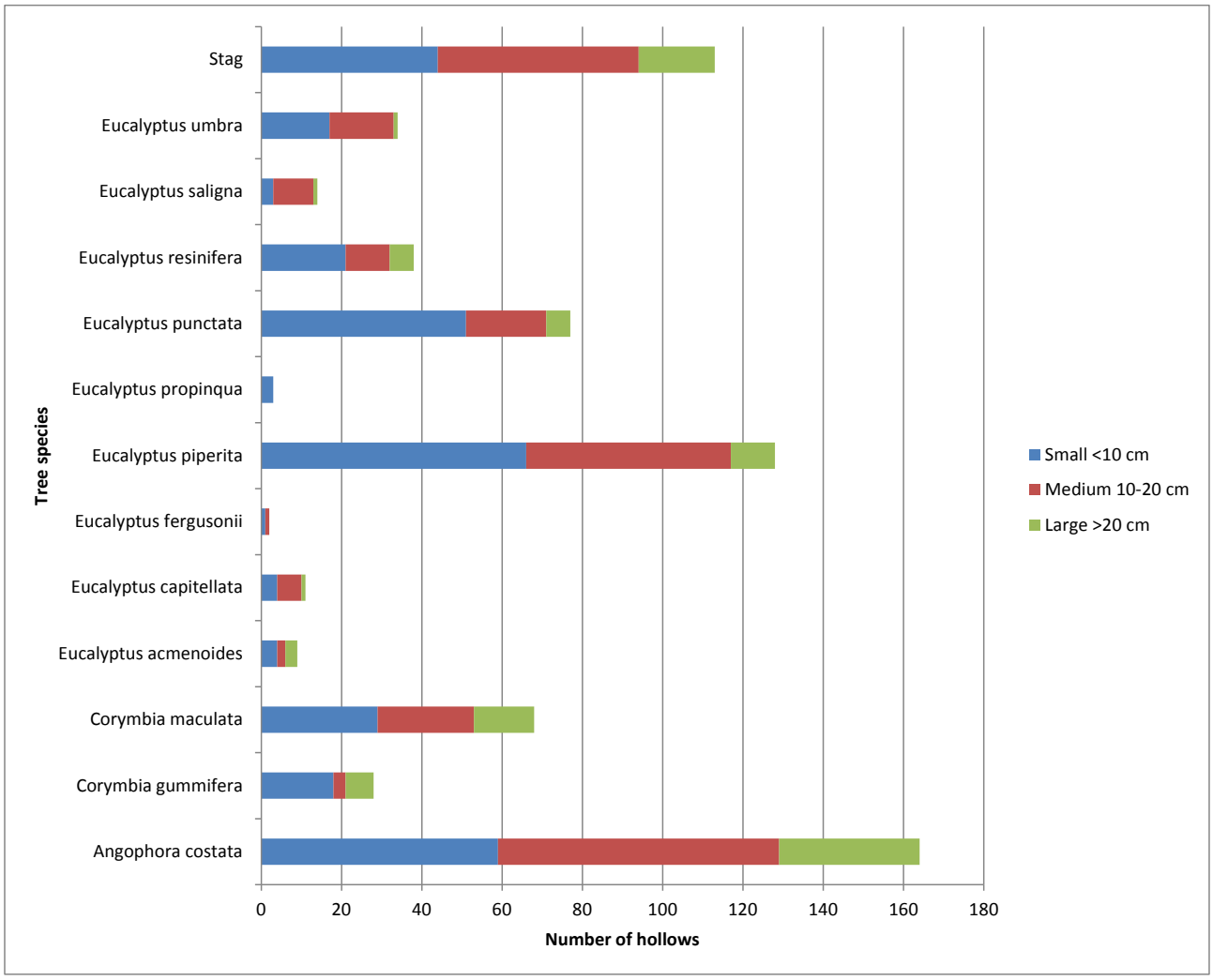


Figure 3.1 Hollow resource details

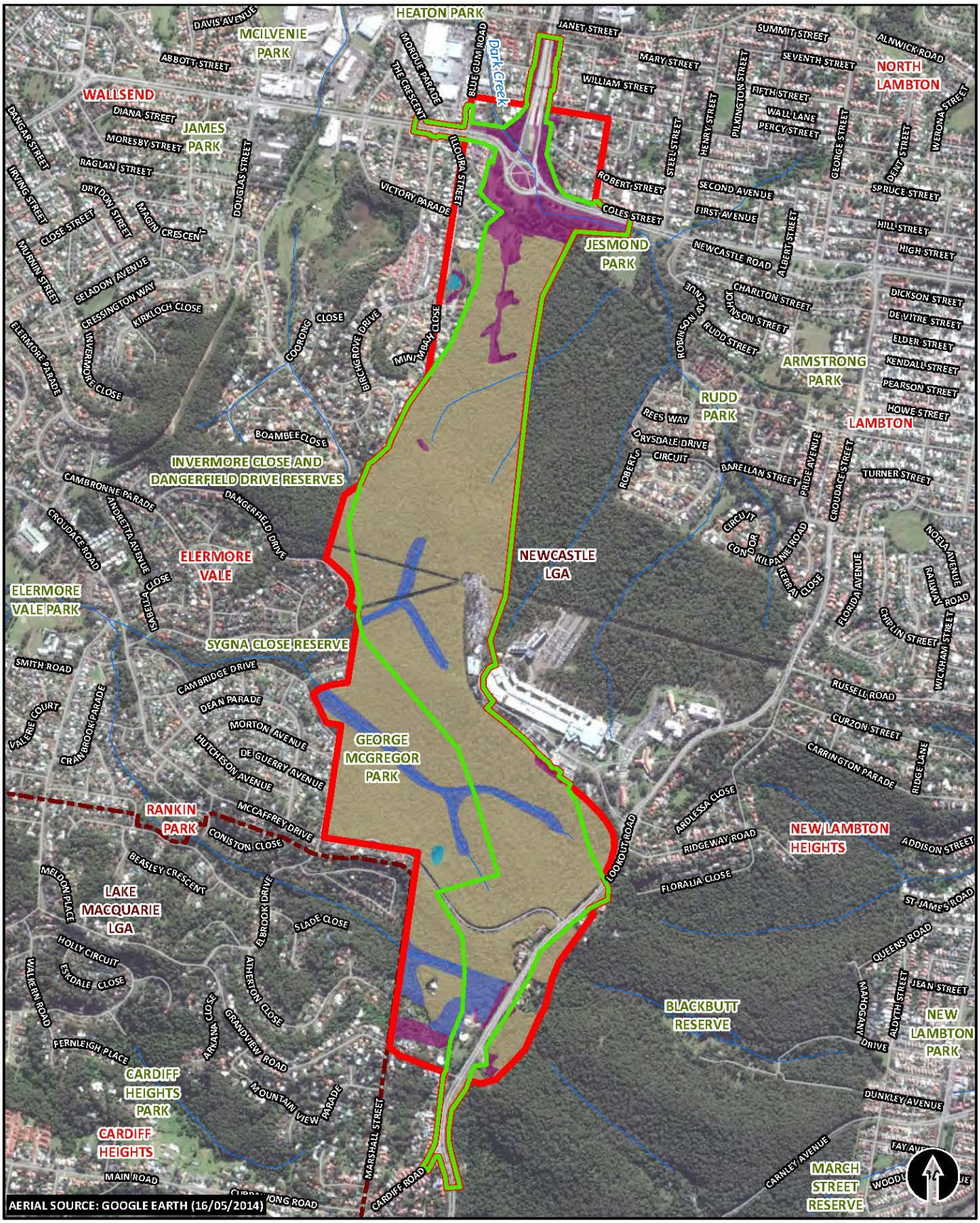


Figure 3.4
Fauna habitat
(Parsons Brinckerhoff 2014)

4. Threatened biodiversity

4.1 Threatened ecological communities

Threatened ecological communities (critically endangered, endangered and vulnerable) are listed under the TSC Act and EPBC Act. No threatened communities under the *Fisheries Management Act 1994* (FM Act) have been recorded within the Hunter Central Rivers CMA.

Results from the database searches indicated that 18 threatened communities were predicted to occur within the Hunter Central Rivers Hunter Sub-catchment. One of the plant community types are considered to be consistent with a threatened ecological community listed under the TSC Act as outlined in Table 4.1 and illustrated on . A further threatened ecological community of River-flat Eucalypt Forest has potential to be commensurate with one vegetation community within the study area, however this has been assessed as not meeting the criteria for the threatened ecological community and is discussed further in section 4.1.2 below. No threatened ecological communities listed under the EPBC Act were recorded within the study area.

Table 4.1 Threatened ecological communities recorded in the study area

Plant community type	Threatened ecological community	TSC Act	EPBC Act
HU629 Spotted Gum – Broad-leaved Ironbark grassy open forest	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion	Endangered	Not listed

4.1.1 Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion

This threatened ecological community generally occurs on Permian geology in the central to lower Hunter Valley within local government areas (LGAs) located within Sydney Basin Bioregion (e.g. Cessnock, Maitland, Singleton, Lake Macquarie, Newcastle and Port Stephens but may occur within others elsewhere in the Sydney Basin Bioregion). Vegetation representative of the Lower Hunter Spotted Gum – Ironbark Forest endangered ecological community was recorded within the study area (16.4 ha equivalent to 17% of the study area).

To be listed as endangered under the *Threatened Species Conservation Act 1995*, the vegetation must be consistent with the criteria outlined in Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion determination (Department of Environment and Conservation 2005). The vegetation recorded within the study area is considered to be consistent with the scientific determination and the reasons for this are justified in Table 4.2 below.

Table 4.2 Assessment of Lower Hunter Spotted Gum Ironbark Forest

Scientific Determination Criteria	HU631 Spotted Gum – Broad-leaved Ironbark grassy open forest characteristics
1. Does the community occur on Permian geology in the central to lower Hunter Valley	Yes the study area occurs on Permian geology of Newcastle Coal Measures (Lambton subgroup which consists of coal, sandstone, shale, minor conglomerate) sandstone and conglomerate were observed as outcropping.

Scientific Determination Criteria	HU631 Spotted Gum – Broad-leaved Ironbark grassy open forest characteristics
1. Is the community an open forest structure dominated by *Corymbia maculata* and *Eucalyptus fibrosa* with a prickly shrub understorey.	Occurred as an open forest floristic structure and canopy was dominated by *Corymbia maculata* and *Eucalyptus fibrosa* with occasional occurrences *of Eucalyptus punctata, Eucalyptus umbra* and *Angophora costata*. The community was variable with patches of grasses understorey and prickly understorey. The understorey was dominated by prickly species such as *Daviesia ulicifolia, Breynia oblongifolia, Bursaria spinosa* and *Acacia ulicifolia.*
2. Is the groundlayer diverse that include species such as *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.*	Groundlayer was dominated by the grass *species Joycea pallida*, which has been noted to be dominant in eastern occurrences of this community, with co-dominant species being *Entolasia stricta, Cymbopogon refractus, Pomax umbellata, Lomandra multiflora, Lepidosperma laterale and Themeda australis.*
3. Characteristic species listed in the determination	35 of a total of 55 (64%) species listed on the final determination are present within the community. A species list and plot data are provided in Appendix H.
4. Does the study area occur in the Sydney Basin bioregion in the core area of Cessnock or Beresfield or as remnant within the LGAs of Cessnock Maitland Singleton, Lake Macquarie, Newcastle, Port Stephens or Dungog?	Yes the Study area occurs in the Sydney Basin Bioregion within the Newcastle LGA.
5. Threatened species known to occur in this community include *Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora, Persoonia pauciflora, Rutidosis heterogama,* Swift Parrot, Turquoise Parrot, Glossy Black-cockatoo, Regent Honeyeater, Black-chinned Honeyeater, Brown Treecreeper, Powerful Owl, Koala, Yellow-bellied Glider, Squirrel Glider, Common Bent-wing Bat and Eastern Freetail Bat.	Threatened species recorded within the study area include *Grevillea parviflora* subsp. *parviflora,* Powerful Owl and Squirrel Glider.
6. Lower Hunter Spotted Gum Ironbark Forest is part of a complex of ecological communities that were identified in an analysis by the Lower Hunter Central Coast Vegetation mapping project (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003). This project has been found to have limitations when applied to fine scale vegetation mapping. Further studies have identified this community as a distinct assemblage of species	The spotted gum assemblages within the study area are commensurate with three of the spotted gum communities as described by LHCCREMS (2003). These include Lower Hunter Spotted Gum Ironbark Forest, Coastal Foothills Spotted Gum Ironbark Forest and Hunter Valley Moist Forest. Whilst, Lower Hunter Spotted Gum Ironbark Forest has not been mapped within the study area previously (LHCCREMS 2003) this community is commensurate with the community as described by LHCCREMS.
7. Is the canopy dominated by *Eucalyptus fibrosa* with a prickly shrub understory species.	Yes the canopy is dominated by *Eucalyptus fibrosa,* with a dominant understorey of prickly shrubs such as *Acacia ulicifolia, Daviesia ulicifolia* and *Bursaria spinosa.*
Does the community meet the criteria for Lower Hunter Spotted Gum Ironbark Forest	Yes

This community has not previously been recorded as occurring within the study area, however this community is difficult to determine from other spotted gum communities. Bell (2009) has provided further clarification on the determination of this community since its listing in 2005. Hinterland Spotted Gum Red Ironbark Forest has been identified as a variant of Lower Hunter Spotted Gum Ironbark Forest that occurs in the lower Hunter and further east than other forms of Lower Hunter Spotted Gum Ironbark Forest that occur in the Cessnock and upper Hunter areas. This variant has been recorded in Lake Macquarie LGA at Edgeworth and adjoining the Newcastle Link Road, which is within close proximity to the study area. The community within the study area is consistent with the floristic composition of the canopy, understorey and groundlayer of the Hinterland Spotted Gum Red Ironbark Community as outlined in this study.

4.1.2 River-flat Eucalypt Forest on Coastal Floodplains

This threatened ecological community generally occurs on soils associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. This community also generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level. The structure of the community may vary from tall open forests to woodlands. This community occurs in the NSW North Coast, Sydney Basin and South Coast Bioregions. Vegetation that ***may be representative*** of the River-flat Eucalypt Forest on Coastal Floodplains endangered ecological community was recorded within the study area (4.61 ha equivalent to 4% of the study area).

To be listed as endangered under the *Threatened Species Conservation Act 1995*, the vegetation must be consistent with the criteria outlined in River-flat Eucalypt Forest on Coastal Floodplains final determination(NSW Scientific Committee 2005). The vegetation recorded within the study area is not considered to be consistent with the scientific determination and therefore this endangered ecological community does not occur within the study area. The reasons for this are justified in Table 4.3 below.

Table 4.3 Assessment of River-flat Eucalypt Forest

TSC Act final determination diagnostic characteristics for River-flat Eucalypt Forest on Coastal Floodplains	HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant
Distribution that occurs south of Port Stephens and occurs on alluvial soils.	The study area occurs south of Port Stephens in the Newcastle LGA. This community occurs on the coalluvial soils of Cedar Hills soil landscape; however this community occurs at the headwaters of Ironbark Creek and does not occur on a coastal floodplain.
Is the site located on a river flat in the upper part of a coastal floodplain within an active or dominant drainage line.	The vegetation community occurs on the however this community occurs at the headwaters of Ironbark Creek and does not occur on a coastal floodplain.
Does the site consist of open forest or woodland with a mixture of Eucalypt or Angophora Trees particularly *Eucalyptus amplifolia* or *Eucalyptus tereticornis or Eucalyptus saligna* or *Eucalyptus grandis* (north of Sydney)*?*	Yes the community structure is that of tall open forest with the dominant species being *Eucalyptus saligna* and *Eucalyptus acmenoides.*
Whether any of the listed characteristic species occur in the shrub and ground layer (including as part of the seedbank in the soil).	Based on the surveys completed, 41 (46%) of the species listed in the final determination of the River-flat Eucalypt Forest vegetation were recorded within the community. The shrub layer was modified by weed incursions by Lantana and Small-leaved Privet.
Are there relatively low numbers of She-oaks, Paperbarks and Swamp Mahoganies?	Yes, no Swamp Mahoganies or paperbarks, a small number of *Allocasuarina torulosa* (Forest She-oak) were recorded in the community.
Do the patches within the Study Area meet the criteria for classification of the vegetation as the listed community?	No – This community does not occur on a coastal floodplain.

4.2 Threatened populations

Two endangered populations are listed to occur within the study area for the Hunter Central Rivers catchment Hunter subregion: Emu population in the NSW North Coast Bioregion and Port Stephens Local Government area and Koala, Hawkes Nest and Tea Gardens population. However neither of these species was recorded nor have habitat within the study area. No other endangered populations are considered to occur within the study area.

4.3 Threatened species

4.3.1 Flora

The field surveys identified three threatened flora as being recorded within the ecological study area and within the vicinity of the proposal area. These threatened species are outlined in Table 4.4 below and shown in . The sections below describe the findings of the recorded threatened flora species within the *Tetratheca juncea* study area.

Table 4.4 Threatened flora species recorded within the ecological study area

Scientific name	Common name	TSC act status[2]	EPBC act status[1]
Tetratheca juncea	Black-eyed Susan	Vulnerable	Vulnerable
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	Vulnerable	Vulnerable
Syzygium paniculatum	Magenta Lily Pilly	Endangered	Vulnerable

(1) Listed as vulnerable (V), endangered (E) or critically endangered (CE) under the EPBC Act

(2) Listed as an endangered population (EP), vulnerable (V), endangered (E) or critically endangered (CE) under the TSC Act

The remaining threatened flora species (listed in Table 2.5) that were targeted for were not recorded within the study area.

4.3.1.1 *Tetratheca juncea*

A large population of 10,381 plant clumps were recorded within the *Tetratheca juncea* study area. The locations of these are shown in , whilst Photo 4.1 shows the flowers of *Tetratheca juncea* within the study area. The threatened species study area is located with the central coast metapopulation for *Tetratheca juncea* identified in the Referral Guidelines for *Tetratheca juncea* (Department of Sustainability Environment Water Population and Communities 2011). The threatened flora study area contained five subpopulations, three within Blackbutt Reserve and the remaining two subpopulations were recorded on the western portion of the threatened species study area which encompassed the study area, George McGregor Park and the surrounding bushland to the north of the John Hunter Hospital (refer to). A subpopulation is defined as plant clumps that area separated by distances of less than 500 m within suitable habitat or less than 100 m in degraded habitat or non-native vegetation (Department of Sustainability Environment Water Population and Communities 2011). The subpopulations were defined on whether the pollinator, a native bee, could travel between populations and McCaffrey Drive would not be a significant barrier to a bee to transfer genetic material.

Subpopulation 1 was the largest subpopulation recorded (8176 plant clumps) and was located to the east of Dangerfield Drive and adjoining Sygna Close and extended further south through McGregor Park and across McCaffery Drive. These high density populations were recorded within two habitat types, the majority of the population occurred within HU621 Smooth-barked Apple – Red Bloodwood open forest, with smaller populations occurring within the HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest.

Table 4.5 is a breakdown of the numbers of *Tetratheca juncea* plant clumps recorded within the subpopulations and Table 4.6 is a breakdown of the numbers of *Tetratheca juncea* within the study area and reserves in the threatened flora study area. Subpopulation 2 contained 4 plant clumps within the HU631 Spotted Gum – Grey Ironbark open forest – atypical variant. Whilst this community has been designated as habitat in the referral guidelines only this small population was recorded within the spotted gum communities throughout the threatened flora study area. No further plant clumps were recorded in the northern portion of

the study area from north of Dangerfield Drive to the Jesmond roundabout, this vegetation was generally composed of Coastal Narrabeen Moist Forest (Blackbutt dominated) and wet sclerophyll communities.

In Blackbutt Reserve three subpopulations () were recorded within the HU621 Smooth-barked Apple – Red Bloodwood open forest and HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest vegetation community types. Blackbutt Reserve contained one vegetation community Subtropical Rainforest, which did not occur within the Study Area on the western side of Lookout Road. In addition Blackbutt Reserve a smaller area of HU621 Smooth-barked Apple – Red Bloodwood open forest habitat compared to the study area. Blackbutt Reserve contained larger areas of Coastal Narrabeen Moist Forest (Blackbutt dominated),HU 631 Spotted Gum – Grey Ironbark open forest– atypical variant, HU 631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant, HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant and whilst. *Tetratheca juncea* can be recorded within these communities it was not recorded within any of these communities within Blackbutt Reserve.

Table 4.5 Number of *Tetratheca juncea* plant clumps within each Subpopulation

Subpopulation (Location)	No of *Tetratheca juncea* plant clumps
Subpopulation 1 (West of Lookout Road)	8,176
Subpopulation 2 (West of Lookout Road)	4
Subpopulation 3 (Blackbutt Reserve)	5
Subpopulation 4 (Blackbutt Reserve)	2,162
Subpopulation 5 (Blackbutt Reserve)	34
Total number of *Tetratheca juncea* plant clumps	**10,381**

Table 4.6 Number of *Tetratheca juncea* plant clumps recorded

Location	No of *Tetratheca juncea* plant clumps
Study area	6,259
Invermore Close & Dangerfield Drive Reserve and bushland to the north east of John Hunter Hospital	1,921
Blackbutt Reserve	2,201
Total number of plant clumps recorded within the Threatened flora study area	**10,381**

Determination of peak flowering

A total of 36 stems were sampled from 36 plant clumps at nine locations within the threatened flora study area. Four plant clumps, separated by a minimum of 10 m were sampled at each of the nine locations. Table 4.7 below outlines the results from the stem counts and an average of 82% for all of the flowering stems was observed.

It is concluded that *Tetratheca juncea* was at peak flowering being over 75% at the time of the targeted surveys as outlined in the methodology listed on the federal species profile for *Tetratheca juncea* (SPRAT) (Department of the Environment 2013). Thus, further detailed parallel transect were conducted throughout the Threatened flora study area, which included the study area, adjoining bushland and Blackbutt Reserve. Photo 4.2 shows the high numbers of flowers that were observed on plant clumps within the study area.

Determination of peak flowering

A total of 36 stems were sampled from 36 plant clumps at nine locations. Four plant clumps, separated by a minimum of 10 m were sampled at each of the nine locations. Table 4.7 below outlines the results from the stem counts and an average of 82% for all of the flowering stems was observed. Therefore it was concluded that *Tetratheca juncea* was at peak flowering being over 75% at the time of the targeted surveys. Thus, further detailed parallel transect were conducted throughout the Threatened flora study area, which included the study area, adjoining bushland and Blackbutt Reserve. Photo 4.2 shows the high numbers of flowers that were observed on plant clumps within the study area.

Table 4.7 Determination of peak flowering

Location	Plant clump No.	No. of Flowers	No. of buds	No. of Seed Capsules	Percentage Flowers[1]
TJ1	1	9	2	0	82
TJ1	2	10	10	0	50
TJ1	3	6	4	1	55
TJ1	4	6	0	0	100
TJ2	5	4	4	0	50
TJ2	6	10	4	1	67
TJ2	7	7	2	0	78
TJ2	8	2	0	0	100
TJ3	9	12	3	0	80
TJ3	10	15	3	1	79
TJ3	11	4	1	0	80
TJ3	12	5	0	0	100
TJ4	13	10	1	0	91
TJ4	14	10	2	0	83
TJ4	15	26	3	0	90
TJ4	16	22	3	1	85
TJ5	17	28	8	0	78
TJ5	18	23	4	0	85
TJ5	19	40	7	0	85
TJ5	20	17	3	0	85
TJ6	21	31	6	1	82
TJ6	22	43	11	0	80
TJ6	23	23	2	0	92
TJ6	24	36	7	0	84
TJ7	25	26	4	0	87
TJ7	26	8	2	0	80
TJ7	27	22	2	1	88

Location	Plant clump No.	No. of Flowers	No. of buds	No. of Seed Capsules	Percentage Flowers[1]
TJ7	28	30	7	0	81
TJ8	29	6	2	0	75
TJ8	30	14	1	0	93
TJ8	31	12	1	1	86
TJ8	32	7	2	0	78
TJ9	33	12	1	0	92
TJ9	34	13	1	0	93
TJ9	35	31	4	1	86
TJ9	36	17	2	0	89
Totals		**597**	**119**	**8**	**% Average 82**

(1) 100xFlowers/(Flowers+Buds+Seed Capsules) formula as per Federal *Tetratheca juncea* SPRAT survey guidelines (Department of the Environment 2013)

Important population of *Tetratheca juncea* recorded

An important population of *Tetratheca juncea* is defined if it meets any one of the following criteria as set out by the referral guidelines (Department of Sustainability Environment Water Population and Communities 2011):

1. Has greater than 1000 plant clumps.
2. An area of habitat has an average estimated plant clump density of 20 clumps/hectare or greater.
3. Occurs in rare habitat (see section 3 of the referral guidelines).
4. Occurs in an area of 'important habitat' as defined in Maps 4a and 4b (of the referral guidelines) and has greater than 500 plant clumps.
5. Occurs at or near the distributional limits of *Tetratheca juncea.*
6. Occurs in close proximity to a protected area (e.g. National Park) where *Tetratheca juncea* is known to occur. Close proximity refers to:
    a) within 500 m if connected by a suitable habitat corridor such as native vegetation
    b) within 100 m over disturbed habitat or non-native vegetation.

The study area meets criteria 1, 2, 3 and 6. Within the study area (to the west of Lookout Road) there are over 1000 plant clumps (8,180 plant clumps in subpopulations 1,2) and an average of 207 plant clumps per hectare. A portion of the population occurs in rare habitat of HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest and the study area occurs within 100 m of Blackbutt Reserve in which a known population of this species occurs.

In addition, the study area may also meet criteria 4, whilst the study area is not mapped within important habitat, it is mapped within modelled habitat for this species within Map 3 of the referral guidelines

In conclusion the population of as the recorded population of *Tetratheca juncea* meets several of the above criteria it is deemed to be an important population as defined under the EPBC Act. Therefore it is highly likely that a referral to the commonwealth will be required for this species as the project is likely to remove a portion of an important population of *Tetratheca juncea*.

Photo 4.1 ***Tetratheca juncea*** **recorded within the study area**

Photo 4.2 ***Tetratheca juncea*** **growing as mats during peak flowering period**

4.3.1.2 *Grevillea parviflora* subsp. *parviflora*

Grevillea parviflora subsp. *parviflora* was recorded at two locations within the study area (, Photo 4.3 and Photo 4.4). Two populations with a total of 109 individuals (86 within the current design area) were recorded during the field survey from 25 GPS points. The species was recorded towards the centre of the study area (generally within remnant bush between Sygna Close and John Hunter Hospital).

The species occurred in areas immediately adjacent walking tracks and within remnant vegetation (low level of disturbance witnessed) on sandy substrates. The species was associated with the HU621 Smooth-barked Apple – Red Bloodwood open forest vegetation types as mapped within the study area.

Samples of this species has been forwarded to the Royal Botanic Gardens Sydney and was confirmed to be *Grevillea parviflora* subsp. *parviflora* (Appendix E).

Photo 4.3 ***Grevillea parviflora* subsp. *parviflora* flowering within the study area**

Photo 4.4 ***Grevillea parviflora* subsp. *parviflora* within HU621 Smooth-barked Apple – Red Bloodwood open forest within the Study Area**

4.3.1.3 *Syzygium paniculatum*

Syzygium paniculatum was recorded at one location within the study area (Photo 4.5 and Photo 4.6). A total of eight individuals were recorded within George McGregor Park behind Cambridge Drive along Ironbark Creek (). This species was growing on the banks of an unnamed creek which flows into Sygna Close Reserve. It is unknown if this species is as a result of bird dispersal from nearby gardens, or if it is naturally occurring. No further individuals were located upstream from these individuals.

This species was identified from the similar species *Syzygium oleosum* by the higher density of oil dots which are often present in the specimens from the northern end of the range. A specimen of this *Syzygium paniculatum* was forwarded to the Royal Botanical Gardens for confirmation of identification and was confirmed as being *Syzygium paniculatum* (refer to Appendix E).

This species was growing on alluvial soils within the vegetation community of HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – Syncarpia glomulifera variant as mapped within the study area. The individuals of this species that occur within the study area are currently outside of the current proposal area. This species was growing along a creek bank which is currently disturbed by minor weed incursions, rubbish dumping and occasional foot traffic from bushwalkers.

Photo 4.5 *Syzygium paniculatum* growing within George McGregor Park

Photo 4.6 ***Syzygium paniculatum* growing within Spotted Gum Grey Ironbark open forest – *Eucalyptus fergusonii* variant vegetation community**

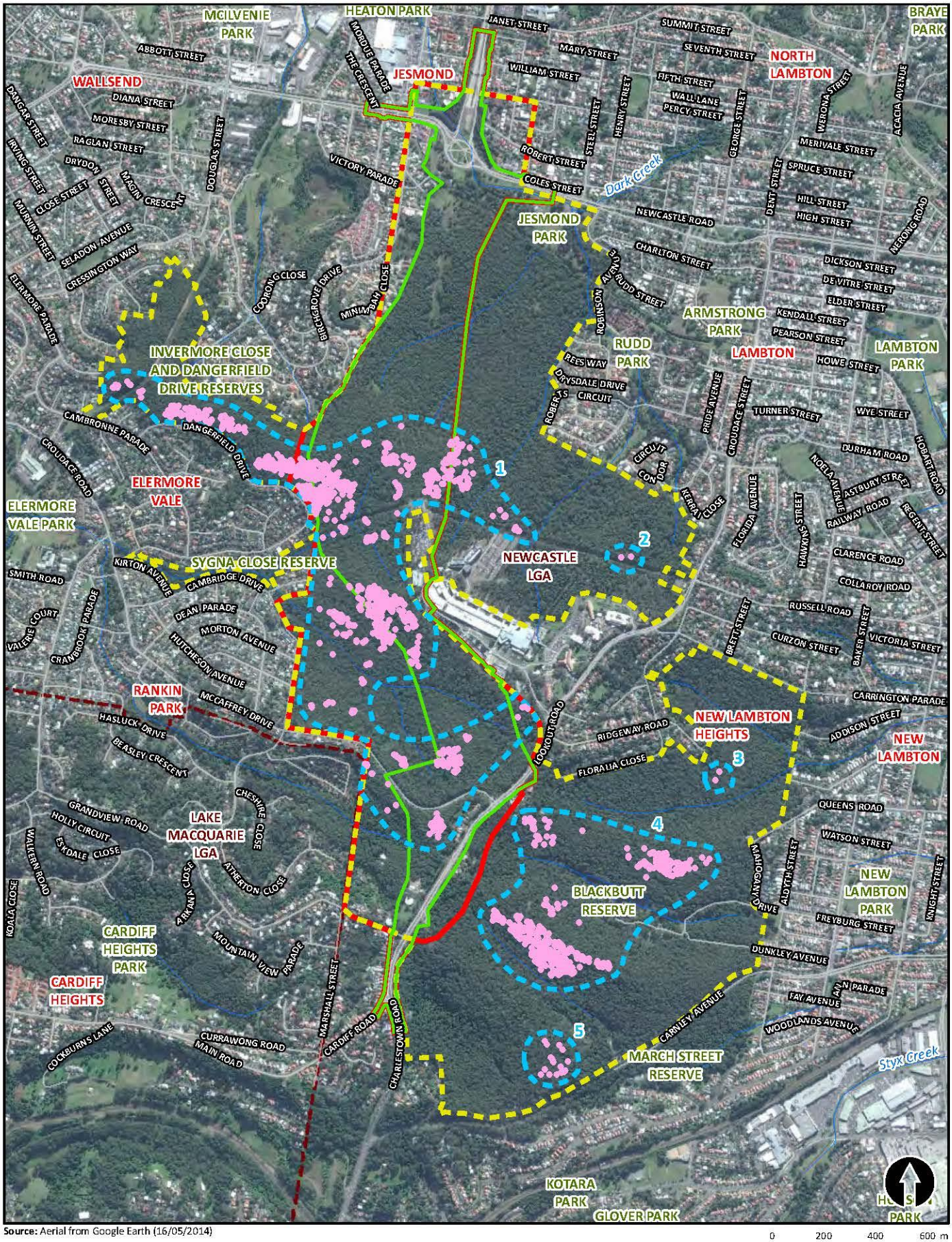
4.3.2 Other threatened flora

A further six threatened flora species (refer Table 4.8) are recognised to have moderate or highly likelihood of occurrence but were not recorded during the current surveys, within the study area. Targeted surveys have been undertaken for each of these species within their appropriate flowering period (see section 2.5.3.3 and Table 2.5) and none of these five threatened flora species were identified within the study area. Therefore, it is considered that the likelihood of occurrence of these species within the study area to be low.

Table 4.8 Threatened flora species assessed to have a moderate or greater likelihood of occurrence in the study area

Common name	*Scientific name*	EPBC Act[1]	TSC Act[2]
Netted Bottle Brush	*Callistemon linearifolius*	-	V
Leafless Tongue Orchid	*Cryptostylis hunteriana*	V	V
Thick Lip Spider Orchid	*Caladenia tessellata*	V	E
Heath Wrinklewort	*Rutidosis heterogama*	V	V
Newcastle Doubletail	*Diuris praecox*	V	V
Red Helmet Orchid	*Corybas dowlingii*	-	E

(1) Listed as vulnerable (V), endangered (E) under the EPBC Act.
(2) Listed as an vulnerable (V), endangered (E) under the TSC Act.



Source: Aerial from Google Earth (16/05/2014)

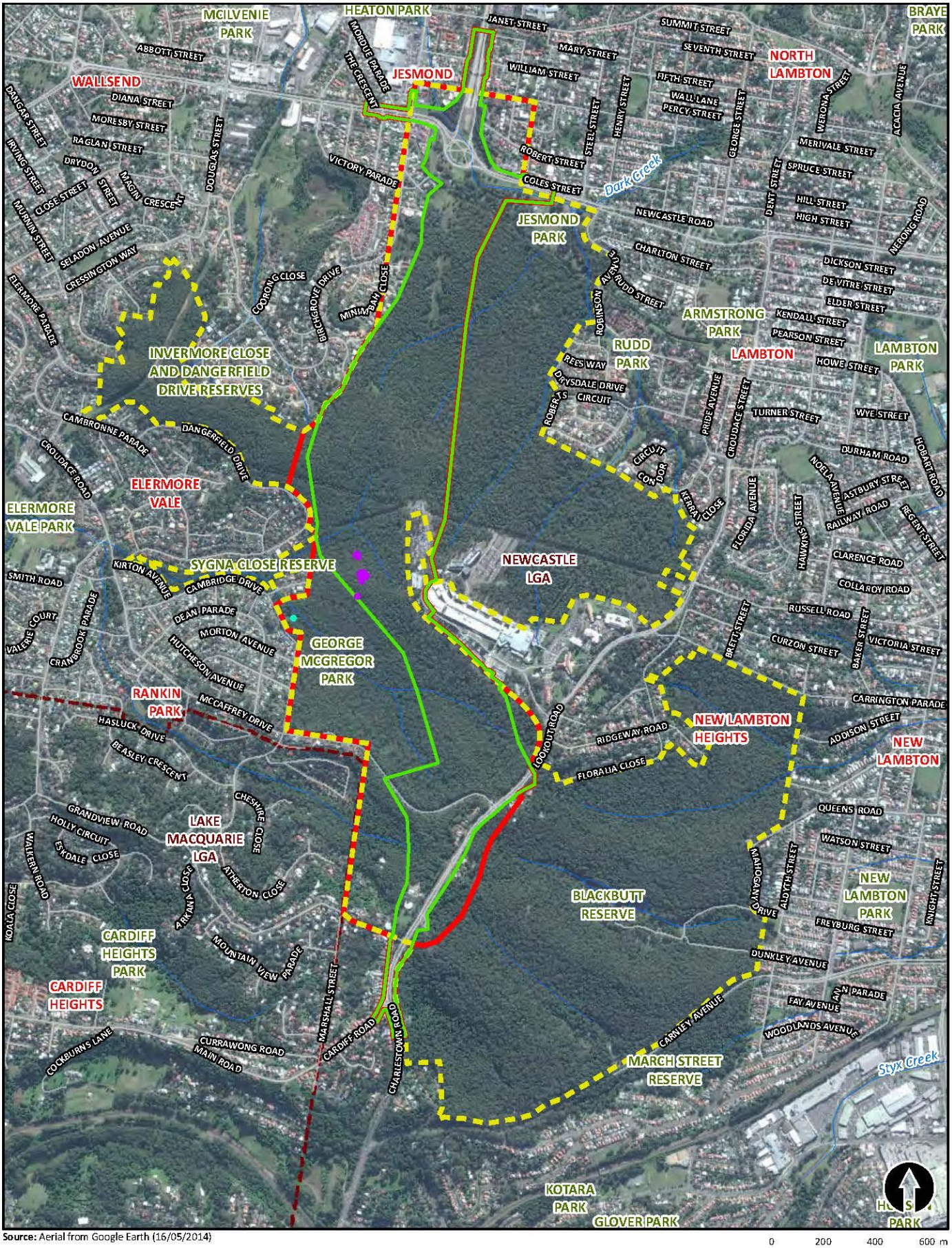
0 200 400 600 m

- Local roads
- Creek lines
- Proposal area
- Study area
- Threatened flora study area
- Local government area

Threatened flora species

- *Tetratheca juncea*
- Subpopulations of *Tetratheca juncea*

Figure 4.1
Tetratheca juncea locations



Source: Aerial from Google Earth (16/05/2014)

0 200 400 600 m

- Local roads
- Creek lines
- Proposal area
- Study area
- Threatened flora study area
- Local government area

Threatened flora species

- *Grevillea parviflora*
- *Syzygium paniculatum*

Figure 4.2
Grevillea parviflora subsp. parviflora and *Syzygium paniculatum* locations

4.3.3 Fauna

Five threatened fauna species: Grey-headed Flying-fox, Little Bentwing Bat, Little Lorikeet, Squirrel Glider and Powerful Owl were recorded during the field surveys (refer to Table 4.9).

Table 4.9 Threatened fauna species recorded during the current field surveys

Common name	Scientific name	EPBC Act[1]	TSC Act[2]
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V
Little Lorikeet	*Glossopsitta pusilla*	–	V
Little Bentwing Bat	*Miniopterus australis*	–	V
Powerful Owl	*Ninox strenua*	–	V
Squirrel Glider	*Petaurus norfolcensis*	–	V

(1) Listed as vulnerable (V) under the EPBC Act.
(2) Listed as an vulnerable (V) under the TSC Act.

4.3.3.1 Threatened blossom nomads

Grey-headed Flying-fox were observed flying over the study area. There are blossom-producing trees within the study area and the Project footprint that provide foraging resources for this species and the presence of a flying-fox camp to the southeast in Blackbutt Reserve (refer to Photo 4.7), suggesting that this species would use the study area regularly in numbers when trees are flowering onsite.

Photo 4.7 Grey-headed Flying Fox Camp within Blackbutt Reserve

A pair of another blossom-nomad, the Little Lorikeet, was observed flying over the study area during field surveys and the study area is likely to provide, seasonal foraging resources and potential breeding hollows for this species.

Two seasonally occurring Endangered blossom nomad species, the Swift Parrot and Regent Honeyeater, were not observed within the study area during the survey period. A favoured winter-blossom producing tree for these species, Spotted Gum (*Corymbia maculata*), was common across the study area, however this species was not carrying blossom during the 2014 season, and this maybe in response to low rainfall in the region over the last three years. Ferguson's Ironbark (*Eucalyptus fergusonii*), which is sometimes used by Swift Parrots in the Lower Hunter Region was also not flowering during the 2014 survey period. This is not unusual as many trees take long periods to set blossom and Swift Parrots and Regent Honeyeaters do not always use blossom when it occurs in every instance, due to the occurrence of suitable resources elsewhere in their range.

4.3.3.2 Threatened microchiropteran bats

The study area represents a large area of canopy and mid-storey woodland/ forest habitats, dissected by riparian gullies, which are the favoured foraging locations for small insectivorous bats. It is considered highly likely that those species that have been recorded in the wider project locality would utilise resources within the study area on at least an intermittent basis. The study area was not observed to contain roosting areas for threatened cave-dwelling microchiropteran bats, such as the Eastern Bent-winged Bat, Southern Myotis and Large-eared Pied Bat, but their wide ranging foraging habits suggest that they would use the study area for foraging purposes from time to time. The study area contained an abundance of potential roosting habitat for threatened hollow-dwelling microchiropteran bats, such as Yellow-bellied Sheathtail-bat, Eastern Freetail-bat and Eastern False Pipistrelle. These species, together with other hollow-dwelling microchiropteran bats are likely to use the study area for foraging and roosting purposes on at least an intermittent basis. Previous surveys by Umwelt Environmental Consultants (2006) have recorded five threatened microbats including Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Little Bentwing Bat, Eastern Bentwing Bat and Greater Broad-nosed Bat within the study area.

4.3.3.3 Threatened arboreal mammals

One threatened arboreal mammal, the Squirrel Glider (and Photo 4.8), was recorded during arboreal mammal trapping surveys, and this species is widely, yet sparsely, distributed through dry woodlands and forests in the Lower Hunter. Woodland within the study area was highly suited to a range of arboreal mammals, due to the relatively high-density of hollow-bearing trees, abundant foliage for folivorous species, such as the possums, and the variety of canopy trees (Myrtaceae family) and understorey plants (proteaceous shrubs) that produce nectar and pollen for gliders. The abundance of arboreal mammal habitat within the study area is the likely reason, together with an abundance of large hollows, that Powerful Owls are strongly associated with the study area; as arboreal mammals, such as the Common Ringtail Possum and the Squirrel Glider, are the favoured prey animal guild of these owls.

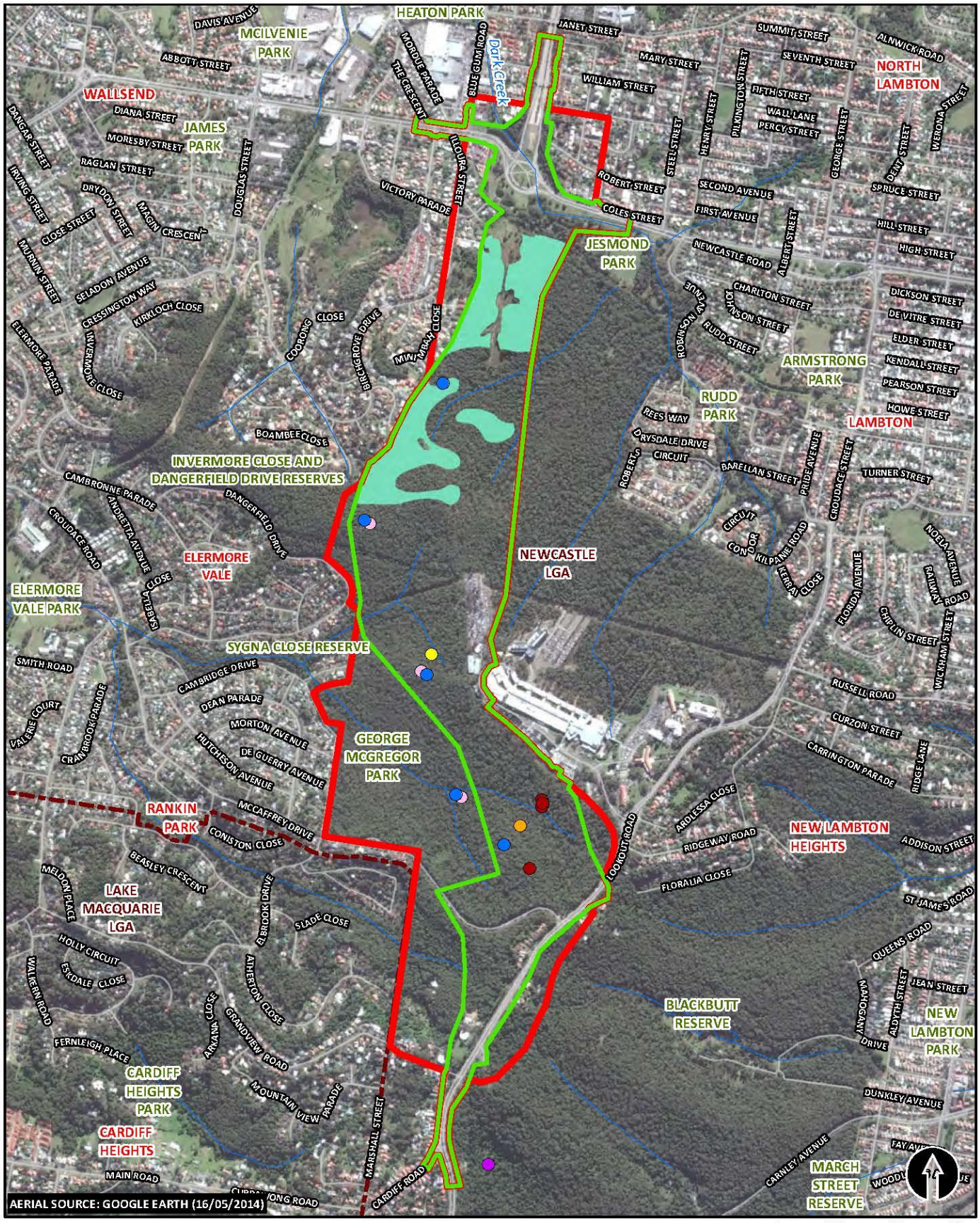


Figure 4.3
Endangered ecological communities and threatened fauna (Parsons Brinckerhoff 2014)

Photo 4.8 Squirrel Glider trapped in the Study Area

4.3.3.4 Threatened forest owls

Powerful Owls were observed within the project area and the study area on a number of occasions, and targeted surveys were conducted during early evenings to determine if a pair had set up a breeding territory in the locality. Observations of Powerful Owl behaviour within the study area suggested that the pair had commenced breeding cycle during the 2014 breeding season. On a number of occasions the male was observed commencing to call in the early evening around sunset from the gully through which the project footprint is located. The lack of movements before calling commenced suggested that this location was a favoured roosting location. On two occasions the female was observed to join the male in the canopy of large eucalypts at his calling location.

Early in the survey period, the female was observed leaving the male and flying directly back along the flight path she had flown to join the male. The direction she flew was carefully noted, so that further surveys might endeavour to locate a possible nest hollow location. A number of large hollows along the flight path were discovered and subsequent surveys focused attention on these hollows to confirm if a nesting site was in in this area. No nesting hollow could be confirmed, but a number of key breeding-hollow candidates were subject to Sulphur-crested Cockatoo visitation during surveys, which has been circumstantially implicated in the causing of Powerful Owls to break from hollow selection in the past (Birds in Backyards 2013). Although, observed movements of the female Powerful Owl suggested that a most likely location for a potential nesting hollow was to the south of the proposal area, the gully from which the male called appeared to be a favoured roosting site. Furthermore, the occurrence of Common Ringtail Possums which are a favoured food and the close proximity to the Grey-headed Flying Fox camp which would provide juvenile Grey-headed Flying Foxes which are also a favoured prey food for the Powerful owl, in the proposal area gully and the location of the remains of a Common Ringtail Possum, suggesting Powerful Owl predation in this location, suggested that the gully may play an important role in Powerful Owl habitat use of the study area.

4.3.3.5 Koala

Database searches conducted for the proposal (refer to Section 2.4) did not locate any records of Koala for the study area and Koalas were not recorded during the ecological surveys. The most recent Koala record within 2 km of the proposal was near Blackbutt Reserve in 1986 (Office of Environment and Heritage 2015b). The Department of Environment Koala habitat assessment tool (Department of Environment 2014a) was utilised to determine the quality of Koala habitat in the proposal area and if it contained habitat critical to the survival of the Koala (refer Figure 4.1).

Attribute	Score	Inland	Coastal
Koala occurrence	+2 (high)	Evidence of one or more koalas within the last 5 years.	Evidence of one or more koalas within the last 2 years.
	+1 (medium)	Evidence of one or more koalas within 2 km of the edge of the impact area within the last 10 years.	Evidence of one or more koalas within 2 km of the edge of the impact area within the last 5 years.
	0 (low)	None of the above.	None of the above.
Vegetation composition	+2 (high)	Has forest, woodland or shrubland with emerging trees with 2 or more known koala food tree species, **OR** 1 food tree species that alone accounts for >50% of the vegetation in the relevant strata.	Has forest or woodland with 2 or more known koala food tree species, **OR** 1 food tree species that alone accounts for >50% of the vegetation in the relevant strata.
	+1 (medium)	Has forest, woodland or shrubland with emerging trees with only 1 species of known koala food tree present.	Has forest or woodland with only 1 species of known koala food tree present.
	0 (low)	None of the above.	None of the above.
Habitat connectivity	+2 (high)	Area is part of a contiguous landscape ≥ 1000 ha.	Area is part of a contiguous landscape ≥ 500 ha.
	+1 (medium)	Area is part of a **contiguous landscape** < 1000 ha, but ≥ 500 ha.	Area is part of a contiguous landscape < 500 ha, but ≥ 300 ha.
	0 (low)	None of the above.	None of the above.
Key existing threats	+2 (high)	Little or no evidence of koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence. Areas which score 0 for koala occurrence and have no dog or vehicle threat present	
	+1 (medium)	Evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence, **OR** Areas which score 0 for koala occurrence and are likely to have some degree dog or vehicle threat present.	
	0 (low)	Evidence of frequent or regular koala mortality from vehicle strike or dog attack in the study area at present, **OR** Areas which score 0 for koala occurrence and have a significant dog or vehicle threat present.	
Recovery value	+2 (high)	Habitat is likely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	
	+1 (medium)	Uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	
	0 (low)	Habitat is unlikely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	

Figure 4.1 Koala habitat assessment tool

A score of 3 out of 10 was determined for the Koala habitat in the study area based on the Koala habitat assessment tool (refer Figure 4.1 and Table 4.10). Impact areas that score four or less using the habitat assessment tool for the Koala do not contain habitat critical to the survival of the Koala. Based on this value, the study area does not contain habitat critical to the survival of the Koala.

Table 4.10 Completed Koala habitat assessment tool for the study area

Attribute	Score	Habitat Appraisal	
Koala Occurrence	0	Desktop	▪ Database searches conducted for the proposal did not locate any records of Koala for the study area. ▪ The most recent Koala record within 2km of the proposal was near Blackbutt Reserve in 1986(Office of Environment and Heritage 2015b).
		On-site	▪ No Koalas or traces of Koalas were recorded during the ecological surveys
Vegetation structure and composition	2	Desktop	▪ LGA vegetation mapping and database searches indicate *Eucalyptus robusta* and *Eucalyptus punctata* are present and likely to be present in the study area.
		On-site	▪ Habitat ground-truthing was carried out during field surveys and two feed tree species listed under SEPP 44 Schedule 2 were identified within the study area: *Eucalyptus robusta* and *Eucalyptus punctata*.
Habitat connectivity	0	▪ The habitat that will be impacted by the proposal is located within isolated urban bushland bounded by artificial barriers (roadways, cleared lands and residential development). ▪ The size of the contiguous habitat landscape is 287.65ha (which includes additional areas to the study area)	
Key existing threats	0	Desktop	▪ Desktop assessment did not show any Koala road kill or Koala death records within 2km or the study area.
		On-site	▪ The status of dog populations and level of predation is not known. During surveys the area was observed to be heavily used by dog walkers including off leash walking.
Recovery value	0	▪ Due to the size of the continuous landscape, vegetation composition and level of threats present the habitat is considered unlikely to be an important for the recovery of the Koala. ▪ Majority of the larger habitat area will remain given the projects linear corridor and major corridors will remain to major nearby tracts of bushland. (Blackbutt reserve).	
Total	2	Decision: not habitat critical to the survival of the Koala – assessment of significance not required.	

4.3.3.6 Other threatened fauna

A further 18 threatened fauna (refer to Table 4.11) are recognised to have moderate or highly likelihood of occurrence but were not recorded during the current surveys, within the study area and assessments of impacts will be undertaken when the design of the project has been finalised.

Table 4.11 Threatened fauna species assessed to have a moderate or greater likelihood of occurrence in the study area

Common name	Scientific name	EPBC Act[1]	TSC Act[2]
Birds of prey			
Little Eagle	*Hieraaetus morphnoides*	–	V
Birds – Forest owls			
Masked Owl (southern mainland)	*Tyto novaehollandiae novaehollandiae*	–	V
Sooty Owl	*Tyto tenebricosa*	–	V
Birds – Woodland			
Regent Honeyeater	*Anthochaera phrygia*	–	V
Varied Sittella	*Daphoenositta chrysoptera*	–	V
Birds – Cockatoos			
Gang-gang Cockatoo	*Callocephalon fimbriatum*	–	V
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	–	V
Opportunistic Blossom Nomads			
Swift Parrot	*Lathamus discolor*	E	E
Mammals			
Spotted-Tailed Quoll (Southern Subspecies)	*Dasyurus maculatus maculatus*	E	V
Koala (NSW, ACT & QLD – excluding SE QLD)[3]	*Phascolarctos cinereus*	V	V
Microchiropteran bats			
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	–	V
Eastern Freetail-bat[3]	*Micronomus norfolkensis (syn. Mormopterus norfolkensis)*	–	V
Little Bent-wing Bat[3]	*Miniopterus australis*	–	V
Eastern Bent-wing Bat[3]	*Miniopterus schreibersii oceanensis*	–	V
Southern Myotis	*Myotis macropus*	–	V
Yellow-bellied Sheathtail-bat[3]	*Saccolaimus flaviventris*	–	V
Greater Broad-nosed Bat[3]	*Scoteanax rueppellii*	–	V

(1) Listed as migratory (M), vulnerable (V), endangered (E) or critically endangered (CE) under the EPBC Act.
(2) Listed as an vulnerable (V), endangered (E) under the TSC Act.

(3) Species previously recorded within f the study area (Umwelt Environmental Consultants 2006).

4.4 Migratory species

Migratory species are protected under international agreements, to which Australia is a signatory, including JAMBA, CAMBA, RoKAMBA and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered Matters of NES and are protected under the EPBC Act.

Three migratory species listed under the EPBC Act; Rufous Fantail, Black-faced Monarch and Cattle Egret were recorded in the study area during field surveys. A further five species listed as migratory under the EPBC Act were identified with a moderate or higher likelihood of occurrence within the study area (refer to Table 4.12).

Both the Rufous Fantail and the Black-faced Monarch set up breeding territories in wet forests similar to those in the study area and it is considered likely that these species would use the study area for breeding purposes. Cattle Egrets roost at the Shortland Wetland Centre to the north of the study area and its presence in disturbed areas of the site is likely due to the presence of horses kept in the vicinity.

Of the eight migratory bird species listed in Table 4.12 as having a moderate or greater chance of occurrence within the study area, two (Fork-tailed Swift and White-throated Needletail) are not considered likely to use the site, but may occur intermittently in the airways over the study area during broad foraging movement throughout the region. A third species, the Satin Flycatcher, is rarely encountered beyond the ranges flanking the Lower Hunter Valley and is considered unlikely to use the site on more than a rare occurrence.

Impacts to migratory species of fauna will be assessed further once the final design of the proposed works is completed.

Table 4.12 Migratory fauna species assessed to have a moderate or greater likelihood of occurrence in the study area

Common Name	Scientific name	EPBC Act[1]	Recorded
Fork-tailed Swift	*Apus pacificus*	M	No
Cattle Egret	*Area ibis*	M	Yes
White-bellied Sea-eagle	*Haliaetus leucogaster*	M	No
White-throated Needletail	*Hirundapus caudacutus*	M	No
Rainbow Bee-eater	*Merops ornatus*	M	No
Black-faced Monarch	*Monarcha melanopsis*	M	Yes
Satin Flycatcher	*Myiagra cyanoleuca*	M	No
Rufous Fantail	*Rhipidura rufifrons*	M	Yes

(1) Listed as migratory (M) under the EPBC Act.

4.5 Groundwater dependent ecosystems

Groundwater dependant ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation 2002). When considering GDEs, groundwater is generally defined as the saturated zone of the regolith (the layer of loose rock resting on bedrock, constituting the surface of most land) and its associated capillary

fringe, however it excludes soil water held under tension in soil pore spaces (the unsaturated zone or vadose zone) (Eamus *et al.* 2006).

GDEs include a diverse range of ecosystems as shown in Figure 4.2. These ecosystems range from those entirely dependent on groundwater to those that may use groundwater while not having a dependency on it for survival (i.e. ecosystems or organisms that use groundwater opportunistically or as a supplementary source of water) (Hatton & Evans 1998). Eamus *et al.* (2006) considers the following broad classes of these ecosystems:

- Aquifer and cave ecosystems, where stygofauna (groundwater-inhabiting organisms) may reside within the groundwater resource. The hyporheic zones (see ecosystem 5 in Figure 4.2) of rivers and floodplains are also included in this category because these ecotones often support stygobites (obligate groundwater inhabitants).
- All ecosystems dependent on the surface expression of groundwater. This category includes base-flow rivers and streams, wetlands (see ecosystems 2 and 3 in Figure 4.2), some floodplains and mound springs and estuarine seagrass beds. While it is acknowledged that plant roots are generally below ground, this class of groundwater dependant ecosystems requires a surface expression of groundwater, which may, in many cases, then soak below the soil surface and thereby become available to plant roots.
- All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the saturated zone of the water table) when roots penetrate this zone. This class includes terrestrial ecosystems such as River Red Gum (*Eucalyptus camaldulensis*) forests on the Murray–Darling basin (see ecosystems 1 and 4 in Figure 4.2). No surface expression of groundwater is required in this class of groundwater dependant ecosystems.

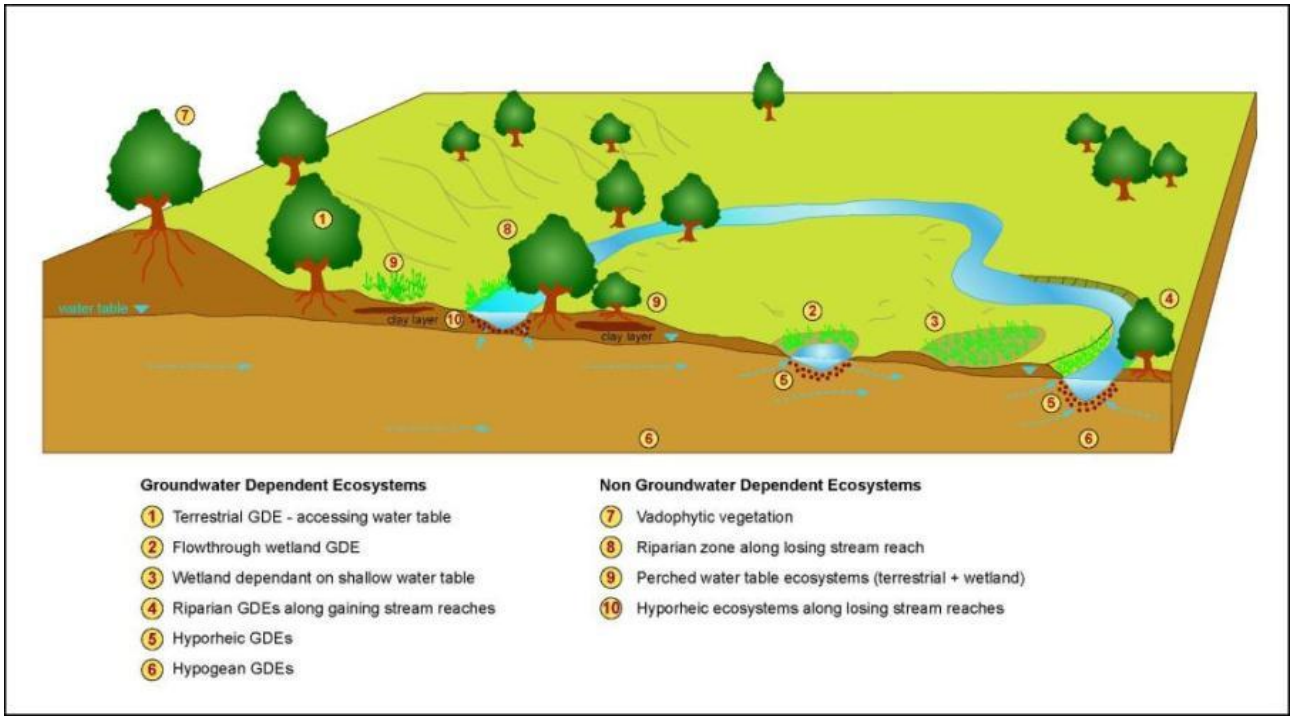


Figure 4.2 Conceptual biophysical model of groundwater dependent ecosystems

GDEs possess a range of values, including being important and sometimes rare ecosystems in themselves, as well as providing important ecosystem services such as water purification (Department of Land and Water Conservation 2002). Groundwater is also an increasingly important resource for human uses in Australia (there was a 90 per cent increase in groundwater extraction between 1985 and 1997 (National Land and Water Resources Audit 2001). Nationally groundwater is extracted for uses including irrigation (48%), urban

and industrial use (33%) and stock watering and rural use (19%) (Department of the Environment and Heritage 2001).

The potential for groundwater extraction to exceed recharge has resulted in awareness of the effects of groundwater availability or regimes that may result in adverse impacts to groundwater dependent ecosystems (2003), and thereby threaten the values they provide.

4.5.1 Legislation

Due to the concern of the impacts upon groundwater dependent ecosystems several levels of legislation have been developed. These include state legislation and state planning polices and these include the following:

- *Water Management Act 2000* in which the Minister for Land and Water Conservation manages and controls the extraction of groundwater. Section 5(2)a of the Act relates to protection of water source: and Section 5(2)c relates to water quality. Both of these sections of the Act would directly relate to GDEs as both water quality and quantity would impact upon these ecosystems.
- The NSW State Groundwater Dependent Ecosystem Policy (2002) has been developed to protect ecosystems which have a reliance on groundwater for survival. This document outlines a rapid assessment process which is used for identifying and valuing GDEs which assists in the management of GDEs at a state level.
- Groundwater Dependent Ecosystems Assessment, Registration and Scheduling of High Priority (Department of Land and Water Conservation 2006). This document was written by Department of Land and Water Conservation and was developed to classify GDEs in order of priority of protection.
- Risk Assessment Guidelines for Groundwater Dependant Ecosystems, consisting of four volumes (Kuginis *et al.* 2012a; Kuginis *et al.* 2012b; Serov *et al.* 2012; Williams *et al.* 2012). These documents were commissioned by the Department of Primary Industries – Office of Water as part of the National Water Commission Coastal Groundwater Dependent Ecosystem Project. This project was commissioned to gain further information on the Coastal GDE environment to support ecological and dependency evaluations for GDEs.

The above documents have been used in this report to assist in the identification of GDEs within the study area.

4.5.2 GDEs in the study area

Whether or not ecosystems show some level of groundwater dependence will depend, in part, on their location in the landscape relative to the level of groundwater. Within the Study Area, the groundwater source is likely to be from shallow unconsolidated alluvial aquifers associated with the creeklines.

Dependence (or interaction) of the vegetation communities identified in the Study Area on groundwater was determined by aligning them with the groundwater dependant ecosystem types identified by the Groundwater Dependent Ecosystems Assessment, Registration and Scheduling of High Priority (Department of Land and Water Conservation 2006).

Two plant community types have been determined as being intermittently dependent upon groundwater, with the *Gahnia clarkei* variant of the HU621 Smooth-barked Apple – Red Bloodwood open forest being likely to be dependent upon groundwater (refer to Table 4.13). The first two communities are riparian communities and are likely to rely on surface water runoff and accessing groundwater when groundwater levels are high. In contrast the remaining community is likely to occur as a result of a groundwater seep and be dependent upon groundwater.

Table 4.13 Plant community types dependency upon ground water

Plant community type[1]	GDE type	Class	Description of Class	Habitat	Dependency on groundwater[2]
HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – Syncarpia glomulifera variant	Riparian and terrestrial vegetation (T)	T1	Riparian vegetation community	Terrestrial	Intermittently
HU637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Riparian and terrestrial vegetation (T)	T1	Riparian vegetation community	Terrestrial	Intermittently
HU621 Smooth-barked Apple – Red Bloodwood open forest – *Gahnia clarkei* variant	Wetlands (W)	W10	Sedge Swamp	Epigean	Known

(1) Vegetation Communities as per Parsons Brinckerhoff Vegetation communities described in Section 3.2 of this report.

(2) Known groundwater dependency as per (Eamus et al. 2006).

5. Conclusions

This ecological survey report comprises the findings from detailed field surveys and desk-top investigations completed over the study area and associated habitats. These surveys included targeted threatened flora surveys both within the study area and within Blackbutt Reserve. Targeted winter fauna surveys and trapping surveys were also completed for threatened fauna.

The study area occurs within the Newcastle LGA from the Jesmond roundabout to McCaffreys Drive, Rankin Park and is part of a large predominantly intact remnant of native vegetation surrounded by suburban areas of the suburbs of Jesmond, Elermore Vale and Rankin Park. The south west portion of the study area is designated as George McGregor Park with the remaining area being vacant native bushland. Key biodiversity values within the study area included:

- The presence of Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion, which is listed as a threatened community under the TSC Act.
- The presence of three threatened plants, including a large important population (over 8,000 plant clumps in the study area) of *Tetratheca juncea* (Vulnerable under both the TSC Act and EPBC Act), *Grevillea parviflora* subsp. *parviflora* (Vulnerable under both the TSC Act and EPBC Act) and *Syzygium paniculatum* (Endangered under the TSC Act and Vulnerable under the EPBC Act).
- The presence of five threatened animals, including Powerful Owl (Vulnerable under TSC Act) and may have nesting opportunities within the study area, Grey-headed Flying-fox (Vulnerable under both the TSC Act and EPBC Act), Squirrel Glider (Vulnerable under TSC Act), Little Bentwing Bat (Vulnerable under TSC Act) and Little Lorikeet (Vulnerable under TSC Act).
- The presence of three migratory species, including Rufous Fantail, Black-faced Monarch and Cattle Egret (listed as Migratory under the EPBC Act).
- Known and potential habitat for an additional 18 species of animal listed as threatened under the TSC Act and/or EPBC Act and five additional species of animal listed as Migratory under the EPBC Act.

The vegetation recorded within the study area generally occurred in good condition. Although not all vegetation was consistent with a threatened ecological community listed under the TSC, they did contain a high diversity of native species and high connectivity to other bushland remnants. This vegetation provides habitat for a number of threatened and non-threatened flora and fauna species.

5.1 Recommendations

A change in the design of the proposed inner city bypass occurred after targeted field surveys have been completed. Therefore several threatened species will require further targeted seasonal surveys within the extended proposal area. These including the following:

- *Diuris praecox* and *Corybas dowlingii* in June to August
- *Cryptostylis hunteriana* in November to February
- Hollow-bearing tree surveys
- Targeted Powerful Owl breeding and roosting surveys.

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Newcastle Inner City Bypass: Rankin Park to Jesmond

Biodiversity Survey Report

Appendices
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Appendix A

Plant species recorded

Table A-1 – Plant Species Recorded within the Study Area

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Acanthaceae	*Brunoniella australis*	Blue Trumpet			Y
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower			Y
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair			Y
Adiantaceae	*Adiantum formosum*	Giant Maidenhair			Y
Adiantaceae	*Cheilanthes sieberi subsp. sieberi*				Y
Adiantaceae	*Pellaea falcata*	Sickle Fern			Y
Anthericaceae	*Thysanotus spp.*	Fringe Lily			Y
Apiaceae	*Actinotus minor*	Lesser Flannel Flower			Y
Apiaceae	*Centella asiatica*	Pennywort			Y
Apiaceae	*Daucus glochidiatus*	Native Carrot			Y
Apiaceae	*Hydrocotyle bonariensis*	American Pennywort			N
Apiaceae	*Hydrocotyle peduncularis*				Y
Apiaceae	*Hydrocotyle tripartita*	Pennywort			Y
Apiaceae	*Platysace lanceolata*	Shrubby Platysace			Y
Apocynaceae	*Parsonsia straminea*	Common Silkpod			Y
Araceae	*Gymnostachys anceps*	Settlers Flax			Y
Araceae	*Monstera deliciosa*	Fruit Salad Plant			N
Araliaceae	*Hedera helix*	English Ivy			N
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax			Y
Araucariaceae	*Araucaria bidwillii*				Y
Arecaceae	*Livistona australis*	Cabbage Palm			Y
Asclepiadaceae	*Marsdenia suaveolens*	Scented Marsdenia			Y
Asclepiadaceae	*Tylophora barbata*	Bearded Tylophora			Y
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern			N
Asparagaceae	*Asparagus officinalis*	Asparagus			N
Aspleniaceae	*Asplenium australasicum*				Y
Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern			Y
Asteraceae	*Ageratina adenophora*	Crofton Weed			N
Asteraceae	*Bidens pilosa*	Cobblers Pegs			N
Asteraceae	*Chrysanthemoides monilifera subsp. rotundata*	Bitou Bush			N
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting			Y
Asteraceae	*Cirsium vulgare*	Spear Thistle			N

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Asteraceae	*Conyza sp.*				N
Asteraceae	*Hypochaeris glabra*	Smooth Catsear			N
Asteraceae	*Hypochaeris radicata*	Catsear			N
Asteraceae	*Lagenifera stipitata*	Blue Bottle-daisy			Y
Asteraceae	*Olearia tomentosa*	Toothed Daisy-bush			Y
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood			Y
Asteraceae	*Senecio hispidulus*	Hill Fireweed			Y
Asteraceae	*Senecio madagascariensis*	Fireweed			N
Asteraceae	*Soliva stolonifera*	Jo-jo			N
Asteraceae	*Sonchus oleraceus*	Common Sowthistle			N
Asteraceae	*Taraxacum officinale*	Dandelion			N
Asteraceae	*Vernonia cinerea*				Y
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine			Y
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern			Y
Blechnaceae	*Doodia aspera*	Prickly Rasp Fern			Y
Caryophyllaceae	*Stellaria media*	Common Chickweed			N
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak			Y
Casuarinaceae	*Casuarina glauca*	Swamp Oak			Y
Celastraceae	*Maytenus silvestris*	Narrow-leaved Orangebark			Y
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush			Y
Commelinaceae	*Commelina cyanea*	Native Wandering Jew			Y
Convolvulaceae	*Convolvulus erubescens*				Y
Convolvulaceae	*Dichondra repens*	Kidney Weed			Y
Cunoniaceae	*Callicoma serratifolia*	Black Wattle			Y
Cunoniaceae	*Ceratopetalum apetalum*	Coachwood			Y
Cyatheaceae	*Cyathea cooperi*	Straw Treefern			Y
Cyperaceae	*Carex appressa*	Tussock Sedge			Y
Cyperaceae	*Cyperus eragrostis*	Umbrella Sedge			N
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge			Y
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge			Y
Cyperaceae	*Gahnia erythrocarpa*				Y
Cyperaceae	*Gahnia melanocarpa*	Black-fruit Saw-sedge			Y
Cyperaceae	*Gahnia microstachya*	Slender Saw-sedge			Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge			Y
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge			Y
Cyperaceae	*Ptilothrix deusta*				Y
Davalliaceae	*Nephrolepis cordifolia*	Fishbone Fern			Y
Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern			Y
Dennstaedtiaceae	*Pteridium esculentum*	Bracken			Y
Dicksoniaceae	*Calochlaena dubia*	Common Ground Fern			Y
Dilleniaceae	*Hibbertia aspera*				Y
Dilleniaceae	*Hibbertia dentata*	Twining Guinea Flower			Y
Dilleniaceae	*Hibbertia empetrifolia*				Y
Dilleniaceae	*Hibbertia linearis*				Y
Dilleniaceae	*Hibbertia scandens*	Climbing Guinea Flower			Y
Dilleniaceae	*Hibbertia sp.*				Y
Dioscoreaceae	*Dioscorea transversa*	Native Yam			Y
Droseraceae	*Drosera peltata*	Pale Sundew			Y
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash			Y
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V	V	Y
Epacridaceae	*Epacris pulchella*	NSW Coral Heath			Y
Epacridaceae	*Leucopogon juniperinus*	Long-flower Beard-heath			Y
Epacridaceae	*Leucopogon lanceolatus*	Lance Beard Heath			Y
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush			Y
Euphorbiaceae	*Glochidion ferdinandi*	Cheese Tree			Y
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart, Native Poplar			Y
Euphorbiaceae	*Phyllanthus gunnii*	Shrubby Spurge			Y
Euphorbiaceae	*Phyllanthus hirtellus*	Thyme Spurge			Y
Eupomatiaceae	*Eupomatia laurina*	Bolwarra			Y
Fabaceae (Caesalpinioideae)	*Senna pendula*	Easter Cassia			N
Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea			Y
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*				Y
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil			Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Fabaceae (Faboideae)	*Erythrina X sykesii*	Coral tree			N
Fabaceae (Faboideae)	*Glycine clandestina*	Twining Glycine			Y
Fabaceae (Faboideae)	*Glycine tabacina*				Y
Fabaceae (Faboideae)	*Gompholobium latifolium*	Golden Glory Pea			Y
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla			Y
Fabaceae (Faboideae)	*Hovea linearis*				Y
Fabaceae (Faboideae)	*Indigofera australis*	Austral Indigo			Y
Fabaceae (Faboideae)	*Kennedia rubicunda*	Red Kennedy Pea			Y
Fabaceae (Faboideae)	*Mirbelia rubiifolia*	Heathy Mirbelia			Y
Fabaceae (Faboideae)	*Platylobium formosum*	Handsome Flat-pea			Y
Fabaceae (Faboideae)	*Podolobium ilicifolium*	Prickly Shaggy Pea			Y
Fabaceae (Faboideae)	*Podolobium scandens*	Netted Shaggy Pea			Y
Fabaceae (Faboideae)	*Pultenaea daphnoides*	Large-leaf Bush-pea			Y
Fabaceae (Faboideae)	*Pultenaea euchila*				Y
Fabaceae (Faboideae)	*Pultenaea paleacea var. paleacea*				Y
Fabaceae (Faboideae)	*Pultenaea retusa*	Blunt Bush-pea			Y
Fabaceae (Faboideae)	*Pultenaea spinosa*	Grey Bush-pea			Y
Fabaceae (Faboideae)	*Pultenaea villosa*				Y
Fabaceae (Faboideae)	*Trifolium dubium*	Yellow Suckling Clover			N
Fabaceae (Faboideae)	*Trifolium repens*	White Clover			N
Fabaceae (Faboideae)	*Vicia sativa*	Common Vetch			N
Fabaceae (Mimosoideae)	*Acacia falcata*				Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Fabaceae (Mimosoideae)	*Acacia fimbriata*	Fringed Wattle			Y
Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally			Y
Fabaceae (Mimosoideae)	*Acacia irrorata*	Green Wattle			Y
Fabaceae (Mimosoideae)	*Acacia linearis*				Y
Fabaceae (Mimosoideae)	*Acacia linifolia*	Flax-leaved Wattle			Y
Fabaceae (Mimosoideae)	*Acacia longifolia subsp. longifolia*	Sydney Golden Wattle			Y
Fabaceae (Mimosoideae)	*Acacia maidenii*	Maidens Wattle			Y
Fabaceae (Mimosoideae)	*Acacia myrtifolia*	Red-stemmed Wattle			Y
Fabaceae (Mimosoideae)	*Acacia terminalis subsp. augustifolia*	Sunshine Wattle			Y
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses			Y
Goodeniaceae	*Brunonia australis*	Blue Pincushion			Y
Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia			Y
Goodeniaceae	*Goodenia ovata*	Hop Goodenia			Y
Haloragaceae	*Gonocarpus tetragynus*	Common Raspwort			Y
Haloragaceae	*Gonocarpus teucrioides*				Y
Juncaceae	*Juncus usitatus*	Billabong Rush			Y
Lamiaceae	*Plectranthus verticillatus subsp*				N
Lauraceae	*Cassytha glabella*	Slender Dodder-laurel			Y
Lauraceae	*Cassytha pubescens*				Y
Lauraceae	*Cinnamomum camphora*	Camphor Laurel			N
Lauraceae	*Endiandra sieberi*	Hard Corkwood			Y
Lemnaceae	*Spirodela polyrhiza*	Large Duckweed			Y
Liliaceae	*Lilium formosanum*	Taiwan Lily			N
Lindsaeaceae	*Lindsaea linearis*	Screw Fern			Y
Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern			Y
Lobeliaceae	*Lobelia dentata*				Y
Lobeliaceae	*Pratia purpurascens*	Whiteroot			Y
Lomandraceae	*Lomandra cylindrica*	Needle Mat-rush			Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Lomandraceae	*Lomandra filiformis subsp. coriacea*				Y
Lomandraceae	*Lomandra filiformis subsp. filiformis*				Y
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			Y
Lomandraceae	*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush			Y
Lomandraceae	*Lomandra obliqua*				Y
Lomandraceae	*Lomandra sp.*				Y
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry			Y
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			Y
Malvaceae	*Howittia trilocularis*	Blue Howittia			Y
Malvaceae	*Sida rhombifolia*	Paddys Lucerne			N
Meliaceae	*Dysoxylum fraserianum*	Rosewood			Y
Meliaceae	*Synoum glandulosum*	Scentless Rosewood			Y
Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine			Y
Menispermaceae	*Stephania japonica var. discolor*	Snake Vine			Y
Moraceae	*Streblus pendulinus*	Whalebone Tree	E		Y
Musaceae	*Musa sp.*				Y
Myrsinaceae	*Rapanea variabilis*	Muttonwood			Y
Myrtaceae	*Acmena smithii*	Lilly Pilly			Y
Myrtaceae	*Angophora costata*	Sydney Red/Rusty Gum			Y
Myrtaceae	*Angophora floribunda*	Rough-barked Apple			Y
Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle			Y
Myrtaceae	*Callistemon citrinus*	Crimson Bottlebrush			Y
Myrtaceae	*Callistemon linearis*	Narrow-leaved Bottlebrush			Y
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush			Y
Myrtaceae	*Corymbia gummifera*	Red Bloodwood			Y
Myrtaceae	*Corymbia maculata*	Spotted Gum			Y
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany			Y
Myrtaceae	*Eucalyptus capitellata*	Brown Stringybark			Y
Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark			Y
Myrtaceae	*Eucalyptus fergusonii subsp. dorsiventralis*				Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Myrtaceae	*Eucalyptus fergusonii subsp. fergusonii x paniculata subsp. p*				Y
Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark			Y
Myrtaceae	*Eucalyptus globoidea*	White Stringybark			Y
Myrtaceae	*Eucalyptus paniculata*	Grey Ironbark			Y
Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint			Y
Myrtaceae	*Eucalyptus punctata*	Grey Gum			Y
Myrtaceae	*Eucalyptus resinifera subsp. resinifera*				Y
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany			Y
Myrtaceae	*Eucalyptus saligna*	Sydney Blue Gum			Y
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark			Y
Myrtaceae	*Eucalyptus umbra*				Y
Myrtaceae	*Leptospermum polygalifolium*				Y
Myrtaceae	*Leptospermum trinervium*	Paperbark Tea-tree			Y
Myrtaceae	*Melaleuca linariifolia*				Y
Myrtaceae	*Syncarpia glomulifera*	Turpentine			Y
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	E1	Y
Myrtaceae	*Tristaniopsis laurina*	Kanuka			Y
Nymphaeaceae	*Nymphaea sp.*				Y
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant			N
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet			N
Oleaceae	*Ligustrum sinense*	Small-leaved Privet			N
Oleaceae	*Notelaea longifolia*	Large Mock-olive			Y
Oleaceae	*Notelaea ovata*				Y
Oleaceae	*Olea europaea subsp. cuspidata*				N
Orchidaceae	*Acianthus fornicatus*	Pixie Caps			Y
Orchidaceae	*Caladenia carnea*	Pink Fingers			Y
Orchidaceae	*Caladenia catenata*	White Caladenia			Y
Orchidaceae	*Calochilus robertsonii*	Purplish Beard Orchid			Y
Orchidaceae	*Cryptostylis subulata*	Large Tongue Orchid			Y
Orchidaceae	*Cymbidium suave*	Snake Orchid			Y
Orchidaceae	*Dipodium punctatum*	Hyacinth Orchid			Y
Orchidaceae	*Diuris aurea*				Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Orchidaceae	*Lyperanthus suaveolens*	Brown Beaks			Y
Orchidaceae	*Pterostylis baptistii*	King Greenhood			Y
Orchidaceae	*Pterostylis longifolia*	Tall Greenhood			Y
Oxalidaceae	*Oxalis debilis*				Y
Oxalidaceae	*Oxalis exilis*	Shady Wood-sorrel			Y
Oxalidaceae	*Oxalis latifolia*	Large-leaf Wood-sorrel			N
Passifloraceae	*Passiflora aurantia var. aurantia*	Blunt-leaved Passionfruit			Y
Passifloraceae	*Passiflora edulis*	Common Passionfruit			N
Phormiaceae	*Dianella caerulea var. producta*				Y
Phormiaceae	*Dianella revoluta*				Y
Pittosporaceae	*Billardiera scandens*	Appleberry			Y
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn			Y
Pittosporaceae	*Pittosporum pauciflorus*	Orange Thorn			Y
Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			Y
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum			Y
Plantaginaceae	*Plantago lanceolata*	Lambs Tongues			N
Poaceae	*Aristida sp.*				Y
Poaceae	*Aristida vagans*	Threeawn Speargrass			Y
Poaceae	*Austrostipa scabra*	Speargrass			Y
Poaceae	*Avena fatua*	Wild Oats			N
Poaceae	*Axonopus fissifolius*	Narrow-leafed Carpet Grass			N
Poaceae	*Briza maxima*	Quaking Grass			N
Poaceae	*Briza minor*	Shivery Grass			N
Poaceae	*Briza subaristata*				N
Poaceae	*Chloris gayana*	Rhodes Grass			N
Poaceae	*Cortaderia selloana*	Pampas Grass			N
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass			Y
Poaceae	*Cynodon dactylon*	Common Couch			Y
Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass			Y
Poaceae	*Digitaria parviflora*	Small-flowered Finger Grass			Y
Poaceae	*Echinopogon caespitosus var. caespitosus*	Tufted Hedgehog Grass			Y
Poaceae	*Ehrharta erecta*	Panic Veldtgrass			N

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Poaceae	*Entolasia marginata*	Bordered Panic			Y
Poaceae	*Entolasia stricta*	Wiry Panic			Y
Poaceae	*Hyparrhenia hirta*	Coolatai Grass			N
Poaceae	*Imperata cylindrica*	Bladey Grass			Y
Poaceae	*Joycea pallida*	Silvertop Wallaby Grass			Y
Poaceae	*Microlaena stipoides*				Y
Poaceae	*Oplismenus aemulus*				Y
Poaceae	*Oplismenus imbecillis*	Creeping Beard Grass			Y
Poaceae	*Panicum maximum var. maximum*	Guinea Grass			N
Poaceae	*Panicum simile*	Two-colour Panic			Y
Poaceae	*Paspalidium sp.*				Y
Poaceae	*Paspalum distichum*	Water Couch			Y
Poaceae	*Paspalum urvillei*	Vasey Grass			N
Poaceae	*Pennisetum clandestinum*	Kikuyu Grass			N
Poaceae	*Phragmites australis*	Common Reed			Y
Poaceae	*Poa affinis*				Y
Poaceae	*Poa labillardieri*	Tussock			Y
Poaceae	*Setaria palmifolia*	Palm Grass			N
Poaceae	*Sporobolus africanus*	Parramatta Grass			N
Poaceae	*Sporobolus caroli*	Fairy Grass			Y
Poaceae	*Sporobolus creber*	Slender Rats Tail Grass			Y
Poaceae	*Themeda australis*	Kangaroo Grass			Y
Polygalaceae	*Comesperma ericinum*	Heath Milkwort			Y
Polygonaceae	*Persicaria sp.*				Y
Polygonaceae	*Rumex crispus*	Curled Dock			N
Polypodiaceae	*Platycerium bifurcatum*	Elkhorn			Y
Proteaceae	*Banksia spinulosa var. collina*				Y
Proteaceae	*Grevillea parviflora subsp. parviflora*	Small-flower Grevillea	V	V	Y
Proteaceae	*Grevillea sericea subsp. sericea*				Y
Proteaceae	*Hakea bakeriana*				Y
Proteaceae	*Lambertia formosa*	Mountain Devil			Y
Proteaceae	*Lomatia silaifolia*	Crinkle Bush			Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Proteaceae	*Persoonia levis*	Broad-leaved Geebung			Y
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung			Y
Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris			Y
Ripogonaceae	*Ripogonum album*	White Supplejack			Y
Rosaceae	*Rubus fruticosus*	Blackberry complex			N
Rosaceae	*Rubus moluccanus var. trilobus*	Molucca Bramble			Y
Rubiaceae	*Galium binifolium*	Reflexed Bedstraw			Y
Rubiaceae	*Morinda jasminoides*	Jasmine Morinda			Y
Rubiaceae	*Opercularia diphylla*				Y
Rubiaceae	*Opercularia hispida*	Hairy Stinkweed			Y
Rubiaceae	*Pomax umbellata*	Pomax			Y
Rubiaceae	*Richardia humistrata*				N
Rutaceae	*Melicope micrococca*	Hairy-leaved Doughwood			Y
Rutaceae	*Zieria smithii subsp. smithii*				Y
Sambucaceae	*Sambucus australasica*	Native Elderberry			Y
Santalaceae	*Exocarpos cupressiformis*	Native Cherry			Y
Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush			Y
Sapindaceae	*Guioa semiglauca*				Y
Scrophulariaceae	*Veronica persica*	Creeping Speedwell			N
Smilacaceae	*Smilax australis*	Sarsaparilla			Y
Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla			Y
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush			N
Solanaceae	*Solanum nigrum*	Black-berry Nightshade			N
Solanaceae	*Solanum prinophyllum*	Forest Nightshade			Y
Sterculiaceae	*Brachychiton acerifolius*	Illawarra Flame Tree			Y
Sterculiaceae	*Brachychiton populneus subsp. populneus*				Y
Thymelaeaceae	*Pimelea linifolia*	Slender Rice-flower			Y
Typhaceae	*Typha orientalis*	Broad-leaved Cumbungi			Y
Ulmaceae	*Trema tomentosa var. viridis*	Native Peach			Y
Verbenaceae	*Clerodendrum tomentosum*				Y
Verbenaceae	*Lantana camara*	Lantana			N
Verbenaceae	*Verbena officinalis*	Common Verbena			N
Violaceae	*Viola hederacea*	Ivy-leaved Violet			Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native[3]
Vitaceae	*Cissus antarctica*	Water Vine			Y
Vitaceae	*Cissus hypoglauca*	Giant Water Vine			Y
Vitaceae	*Cissus opaca*	Small-leaved Water Vine			Y
Xanthorrhoeaceae	*Xanthorrhoea latifolia*				Y
Xanthorrhoeaceae	*Xanthorrhoea minor*				Y
Xanthorrhoeaceae	*Xanthorrhoea resinosa*	Spear Grass-tree			Y
Zamiaceae	*Macrozamia communis*				Y
Zamiaceae	*Macrozamia flexuosa*				Y

Notes:
(1) V = Vulnerable, E = Endangered as listed under the EPBC Act
(2) V = Vulnerable, E1 = Endangered as listed under the TSC Act
(3) Y = native, N = exotic

Appendix B

Fauna species recorded

Table B.1 – Animal Species Recorded within the Study Area

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Record Type[3]
Amphibians					
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog			O
Myobatrachidae	*Uperoleia laevigata*	Smooth Toadlet			O
Reptiles					
Scincidae	*Lampropholis delicata*	Grass Skink			O
Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake			O
Birds					
Accipitridae	*Accipiter fasciatus*	Brown Goshawk			O
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra			O
Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher			O
Anatidae	*Anas castanea*	Chestnut Teal			O
Anatidae	*Anas superciliosa*	Pacific Black Duck			O
Anatidae	*Chenonetta jubata*	Australian Wood Duck			O
Ardeidae	*Ardea ibis*	Cattle Egret	M		O
Ardeidae	*Egretta novaehollandiae*	White-faced Heron			O
Artamidae	*Cracticus torquatus*	Grey Butcherbird			O
Artamidae	*Gymnorhina tibicen*	Australian Magpie			O
Artamidae	*Strepera graculina*	Pied Currawong			O
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo			O
Cacatuidae	*Cacatua roseicapilla*	Galah			O
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			O
Campephagidae	*Coracina tenuirostris*	Cicadabird			O
Charadriidae	*Vanellus miles*	Masked Lapwing			O
Cinclosomatidae	*Psophodes olivaceus*	Eastern Whipbird			O
Climacteridae	*Cormobates leucophaeus*	White-throated Treecreeper			O
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove			O
Columbidae	*Ocyphaps lophotes*	Crested Pigeon			O
Columbidae	*Streptopelia chinensis*	Spotted Turtle-Dove		U	O
Coraciidae	*Eurystomus orientalis*	Dollarbird			O
Corvidae	*Corvus coronoides*	Australian Raven			O
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo			O

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Record Type[3]
Cuculidae	*Eudynamys scolopacea*	Common Koel			O
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo			O
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird			O
Dicruridae	*Dicrurus bracteatus*	Spangled Drongo			O
Dicruridae	*Grallina cyanoleuca*	Magpie-lark			O
Dicruridae	*Monarcha melanopsis*	Black-faced Monarch	M		O
Dicruridae	*Myiagra rubecula*	Leaden Flycatcher			O
Dicruridae	*Rhipidura fuliginosa*	Grey Fantail			O
Dicruridae	*Rhipidura leucophrys*	Willie Wagtail			O
Dicruridae	*Rhipidura rufifrons*	Rufous Fantail	M		O
Hirundinidae	*Hirundo neoxena*	Welcome Swallow			O
Maluridae	*Malurus cyaneus*	Superb Fairy-wren			O
Maluridae	*Malurus lamberti*	Variegated Fairy-wren			O
Meliphagidae	*Anthochaera carunculata*	Red Wattlebird			O
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater			O
Meliphagidae	*Manorina melanocephala*	Noisy Miner			O
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater			O
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater			O
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird			O
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole			O
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler			O
Pardalotidae	*Acanthiza nana*	Yellow Thornbill			O
Pardalotidae	*Acanthiza pusilla*	Brown Thornbill			O
Pardalotidae	*Gerygone mouki*	Brown Gerygone			O
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote			O
Pardalotidae	*Sericornis frontalis*	White-browed Scrubwren			O
Pardalotidae	*Sericornis magnirostris*	Large-billed Scrubwren			O
Passeridae	*Neochmia temporalis*	Red-browed Finch			O
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin			O
Podargidae	*Podargus strigoides*	Tawny Frogmouth			O
Psittacidae	*Alisterus scapularis*	Australian King-Parrot			O
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet		V	O

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Record Type[3]
Psittacidae	*Platycercus elegans*	Crimson Rosella			O
Psittacidae	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet			O
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet			O
Ptilonorhynchidae	*Ptilonorhynchus violaceus*	Satin Bowerbird			O
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen			O
Strigidae	*Ninox novaeseelandiae*	Southern Boobook			O
Strigidae	*Ninox strenua*	Powerful Owl		V	O
Mammals					
Macropodidae	*Wallabia bicolor*	Swamp Wallaby			O
Molossidae	*Austronomus australis*	White-striped Freetail Bat			A
Molossidae	*Mormopterus ridei*	Eastern Freetail Bat			A
Miniopteridae	*Miniopterus australis*	Little Bentwing Bat		V	A
Petauridae	*Petaurus norfolcensis*	Squirrel Glider		V	T
Petauridae	*Pseudocheirus peregrinus*	Common Ringtail Possum			O
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum			O
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	O
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattle Bat			A
Vespertilionidae	*Chalinolobus morio*	Chocolate Wattle Bat			A
Vespertilionidae	*Scotorepens orion*	Eastern Broad-nosed Bat			A
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat			H, A

Notes:
(1) V = Vulnerable, M = Migratory as listed under the EPBC Act
(2) V = Vulnerable, E1 = Endangered as listed under the TSC Act
(3) O = Observed, T = Trapped (Arboreal Elliott B Trap), A = Anabat detection, H = Harp Trap

Appendix C

Threatened species of plant

Table C.1 – Threatened species of plant known or predicted to occur within the Study Area

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Asclepiadaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E1	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997; NSW National Parks and Wildlife Service 2002).	EPBC Search	Low. No suitable habitat was recorded within the study area.
Asteraceae	*Rutidosis heterogama*	Heath Wrinklewort	V	V	Occurs in coastal districts from Maclean to the Hunter Valley and inland to the Torrington region. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (Department of Environment and Conservation 2005; Royal Botanic Gardens 2005).	EPBC Search, PlantNet	Moderate. Potential habitat was recorded in the study area.
Casuarinaceae	*Allocasuarina defungens*	Dwarf Heath Casuarina	E	E1	Only occurs in NSW, from the Nabiac area (north-west of Forster) to Byron Bay on the NSW north coast. It grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. It also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains (Department of Environment and Conservation 2005).	EPBC Search	Low. No suitable habitat was recorded within the study area.
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V	V	Occurs in coastal districts from Bulahdelah to Port Macquarie where it grows in dry sclerophyll forest and occasionally swampy heath in sandy, (Harden 1992) low nutrient soils with a dense understorey of grasses. Specifically it is known to occur within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland (Payne *et al.* 2002).	Atlas of NSW, EPBC Search, PlantNet	Recorded. A large population of this species was recorded within the study area.
Juncaginaceae	*Maundia triglochinoides*	-		V	Occurs north from Sydney. Grows in swamps, creeks or shallow freshwater 30 to 60 cm deep on heavy clay, low nutrients. Associated with wetland species such as *Triglochin procerum* (Harden 1993).	PlantNet	Low. No suitable habitat was recorded within the study area.

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Malvaceae	*Commersonia prostrata* (Syn. *Rulingia prostrata*)	Dwarf Kerrawang	E	E1	Occurs south of Picton lakes where it mainly grows in gullies along the escarpment, south from Picton Lakes (Harden 2000), on the Southern Tablelands (one plant at Penrose State Forest, one plant at Rowes Lagoon and one plant at Tallong) and on the North Coast (less than 100 plants at the Tomago sandbeds north of Newcastle). It occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum (*Eucalyptus pauciflora*) Woodland at Rose Lagoon; Blue leaved Stringybark (*E. agglomerata*) Open Forest at Tallong; and in Brittle Gum (*E. mannifera*) Low Open Woodland at Penrose; Scribbly Gum (*Eucalyptus haemastoma*) Swamp Mahogany (*E. robusta*) Ecotonal Forest at Tomago. Associated native species may include *Imperata cylindrica*, *Empodisma minus* and *Leptospermum continentale* (Department of Environment and Climate Change 2007).	PlantNet EPBC Search	Low. No suitable habitat was recorded within the study area.
Moraceae	*Streblus pendulinus*	Whalebone Tree	E		On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well developed rainforest, gallery forest and drier, more seasonal rainforest (Australian Tropical Rainforest Plants 2010). On Norfolk Island, the species is found in a variety of forest types, though it is rare (Director of National Parks (DNP) 2004)	EPBC Search	Recorded. However this species is threatened in Norfolk Island only.
Myrtaceae	*Angophora inopina*	Charmhaven Apple	V	V	Restricted to the Charmhaven - Wyee area where it grows in open dry sclerophyll woodland of *Eucalyptus haemastoma* and *Corymbia gummifera* with a dense shrub understorey. Occurs on deep white sandy soils over sandstone, often with some gravelly laterite (Harden 2002; NSW Scientific Committee 1998a).	EPBC Search, PlantNet	Low. No suitable habitat was recorded within the study area.
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush		V	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies (Fairley, A. & Moore 2002; Harden 2002; Robinson 1994). Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (NSW Scientific Committee 1999).	Atlas of NSW, PlantNet	Moderate. Potential habitat was recorded in the study area.

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Myrtaceae	*Eucalyptus camfieldii*	Heart-leaved Stringybark	V	V	Camfield's Stringybark is known from Norah Head, on the NSW Central Coast, to Waterfall and the Royal National Park, south of Sydney (Fairley, Alan 2004). Within this area it occurs in scattered locations including Peats Ridge, Mt Colah, West Head, Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites within the Royal National Park (Fairley, Alan 2004). Camfield's Stringybark occurs in shallow sandy soils overlying Hawkesbury sandstone within coastal heath, generally on exposed sandy ridges. It occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodlands of the slightly more fertile inland areas (Department of the Environment Water Heritage and the Arts 2008). Associated species frequently include Brown Stringybark (*E. capitellata*), Scribbly Gum (*E. haemastoma*), Narrow-leaved Stringybark (*E. oblonga*), Silvertop Ash (*E. sieberi*), Smooth-barked Apple (*Angophora costata*), Dwarf Apple (*A. hispida*), Red Bloodwood (*Corymbia gummifera*), Scrub She-oak (*Allocasuarina distyla*), Slender Tea Tree (*Leptospermum trinervium*), and Fern-leaved Banksia (*Banksia oblongifolia*) (Benson & McDougall 1998; Leigh *et al.* 1984).	EPBC Search, PlantNet	Low. No suitable habitat was recorded within the study area.
Myrtaceae	*Eucalyptus parramattensis subsp. decadens*		V	V	Locally frequent, grows in dry sclerophyll woodland on sandy soils in low, often wet sites (Harden 2002).	EPBC Search, PlantNet	Low. No suitable habitat was recorded within the study area.
Myrtaceae	*Melaleuca biconvexa*	Biconvex Paperbark	V	V	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area (NSW Scientific Committee 1998c). Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects (Department of Environment and Climate Change 2008; Harden 2002).	Atlas of NSW, EPBC Search, PlantNet	Low. No suitable habitat was recorded within the study area.

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	E1	Occurs between Bulahdelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden 2002). On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (Department of Environment and Climate Change 2008).	Atlas of NSW, EPBC Search, PlantNet	Recorded. This species was recorded within the study area but occurred outside of the project area.
Orchidaceae	*Caladenia porphyrea*	-	-	E1	Caladenia porphyrea has a highly restricted geographic distribution. It has been recorded from 2 localities in the Wyong local government area c. 2 km apart {NSW Department of Environment and Conservation, 2006 #1161}.	Atlas of NSW	Low. No suitable habitat was recorded within the study area
Orchidaceae	*Caladenia tessellata*	Thick Lip Spider Orchid	V	E1	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a heathy or sometimes grassy understorey (Bishop 2000). Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas (NSW Scientific Committee 2002).	PlantNet	Moderate. Potential habitat was recorded in the study area.
Orchidaceae	*Corybas dowlingii*	Red Helmet Orchid	-	E1	Corybas dowlingii is a tuberous orchid, forming clonal colonies. It commonly occurs in gullies of tall open forest, typically between 10 and 200m elevation and on well-drained gravelly soil (Jones 2004; Department of Environment and Climate Change).	Atlas of NSW	Moderate. Potential habitat was recorded in the study area.
Orchidaceae	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Harden 1993; NSW National Parks and Wildlife Service 1999).	EPBC Search	Moderate. Potential habitat was recorded in the study area.

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Orchidaceae	*Diuris praecox*	Rough Double Tail	V	V	Occurs in coastal and near-coastal districts from Ourimbah to Nelson Bay where it grows in sclerophyll forest (Harden 1993) often on hilltops or slopes (Bishop 2000).	Atlas of NSW, EPBC Search, PlantNet	Moderate. Potential habitat was recorded in the study area.
Orchidaceae	*Genoplesium insignis (Syn Corunastylis insignis)*	Wyong Midge Orchid	CE	E1	This terrestrial orchid occurs between Chain Valley Bay and Wyong in Wyong local government area. It grows in heathland and forest and is associated with Themeda australis amongst shrubs and sedges. Typically it occurs in dry sclerophyll woodland dominated by Eucalyptus haemastoma, Corymbia gummifera, Angophora costata and Allocasuarina littoralis {Department of Environment and Climate Change, 2009 #2829}.	EPBC Search	Low. No suitable habitat was recorded within the study area.
Orchidaceae	*Phaius australis*	Southern Swamp Orchid	E	E1	Previously occurred as far south as Port Macquarie but is now thought to only occur north of Coffs Harbour. Grows in coastal areas in swampy grassland or forest including rainforest, eucalypt o paperbark forest. Flowers Sept-Oct (Harden 1993; NPWS 2002).	EPBC Search	Low. No suitable habitat was recorded within the study area.
Orchidaceae	*Pterostylis gibbosa*		E	E1	Occurs in the southern part of the Central Coast region with a disjunct population in the Hunter Valley. Grows among grass in sclerophyll forest (Harden 2002). In the Illawarra it grows in Coastal Grassy Red Gum Forest and in Lowland Woolybutt-Melaleuca forest (NSW National Parks and Wildlife Service 2003).	EPBC Search	Low. No suitable habitat was recorded within the study area.
Orchidaceae	*Thelymitra sp. adorata*	Wyong Sun Orchid	CE	CE	A ground orchid up to 60 cm tall with a single leaf. Occurs from 10-40 m elevation. in grassy woodland or occasionally derived grassland in well-drained clay loam or shale derived soils. Generally occurs in Spotted Gum - Ironbark Forest with a diverse grassy understorey and occasional scattered shrubs. Currently known from a few localised occurrences in the area bounded by the towns of Wyong, Warnervale and Wyongah on the New South Wales Central Coast, within the Wyong Local Government Area.	EPBC Search	Low. No suitable habitat was recorded within the study area.

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Polygonaceae	*Muehlenbeckia costata*	Scrambling Lignum		V	This climber has sporadic distribution on North Coast and Northern and Central Tablelands, with one record near Newcastle in a SRA. Inhabits rocky sites at higher altitude, specifically coarse sands and peat in heath, mallee or open eucalypt woodland that exist on granite or acid volcanic outcrops. Responds to disturbance especially fire and clearing for power lines ((Royal Botanic Gardens 2008).	Atlas of NSW	Low. No suitable habitat was recorded within the study area.
Proteaceae	*Grevillea parviflora subsp. parviflora*	Small-flower Grevillea	V	V	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales (Harden 2002; NSW Scientific Committee 1998b).	Atlas of NSW, EPBC Search, PlantNet	Recorded. Two small populations of this species was recorded within the study area.
Proteaceae	*Grevillea shiressii*		V	V	*Grevillea shiressii* is a tall shrub Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils. The species is a fire sensitive obligate seeder that is highly susceptible to local extinction due to frequent fire. Known only from two populations near Gosford, on tributaries of the lower Hawkesbury River north of Sydney (Mooney Mooney Creek and Mullet Creek). Both populations occur within the Gosford Local Government Area (Department of Environment and Climate Change 2007).	Atlas of NSW, PlantNet	Low. No suitable habitat was recorded within the study area.
Rutaceae	*Asterolasia elegans*		E	E1	Only known to occur in one locality, north of Maroota, where it grows in wet sclerophyll forest on moist hillsides (Harden 2002).	EPBC Search	Low. No suitable habitat was recorded within the study area.

Family Name	Species Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Data Source[3]	Likelihood of Occurence[4]
Scrophulariaceae	*Euphrasia arguta*		CE	V	Rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008, it had not been collected for 100 years. Historically, it was recorded from relatively few places within an area extending from Sydney to Bathurst and north to Walcha. Ecological information from historical records is scarce including, 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', 'in meadows near rivers'. The populations that are currently known are located in the Nundle State Forest and on nearby private land, in eucalypt forest with a mixed grass and shrub understorey (NSW Scientific Committee 2011).	PlantNet	Low. No suitable habitat was recorded within the study area.
Zannichelliaceae	*Zannichellia palustris*	-	-	E1	Grows in fresh or slightly saline stationary or slowly flowing water (Royal Botanic Gardens 2005).	Atlas of NSW, PlantNet	Low. No suitable habitat was recorded within the study area.

Notes:

(1) Listed as Extinct (X), Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the EPBC Act.

(2) Listed as an Endangered Population (E2), Vulnerable (V), Endangered (E1), Critically Endangered (CE) or Extinct (E4) under the TSC Act.

(3) EPBC = EPBC Act Protected Matters Search Tool Report
Atlas of NSW Wildlife = Office of Environment and Heritage Bionet Atlas – 10 km buffer of study area
PlantNet = The Royal Botanic Gardens PlantNet database – 25 km buffer of study area

(4) Refer to Section 2.4 of the main report.

Appendix C References

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Appendix D

Threatened species of fauna

Table D.1 – Threatened species of fauna known or predicted to occur within the Study Area

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Fish						
Epinephelus daemelii	Black Cod		V	Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries. Black cod are opportunistic carnivores, eating mainly other fish and crustaceans. They can change from one colour pattern to another in just a few seconds. They are usually black in estuaries and banded around clear water reefs. Black cod are apparently slow growing. Smaller fish are mostly females, but they generally change sex to become males at around 100–110 cm in length. (Department of Primary Industries 2005).	DPI Fisheries, EPBC search	Low No preferred habitat was recorded within the study area.
Amphibians						
Litoria aurea	Green and Golden Bell Frog	V	E1	This species occurs in fragment patches near coastal locations from Lakes Entrance (Vic) to south of the NSW-Qld border. For breeding it utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral locations. Habitat attributes include water bodies that are shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes which include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover used for foraging and shelter. Over-wintering shelter sites may be adjacent to or some distance away from breeding sites but the full range of possible habitat used is not yet well understood (Department of Environment and Conservation 2004, 2005).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee 2000).	EPBC search	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Reptiles						
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb, J.K. & Shine 1994; Webb, J.K & Shine 1998).	EPBC search	Low No preferred habitat was recorded within the study area.
Birds						
Actitis hypoleucos	Common Sandpiper	M		The Common Sandpiper frequents a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity. It is mostly encountered along muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags (Geering *et al.* 2007; Higgins, P.J. & Davies 1996). Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks (Higgins, P.J. & Davies 1996).	EPBC search	Low No preferred habitat was recorded within the study area.
Anas querquedula	Garganey	M		Shows a preference for freshwater wetlands, ponds and sewerage treatment settling ponds. Usually found in shallow water with high biological activity, but avoids wetlands with dense or broken vegetation cover. Likely annual visitor to north Australian wetlands and vagrant in the south (Marchant & Higgins). A rare annual visitor to Australia seen singly or in pairs usually in the company of other ducks.	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Anseranas semipalmata	Magpie Goose		V	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry season this species migrates hundreds of kilometres to perennial swamps (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	EM	CE	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with Casuarina cunninghamiana and Amyema cambagei are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include Eucalyptus sideroxylon (Mugga Ironbark), E. albens (White Box), E. melliodora (Yellow Box) and E. leucoxylon (Yellow Gum) (Garnett & Crowley 2000).	Atlas of NSW, EPBC search	Moderate Potential habitat was recorded in the study area.
Apus pacificus	Fork-tailed Swift	M		Breeds in the northern hemisphere, wintering south to Australia. It is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. It mostly occurs over inland plains but sometimes above foothills or in coastal areas over cliffs, beaches, islands and well out to sea. It also occurs over towns and cities. It mostly occurs over dry and/or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh, grassland, spinifex sandplains, farmland and sand-dunes. It sometimes occurs above forests. It probably roosts aerially, but has occasionally been observed to land (Higgins, P.J. 1999).	Atlas of NSW, EPBC search	Moderate Potential habitat was recorded in the study area.
Ardea ibis	Cattle Egret	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands and very rarely in arid and semi-arid regions. High numbers may occur in moist, poorly drained pastures with high grass; it avoids low grass pastures but has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora (Marchant & Higgins 1990; Morton *et al.* 1989).	Atlas of NSW, EPBC search	Recorded
Botaurus poiciloptilus	Australasian Bittern	E	E1	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Calidris acuminata	Sharp-tailed Sandpiper	M		Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields (Pizzey & Knight 2007).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.
Calidris canutus	Red Knot	M		In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps (Higgins, P.J. & Davies 1996).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.
Calidris ferruginea	Curlew Sandpiper	M	E1	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes (Morcombe 2003).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Calidris melanotos	Pectoral Sandpiper	M		In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species frequents coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. It is usually found in coastal or near coastal habitat but occasionally further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. It has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands (Higgins, P.J. & Davies 1996).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Calidris ruficollis	Red-necked Stint	M		Mostly found in coastal areas, including sheltered inlets, bays lagoons and estuaries. They also occur in shallow wetlands near the coast or inland, including lakes, waterholes and dams (Higgins, P.J. & Davies 1996). They forage in mudflats, shallow water, sandy open beaches, flooded paddocks and in samphire feeding along the edges. The species roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle. Occasionally they roost on exposed reefs or shoals (Higgins, P.J. & Davies 1996) and amongst seaweed, mud and cow-pats (Hobbs 1961). During high tides they may also use sand dunes and claypans.	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Callocephalon fimbriatum	Gang-gang Cockatoo		V	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey & Knight 2007).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.
Calyptorhynchus lathami	Glossy Black-Cockatoo		V	Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 1999b).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.
Charadrius leschenaultii	Greater Sand Plover	M	V	Entirely coastal in NSW foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores. A migratory species it is found in New South Wales generally during the summer months (Pizzey & Knight 2007).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Charadrius mongolus	Lesser Sand Plover	M	V	Migratory bird that migrates from the northern hemisphere to coastal areas of northern and east coast of Australia (Garnett & Crowley 2000). The species is almost strictly coastal during the non-breeding season, preferring sandy beaches, mudflats of coastal bays and estuaries, sand-flats and dunes near the coast, occasionally frequenting mangrove mudflats (IUCN Redlist entry).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Circus assimilis	Spotted Harrier		V	The Spotted Harrier occurs throughout the Australian mainland in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) (Marchant & Higgins 1993). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The diet of the Spotted Harrier includes terrestrial mammals, birds and reptiles, occasionally large insects and rarely carrion (Department of Environment Climate Change and Water 2010).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Daphoenositta chrysoptera	Varied Sittella		V	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (Department of Environment Climate Change and Water 2010).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.
Dasyornis brachypterus	Eastern Bristlebird	E	E1	The habitat of the Eastern Bristlebird is characterised by low dense vegetation. Fire is a feature of all areas where known populations occur. Given the poor flight ability of the species it is though that few individuals survive the passage of fire, survival is dependent on the availability of fire refuges and recolonisation may be relatively slow. The bird is cryptic and camouflaged and rarely seen but may be detected by its distinctive, loud calls. Confined to NSW/Queensland border region, Illawarra region and NSW/Victorian border region (NSW National Parks and Wildlife Service 1997).	EPBC search	Low No preferred habitat was recorded within the study area.
Diomedea exulans	Wandering Albatross	VM	E1	Southern circumpolar distribution, breeding in Australian territory on Macquarie and Heard Islands (Garnett & Crowley 2000). Also breeds in subantarctic islands in the southern Atlantic and Indian oceans (Garnett & Crowley 2000). A pelagic species visiting mainland Australian waters seasonally occasionally occurring within sight of the coast.	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Ephippiorhynchus asiaticus	Black-necked Stork		E1	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Epthianura albifrons	White-fronted Chat		E2	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level (North 1904; Higgins et al. 2001; Barrett et al. 2003). In New South Wales the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins et al. 2001). Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas. (North 1904; Higgins et al. 2001; Barrett et al. 2003). The population in the Sydney Metropolitan Catchment Management Authority region is listed as Endangered (Office of Environment and Heritage 2012).	Atlas of NSW, Atlas of NSW	Low No preferred habitat was recorded within the study area.
Gallinago hardwickii	Latham's Snipe	M		Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Glossopsitta pusilla	Little Lorikeet		V	The Little Lorikeet is a small green lorikeet with black bill and red patch on forehead and throat. The underside is yellow-green. Immatures are duller with less red on face and brown bill. Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins, P.J. 1999).	Atlas of NSW	Recorded
Haliaeetus leucogaster	White-bellied Sea-Eagle	M		Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	Atlas of NSW, EPBC search	Moderate Potential habitat was recorded in the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Hieraaetus morphnoides	Little Eagle		V	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Prey includes birds, reptiles and mammals, with the occasional large insect and carrion. Most of its former native mammalian prey species in inland NSW are extinct and rabbits now form a major part of the diet (Marchant & Higgins 1993).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.
Hirundapus caudacutus	White-throated Needletail	M		Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 2007).	Atlas of NSW, EPBC search	Moderate Potential habitat was recorded in the study area.
Hirundo rustica	Barn Swallow	M		Usually found in airspace over open grassland and wetland habitats such as ponds, freshwater wetlands swimming pools, coastal lagoons and tidal pools. This species is a regular visitor to northern Australia in Qld, NT and WA. This species has been occasional records in NSW at Newcastle, Mullumbimby and Nowra (Higgins, P.J. *et al.* 2006).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Hydroprogne caspia (syn. Sternia caspia)	Caspian Tern	M		The Caspian Tern is found in sheltered coastal embayments preferring sandy or muddy margins. Also found in near-coastal or inland terrestrial wetlands. It forages in open wetlands, preferring sheltered shallow water near the margins. It usually breeds in low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks and occasionally among beachcast debris above the high-water mark or at artificial sites, including islands in reservoirs, or on dredge-spoil. Generally roosting occurs on bare exposed sand or shell spits, banks or shores. (Higgins, P.J. & Davies 1996).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Irediparra gallinacea	Comb-crested Jacana		V	Occurs in floating vegetation of permanent well-vegetated wetlands and dams. Walks on floating plants. Occasionally feeds along muddy wetland margins on east coast of NSW (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Ixobrychus flavicollis	Black Bittern		V	Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Lathamus discolor	Swift Parrot	E	E1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering Acacia pycnantha, is indicated. Sites used vary from year to year. (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).	Atlas of NSW, EPBC search	Moderate Potential habitat was recorded in the study area.
Limicola falcinellus	Broad-billed Sandpiper	M	V	A migratory species that breeds in the northern hemisphere between June and August. Individuals feed both on exposed mudflats and while wading in water (NSW National Parks and Wildlife Service 1999a).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Limosa lapponica	Bar-tailed Godwit	M	V	Occurs in coastal mudflats, sandbars, shores of estuaries, salt marsh and sewage ponds (Morcombe 2003).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Limosa limosa	Black-tailed Godwit	M	V	A coastal species found on tidal mudflats, swamps, shallow river margins and sewage farms. Also found inland on larger shallow fresh or brackish waters. A migratory species visiting Australia between September and May (Pizzey & Knight 2007).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Macronectes giganteus	Southern Giant-Petrel	EM	E1	A partly nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Merops ornatus	Rainbow Bee-eater	M		Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins, P.J. 1999).	EPBC search	Moderate Potential habitat was recorded in the study area.
Monarcha melanopsis	Black-faced Monarch	M		Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 2007).	EPBC search	Recorded
Monarcha trivirgatus	Spectacled Monarch	M		Occurs in the understorey of mountain/lowland rainforests, thickly wooded gullies and waterside vegetation. Migrates to NE NSW in summer to breed (Pizzey & Knight 2007).	EPBC search	Low No preferred habitat was recorded within the study area.
Motacilla flava	Yellow Wagtail	M		This species occurs in a range of habitats including estuarine habitats such as sand dunes, mangrove forests and coastal saltmarshes. This species also occurs in open grassy areas including disturbed sites such as sports grounds and has been recorded on the edges of wetlands, swamps, lakes and farm dams. This species migrates from Asia to Australia in spring-summer. It has been recorded in the estuarine areas of the Hunter River in Newcastle NSW and in Qld and the north of NT and WA (Higgins, P.J. *et al.* 2006).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Myiagra cyanoleuca	Satin Flycatcher	M		Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 2007).	EPBC search	Moderate Potential habitat was recorded in the study area.
Neophema pulchella	Turquoise Parrot		V	The Turquoise Parrot inhabits eucalypt and cypress-pine open forests and woodlands (commonly box or box-ironbark) with native grasses, sometimes with a low shrubby understorey, often in undulating or rugged country, or on footslopes. It also lives in open woodland or riparian gum woodland, and often near ecotones between woodland and grassland, or coastal forest and heath. The Turquoise Parrot requires live or dead trees, stumps and logs for nesting, trees and shrubs for shelter, and seeding grasses and forbs (often beneath trees) for food. The Turquoise Parrot's nest is a cavity in a live or dead tree, stump or log, or even fence post often within 1-2 m of the ground. Hollows average about 0.5 m deep, with an entrance hole of 10 x 7 cm, and a nest chamber 12 x 9 cm in diameter (Garnett & Crowley 2000; Higgins, P.J. 1999).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Ninox connivens	Barking Owl		V	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Ninox strenua	Powerful Owl		V	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, Casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett & Crowley 2000).	Atlas of NSW	Recorded

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Numenius madagascariensis	Eastern Curlew	M		Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and other invertebrates. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia (Pizzey & Knight 2007).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.
Numenius minutus	Little Curlew	M		On passage the species shows a preference for foraging and resting in swampy meadows near lakes and along river valleys. It overwinters on dry inland grassland, bare cultivation, dry mudflats and coastal plains of black soil with scattered shallow pools of freshwater, swamps, lakes or flooded ground. It shows a preference for short grass swards of less than 20 cm tall, and occasionally occurs in dry saltmarshes, coastal swamps, mudflats or sandflats in estuaries, or on the beaches of sheltered coasts (BirdLife International 2009).	EPBC search	Low No preferred habitat was recorded within the study area.
Numenius phaeopus	Whimbrel	M		Migrates to Taiwan, Philippines, PNG, and a race breeding in NE Siberia is found on the north and south-eastern coastlines of Australia. Juveniles arrive to Australia from spring to early summer. Usually only juveniles remain in Australia but very occasionally adults in breeding plumage may be seen in Australian winters (Pizzey & Knight 2007).	EPBC search	Low No preferred habitat was recorded within the study area.
Oxyura australis	Blue-billed Duck		V	Relatively sparse throughout species range. Regularly found breeding in south-east Queensland, north-east South Australia and throughout New South Wales. Found on temperate, fresh to saline, terrestrial wetlands, and occupies artificial wetlands. Prefers deep permanent open water, within or near dense vegetation. Nest in rushes, sedge, Lignum Muehlenbeckia cunninghamii and paperbark Melaleuca (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Pandion cristatus (syn. P. haliaetus)	Eastern Osprey	M	V	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish (Pizzey & Knight 2007).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Petroica boodang	Scarlet Robin		V	In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes. Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. It prefers an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris (Department of Environment Climate Change and Water 2010; Higgins, P.J. & Peter 2002). The species has been found to be absent from remnants surrounded by cereal cropping, less common in isolated patches of 30 ha or less (where there was no tree cover within 200 m and less than 20% cover within 1 km), less common in sites surrounded by cattle grazing and more common in sites with native versus exotic grasses if ungrazed for more than 10 years (Barrett *et al.* 2003).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Plegadis falcinellus	Glossy Ibis	M		It feeds in very shallow water and nests in freshwater or brackish wetlands with tall dense stands of emergent vegetation (e.g. reeds or rushes) and low trees or bushes. It shows a preference for marshes at the edges of lakes and rivers, as well as lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and irrigated cultivation. It less often occurs in coastal locations such as estuaries, deltas, saltmarshes and coastal lagoons. Roosting sites are often large trees that may be far from water. The nest is a platform of twigs and vegetation usually positioned less than 1 m above water in tall dense stands of emergent vegetation (e.g. reeds or rushes), low trees or bushes over water (BirdLife International 2009).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Pluvialis fulva	Pacific Golden Plover	M		Prefers sandy, muddy or rocky shores, estuaries and lagoons, reefs, saltmarsh, and or short grass in paddocks and crops. The species is usually coastal, including offshore islands; rarely far inland. Often observed on beaches and mudflats, sandflats and occasionally rock shelves, or where these substrates intermingle; harbours, estuaries and lagoons (Marchant & Higgins 1993).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Pluvialis squatarola	Grey Plover	M		In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes (Marchant & Higgins 1993). They usually forage on large areas of exposed mudflats and beaches and occasionally in pasture and on muddy margins of inland wetlands (Marchant & Higgins 1993). They usually roost in sandy areas, such as on unvegetated sandbanks or sand-spits on sheltered beaches or other sheltered environments (Jaensch *et al.* 1988; Pegler 1983).	EPBC search	Low No preferred habitat was recorded within the study area.
Pterodroma solandri	Providence Petrel	M	V	A marine species that breeds at Norfolk island and breeds within earth burrows often within rainforest. Occurs across the western Tasman Sea and the entire north Pacific Ocean (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Ptilinopus magnificus	Wompoo Fruit-Dove		V	Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Ptilinopus regina	Rose-crowned Fruit-Dove		V	Occurs in subtropical and dry rainforests and occasionally in moist eucalypt forests and swamp forests where fruit is plentiful. They are thought to move locally as they follow the ripening fruit (NSW National Parks and Wildlife Service 2002).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Ptilinopus superbus	Superb Fruit-Dove		V	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lily pillies and blackberries (Pizzey & Knight 2007).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Puffinus pacificus	Wedge-tailed Shearwater	M		Returns from the North Pacific to their burrows on islands off the coast of NSW. Marine nomadic species that visits land to breed. Known breeding colony at Muttonbird island near Coffs Harbour and islands off Port Stephens in NSW (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Rhipidura rufifrons	Rufous Fantail	M		Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 2007).	EPBC search	Recorded
Rostratula australis (syn. R. benghalensis)	Australian Painted Snipe (Painted Snipe)	VM	E1	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as Eucalyptus camaldulensis (River Red Gum), E. populnea (Poplar Box) or shrubs such as Muehlenbeckia florulenta (Lignum) or Sarcocornia quinqueflora (Samphire). Feeds at the water's edge and on mudlflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	EPBC search	Low No preferred habitat was recorded within the study area.
Sterna albifrons	Little Tern	M	E1	Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets. They nest on sand-spits, sandbanks, ridges or islets in these habitats or gently sloping sandy ocean beaches and occasionally in sand-dunes (Garnett & Crowley 2000).	EPBC search	Low No preferred habitat was recorded within the study area.
Sterna hirundo	Common Tern	M		A non-breeding migrant to Australia, occurring mainly on the east coast and inhabiting marine, pelagic and coastal habitats. Mostly oceanic but often recorded in bays, harbours and estuaries and occasionally in coastal wetlands. Roosting occurs on unvegetated intertidal sandy ocean beaches, shores of estuaries, lagoons and sand bars (Higgins, P.J. & Davies 1996).	Atlas of NSW	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Sternula nereis nereis	Fairy Tern (Australian)	V		Fairy Terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake islands, wetlands, beaches and spits. The subspecies may migrate within southern Western Australia and Tasmania, where they are seen less frequently during the winter months. They are more sedentary in the north of Western Australia, and in South Australia and Victoria (Hill 1988). Fairy Terns nest in small colonies on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches (Higgins, P.J. & Davies 1996; Hill 1988). They nest above the high water mark often in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse. Colonies tend to occupy areas rather than specific sites, and nest sites are often abandoned after one year, even if they have been successful (Saunders 1985).	EPBC search	Low No preferred habitat was recorded within the study area.
Stictonetta naevosa	Freckled Duck		V	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (Muehlenbeckia cunninghamii) within which they build their nests (Garnett & Crowley 2000).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Tringa brevipes (syn. Heteroscelus brevipes)	Grey-tailed Tattler	M		It is often found on sheltered coasts with reefs, rock platforms or with intertidal mudflats. It is also found at intertidal rocky, coral or stony reefs, platforms and islets that are exposed at low tide. It has also been found in embayments, estuaries and coastal lagoons, especially fringed with mangroves. It is rarely seen on open beaches and occasionally found around near-coastal wetlands, such as lagoons, lakes and ponds in sewage farms and saltworks. Inland records for the species are rare (Higgins, P.J. & Davies 1996). The species forages in shallow water, hard intertidal substrates, rock pools, intertidal mudflats, mangroves, banks of seaweed and among rocks and coral rubble, over which water may surge. The species roosts in mangroves, dense stands of shrubs, snags, rocks, beaches, reefs, artificial structures (sea walls, oyster racks), occasionally in near-coastal saltworks and sewage ponds and rarely on sandy beaches or sand banks (Higgins, P.J. & Davies 1996; Rogers 1999).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Tringa nebularia	Common Greenshank	M		Occurs in a range of inland and coastal environments. Inland, it occurs in both permanent and temporary wetlands, billabongs, swamps, lakes floodplains, sewage farms, saltworks ponds, flooded irrigated crops. On the coast, it occurs in sheltered estuaries and bays with extensive mudflats, mangrove swamps, muddy shallows of harbours and lagoons, occasionally rocky tidal ledges. It generally prefers wet and flooded mud and clay rather than sand (Morcombe 2003).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Tringa stagnatilis	Marsh Sandpiper			Occurs in coastal and inland wetlands (salt or fresh water), estuarine and mangrove mudflats, beaches, shallow or swamps, lakes, billabongs, temporary floodwaters, sewage farms and saltworks ponds (Morcombe 2003).	Atlas of NSW, EPBC search	Low No preferred habitat was recorded within the study area.
Tryngites subruficollis	Buff-breasted Sandpiper	M		Breeds in the high Arctic on well drained tundra with tussocks and scant vegetation. During migration it is found on many short grass habitats including agricultural grassland; uses wetlands for resting (BirdLife International 2009).	Atlas of NSW	Low No preferred habitat was recorded within the study area.
Tyto novaehollandiae novaehollandiae	Masked Owl (southern mainland)		V	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett & Crowley 2000).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.
Tyto tenebricosa	Sooty Owl		V	Occurs in wet eucalypt forest and rainforest on fertile soils with tall emergent trees. Typically found in old growth forest with a dense understorey but also occurs in younger forests if nesting trees are present nearby. It nests in large hollows within eucalypts and occasionally caves. It hunts in open and closed forest for a range of arboreal and terrestrial mammals including introduced species and sometimes birds (Garnett & Crowley 2000).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs in moderately wooded habitats, mainly in areas with extensive cliffs and caves and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins (Churchill 1998; Office of Environment and Heritage 2011). Breeding habitat (maternity roosts) is located in roof domes in sandstone caves (Office of Environment and Heritage 2011). Thought to forage below the forest canopy for small flying insects (Churchill 1998).	EPBC search	Moderate Potential habitat was recorded in the study area.
Dasyurus maculatus maculatus	Spotted-Tailed Quoll (Southern Subspecies)	E	V	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999f). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999d, 1999f).	EPBC search	Moderate Potential habitat was recorded in the study area.
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high (Churchill 2008).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.
Miniopterus australis	Little Bent-wing Bat		V	Feeds on small insects beneath the canopy of well timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred (Strahan 1995).	Atlas of NSW	Recorded

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat		V	This species is found along the east coast of Australia from Cape York in Queensland to Castlemaine in Victoria. Habitat includes rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands. Roosts in caves, old mines, stormwater channels and sometimes buildings with populations centred on maternity caves that are used annually for the birth and development of young (Churchill 2008).	Atlas of NSW	High Potential habitat was recorded in the study area. This species has previously been recorded within the study area by Umwelt, 2006.
Mormopterus norfolkensis	Eastern Free-tail bat		V	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008).	Atlas of NSW	High Potential habitat was recorded in the study area. This species has previously been recorded within the study area by Umwelt, 2006.
Myotis macropus	Southern Myotis		V	Found in most habitat types in association with streams and permanent waterways usually at low elevations in flat or undulating landscapes from northern areas of Western Australia, and the Northern Territory, down the entire east coast and the southern coast of Australia to just west of the Victoria/South Australia border and inland along the Murray River. Roosts in caves, tree hollows, in clumps of dense vegetation (e.g. Pandanus), mines, tunnels, under bridges, road culverts and stormwater drains often in abandoned, intact Fairy Martin nests. Roost sites are strongly associated with bodies of water where this species commonly feeds on aquatic insects, shrimp and small fish at the water surface, however, aerial foraging for other insects is also known(Churchill 2008). Breeding habitat likely to coincide with roosting habitat (Office of Environment and Heritage 2011).	Atlas of NSW	Moderate Potential habitat was recorded in the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Petaurus norfolcensis	Squirrel Glider		V (NSW)	The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland. In NSW it is found in dry sclerophyll forest and woodland but not found in dense coastal ranges, inhabits 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. It is associated with mixed tree species stands with a shrub or Acacia midstorey. It requires abundant tree hollows for refuge and nest sites and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999e).	Atlas of NSW	Recorded
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003a).	EPBC search	Low No preferred habitat was recorded within the study area.
Phascolarctos cinereus	Koala (NSW, ACT & QLD - excluding SE QLD)	V	V	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum Eucalyptus tereticornis, Grey Gum E. punctata, Monkey Gum E. cypellocarpa and Ribbon Gum E. viminalis. In coastal areas, Tallowwood E. microcorys and Swamp Mahogany E. robusta are important food species, while in inland areas White Box E. albens, Bimble Box E. populnea and River Red Gum E. camaldulensis are favoured (NSW National Parks and Wildlife Service 1999c, 2003b). Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW TSC Act.	Atlas of NSW, EPBC search	Moderate Potential habitat was recorded in the study area.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available (Johnston 1995; NSW National Parks and Wildlife Service 1999f).	EPBC search	Low No preferred habitat was recorded within the study area.
Pseudomys novaehollandiae	New Holland Mouse	V		The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (Mus musculus), although it can be distinguished by its slightly larger ears and eyes, the absence of a notch on the upper incisors and the absence of a distinctive 'mousy' odour. Known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes (Threatened Species Scientific Committee 2010).	EPBC search	Low No preferred habitat was recorded within the study area.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001).	Atlas of NSW, EPBC search	Recorded

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Chance of occurrence[4]
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat		V	This species is widespread through tropical Australia and migrates to southern Australia in summer. Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts and breeds in tree hollows but has also been recorded roosting under exfoliating bark, in burrows of terrestrial mammals, in soil cracks and under slabs of rock and in the nests of bird and sugar gliders (Churchill 2008).	Atlas of NSW	High Potential habitat was recorded in the study area. This species has previously been recorded within the study area by Umwelt, 2006
Scoteanax rueppellii	Greater Broad-nosed Bat		V	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3–6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 2008)	Atlas of NSW	High Potential habitat was recorded in the study area. This species has previously been recorded within the study area by Umwelt, 2006

Notes:

(1) Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the EPBC Act.

(2) Listed as an Endangered Population (EP), Vulnerable (V), Endangered (E1), Critically Endangered (CE) or Extinct (E4) under the TSC Act.

(3) EPBC = EPBC Act Protected Matters Search Tool Report
Atlas of NSW Wildlife = Office of Environment and Heritage Bionet Atlas – 10 km buffer of study area
Fisheries = Department of Trade and Investment Regional Infrastructure and Services Species, populations & ecological communities database

(4) Refer to Section 2.4 of the main report.

Appendix D References

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Appendix E

Letter from Royal Botanical Gardens Sydney

The Royal
BOTANIC GARDENS
& Domain Trust

National Herbarium of New South Wales

Tanya BANGEL
Parsons Brinckerhoff
PO Box 1162
Newcastle, NSW 2300

Enquiry No: 18717
Botanical.Is@rbgsyd.nsw.gov.au
Fax No: (02) 9251 1952
Ph No: (02) 9231 8111
Date: 14 October 2014

Dear Tanya,

Re: Identification of Plant Sample – Rankin Park - *Syzygium*

Thank you for your enquiry of 09-Oct-14. We are happy to provide the following information:

Syzygium paniculatum – confirmed by Dr Peter G. Wilson 14th October 2014.

Your specimen has smaller leaves than is typical for the species, however it does have the higher density oil dots which are often present in the specimens from the northern end of the range.

An invoice for $44.00 (incl. GST) will be forwarded to you separately by our finance section to cover cost of identification.

Thank you for your enquiry.

Yours sincerely

Andrew Orme
Identification Technical Officer
Botanical Information Service

The Royal
BOTANIC GARDENS
& Domain Trust

National Herbarium of New South Wales

Tanya BANGEL
Parsons Brinckerhoff
PO Box 1162
Newcastle, NSW 2300

Enquiry No: 18700
Botanical.Is@rbgsyd.nsw.gov.au
Fax No: (02) 9251 1952
Ph No: (02) 9231 8111
Date: 18 November 2014

Dear Tanya BANGEL,

Thank you for your enquiry of 03-Oct-14. We are happy to provide the following information:

Please do not send undried material particularly at this time of year as it tends to turn into mouldy mush. We also have to dry your material before we can freeze and identify it.

Grevillea parviflora subsp. *parviflora* (377352 6356704) conf R.O.Makinson 17 Nov 2014
Pterostylis praetermissa (223194 6610519) det Peter H. Weston 10 November 2014

An invoice for $44.00 (incl. GST) will be forwarded to you separately by our finance section to cover cost of identification.

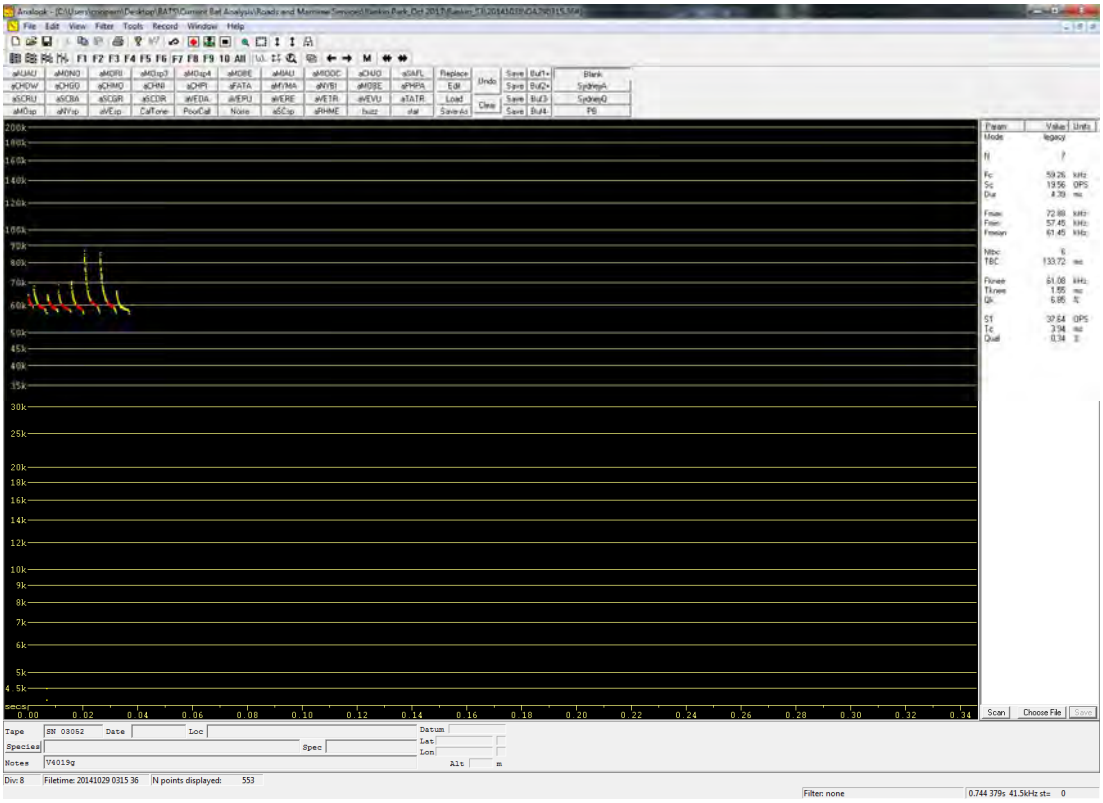
Thank you for your enquiry.

Yours sincerely

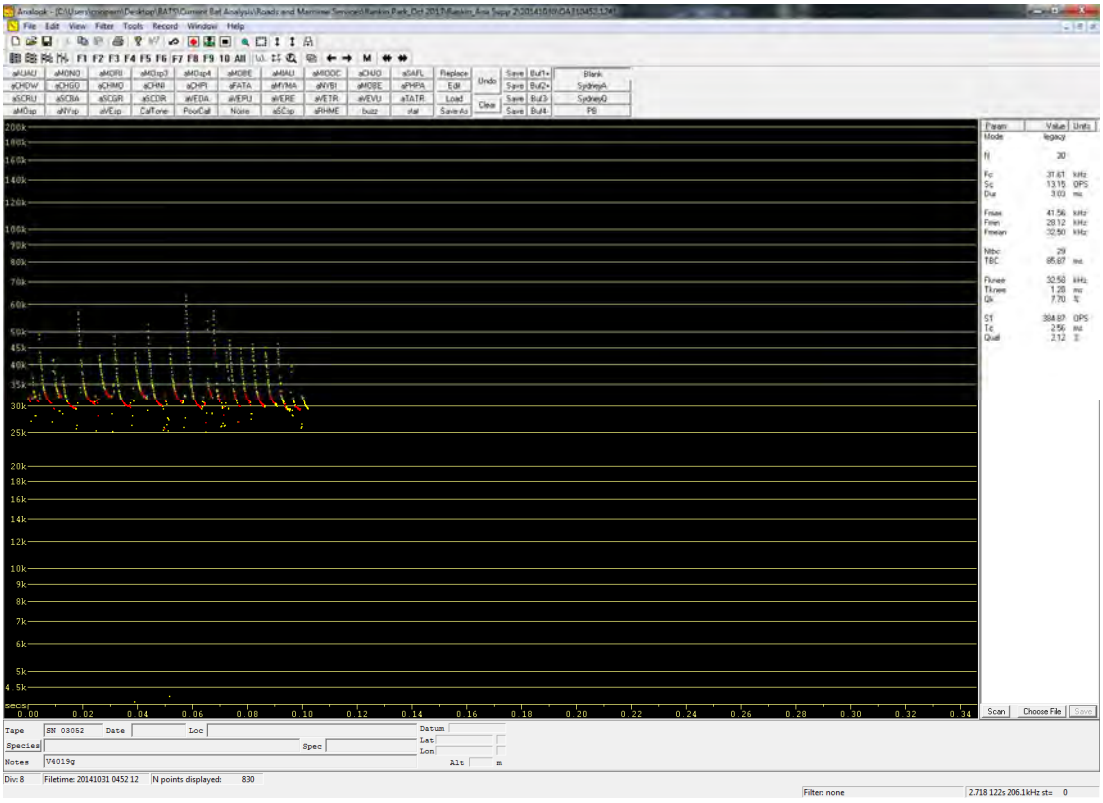
Barbara Wiecek
Identification Botanist
Botanical Information Service

Appendix F

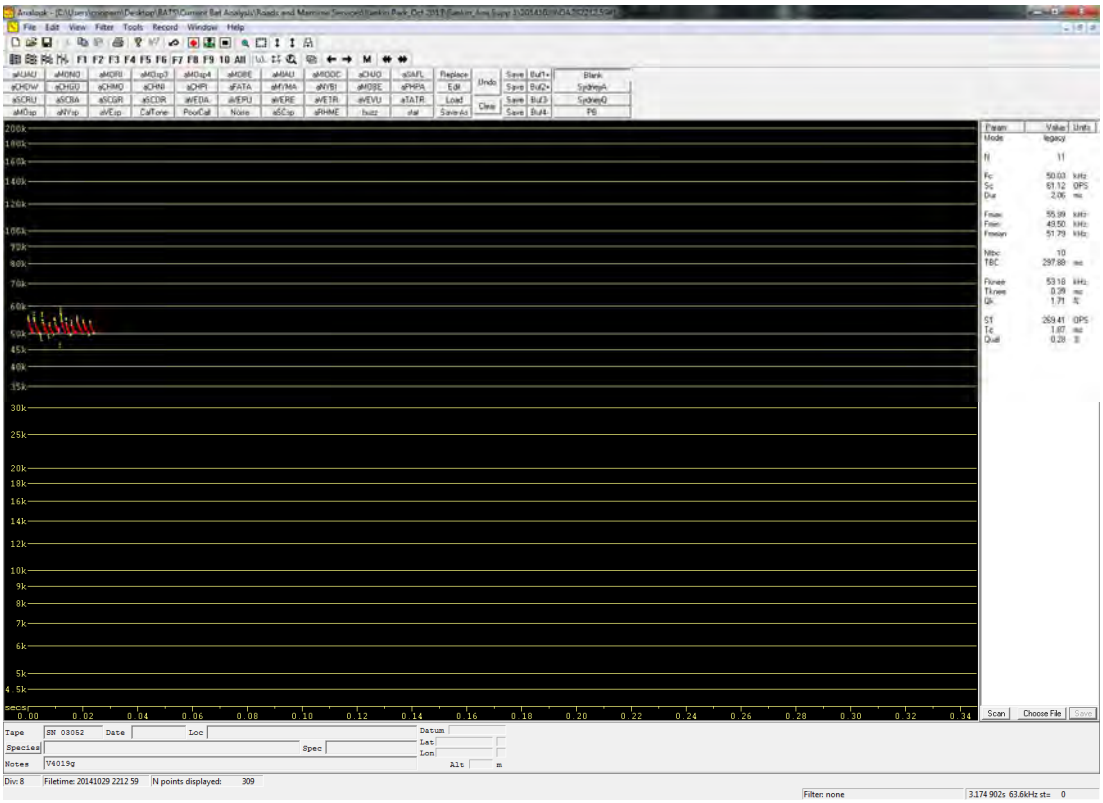
Bat sonograms



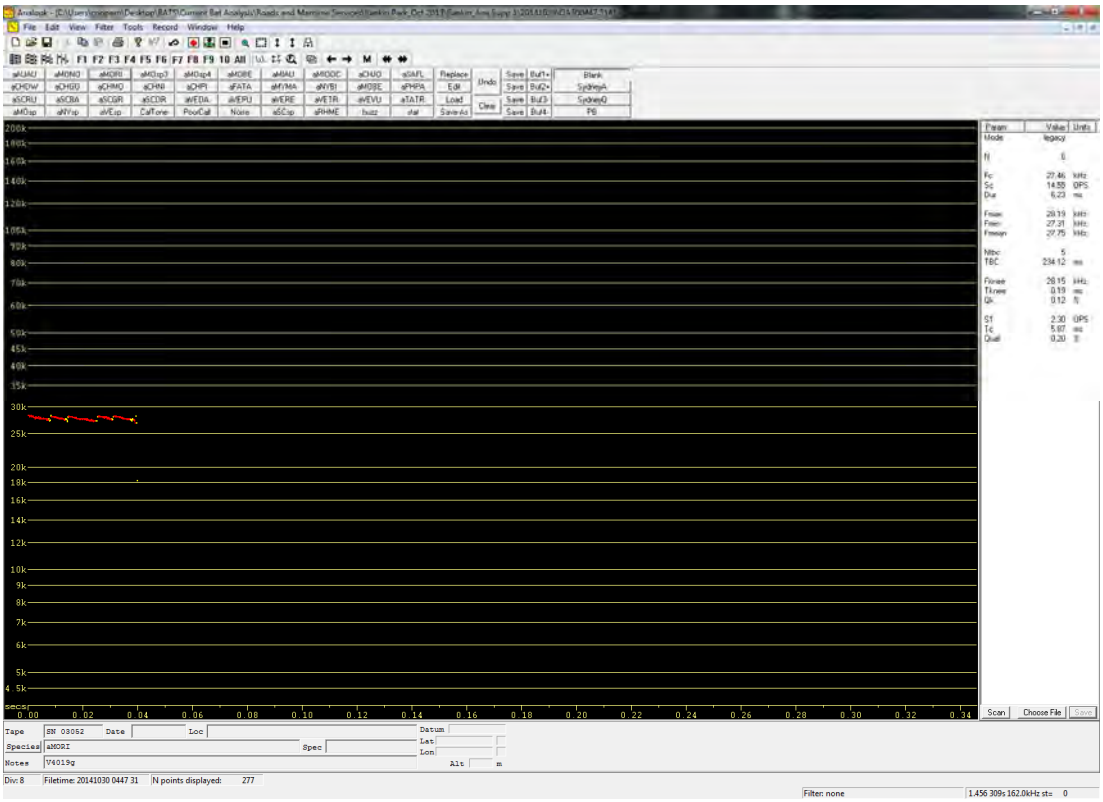
Miniopterus australis – Little Bent-wing Bat



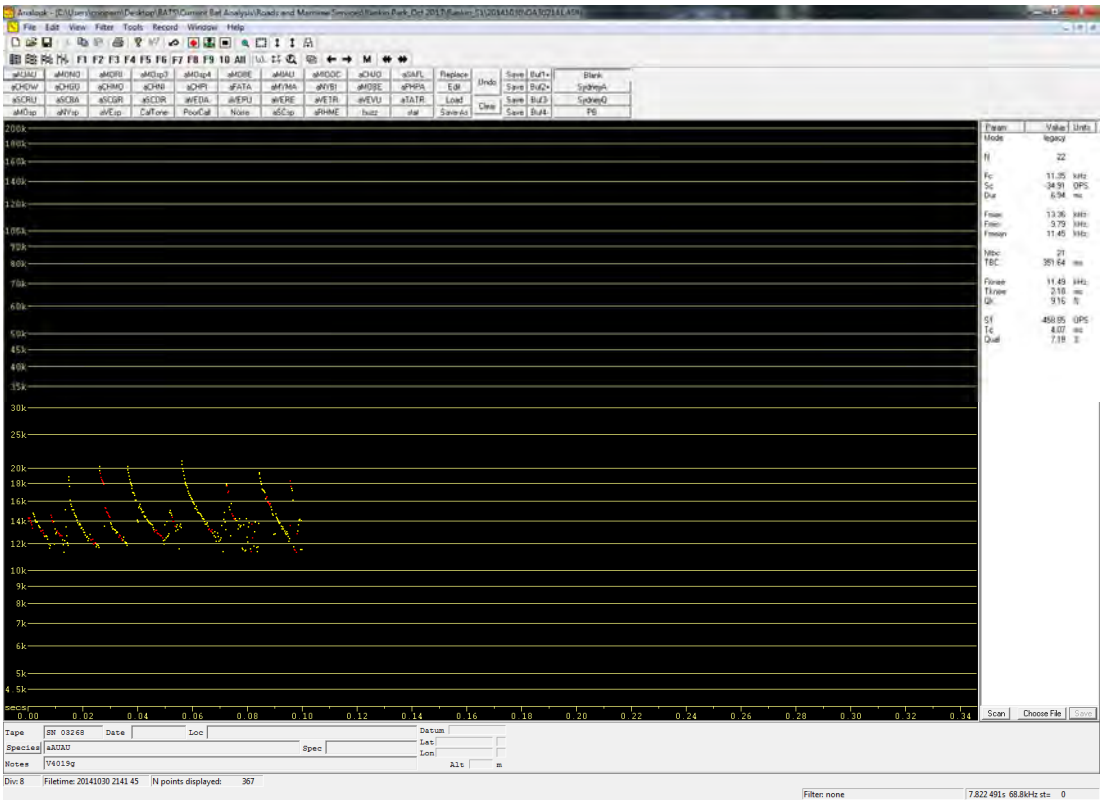
Chalinolobus gouldii – Gould's Wattled Bat



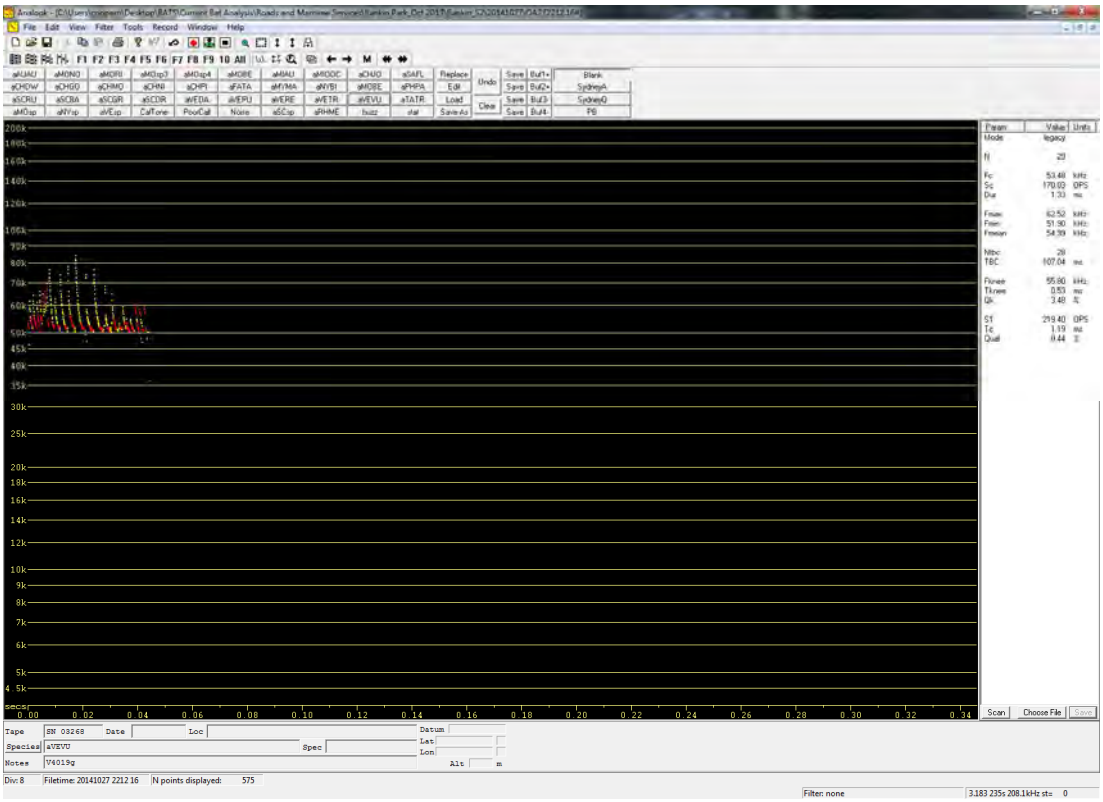
Chalinolobus morio – Chocolate Wattled Bat



Mormopterus ridei – Eastern Freetail Bat



Austronomous australis – White-striped Freetail Bat



Vespadelus vulturnus – Little Forest Bat

Appendix G

Hollow Bearing Tree data

Table G.1: Hollow bearing tree survey results

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
1	*Angophora costata*	0	1	1	Alive	1.6	CB, T	Powerful Owl Roost Tree
2	*Corymbia maculata*	0	1	1	Alive	1.2	CB, CB	Powerful Owl Roost Tree
3	*Corymbia maculata*	2		1	Alive	1.2	CB, T	Powerful Owl Roost Tree
4	*Corymbia gummifera*	1	0	3	Alive	1.3	CB, CB	Powerful Owl Roost Tree
5	*Corymbia gummifera*	0	0	1	Alive	0.9	T	Powerful Owl Roost Tree
6	*Angophora costata*	3	0	1	Alive	0.9	CB, CB	Powerful Owl Roost Tree
7	Stag	1	1	1	Dead	0.5	CB, CB, CB	Powerful Owl Roost Tree
8	*Angophora costata*	0	0	3	Alive	0.8	CB, CB, CB	Powerful Owl Roost Tree
9	*Angophora costata*	0	0	1	Alive	1.6	T	Powerful Owl Roost Tree
10	*Angophora costata*	2	4	3	Alive	1.6	CB, CB, CB	Powerful Owl Roost Tree
11	*Angophora costata*	0	0	1	Alive	0.5	CB	Powerful Owl Roost Tree
12	Stag	0	0	1	Dead	0.5	T	Powerful Owl Roost Tree
13	*Eucalyptus piperita*	3	0	3	Alive	1.7	CB,CB	Powerful Owl Roost Tree
14	*Angophora costata*	1	8	3	Alive	2.0	CB,CB,CB	Powerful Owl Roost Tree
15	*Eucalyptus punctata*	3	0	1	Alive	1.8	CB, CB	Powerful Owl Roost Tree in Gully
16	*Corymbia maculata*	0	0	2	Alive	2.0	CB	Powerful Owl Roost Tree in Gully
17	*Eucalyptus punctata*	0	0	1	Alive	0.7	T	Powerful Owl Roost Tree
18	Stag	0	0	1	Dead	0.9	T	Powerful Owl Roost Tree
19	*Eucalyptus acmenoides*	0	1	1	Alive	0.9	CB, T	Powerful Owl Roost Tree

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
20	*Eucalyptus acmenoides*	0	1	1	Alive	0.8	CB, T	Powerful Owl Roost Tree
21	*Eucalyptus acmenoides*	1	0	1	Alive	0.8	CB,CB	Powerful Owl Roost Tree
22	*Corymbia maculata*	0	0	1	Alive	1.0	CB	Powerful Owl Roost Tree
23	*Eucalyptus piperita*	0	0	2	Alive	0.9	T, CB	Powerful Owl Roost Tree
24	*Eucalyptus piperita*	2	0	0	Alive	1.3	CB	
25	*Angophora costata*	1	4	3	Alive	1.4	CB,CB,CB	Powerful Owl Roost Tree
26	*Eucalyptus piperita*	2	0	0	Alive	1.0	CB	
27	*Corymbia maculata*	1	2	0	Alive	1.1	CB,CB	
28	*Eucalyptus resinifera*	2	1	0	Alive	0.9	CB,CB	
29	*Eucalyptus umbra*	0	1	0	Alive	0.8	CB	
30	*Angophora costata*	0	0	1	Alive	1.2	T	Powerful Owl Roost Tree
31	*Eucalyptus resinifera*	0	1	1	Alive	1.0	CB,T	Powerful Owl Roost Tree, Fire Scar
32	*Angophora costata*	0	1	0	Alive	0.9	CB	
33	*Eucalyptus resinifera*	2	0	0	Alive	1.0	CB	
34	Stag	1	1	0	Dead	0.6	CB, T	
35	*Eucalyptus punctata*	1	0	0	Alive	0.5	CB	
36	Stag	2	4	0	Dead	1.3	CB,CB	
37	*Corymbia maculata*	2	1	0	Alive	1.1	CB	
38	*Corymbia maculata*	1	0	1	Alive	0.9	CB,CB	
39	*Eucalyptus umbra*	1	0	0	Alive	0.8	CB	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
40	Stag	4	0	0	Dead	0.7	CB	
41	*Eucalyptus punctata*	0	2	0	Alive	1.1	CB	
42	Stag	3	1	0	Dead	0.9	CB,T	Fire Scar
43	Stag	0	4	0	Dead	0.6	T, CB	
44	*Eucalyptus punctata*	2	0	0	Alive	1.3	CB	
45	*Eucalyptus umbra*	1	0	1	Alive	1.4	CB,T	Fire Scar
46	*Corymbia maculata*	2	0	0	Alive	1.1	CB	
47	Stag	3	1	0	Dead	1.0	CB,CB	
48	*Corymbia maculata*	0	0	1	Alive	0.9	T	Powerful Owl Roost Tree
49A	Stag	0	1	0	Dead	0.9	T	
49B	*Angophora costata*	0	0	1	Alive	1.1	T	Powerful Owl Roost Tree, Stag Watched
50	*Eucalyptus punctata*	1	2	1	Alive	1.6	CB,CB,T	Powerful Owl Roost Tree
51	*Corymbia maculata*	2	1	0	Alive	1.0	CB,CB	
52	Stag	0	4	0	Dead	1.1	CB	
53	*Eucalyptus umbra*	0	1	0	Alive	1.0	CB	
54	*Corymbia gummifera*	0	0	1	Alive	0.8	CB	Powerful Owl Roost Tree
55	*Eucalyptus piperita*	3	0	0	Alive	1.1	CB	
56	*Eucalyptus resinifera*	3	0	0	Alive	0.5	CB	
57	*Eucalyptus punctata*	4	0	0	Alive	1.1	CB, T	
58	*Eucalyptus punctata*	0	1	1	Alive	1.4	CB,CB	Powerful Owl Roost Tree

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
59	*Eucalyptus punctata*	2	1	0	Alive	0.7	CB,T	
60	Stag	0	0	1	Dead	1.0	T	Powerful Owl Roost Tree
61	*Angophora costata*	2	1	0	Alive	1.1	CB	
62	*Corymbia gummifera*	3	0	0	Alive	1.0	CB	
63	Stag	0	0	1	Dead	0.9	T	Powerful Owl Roost Tree
64	*Corymbia gummifera*	2	1	0	Alive	0.8	T, CB	
65	*Corymbia gummifera*	2	0	1	Alive	2.0	CB,CB	
66	*Angophora costata*	3	1	0	Alive	0.8	CB,CB	
67	*Corymbia gummifera*	2	0	1	Alive	1.2	CB,CB	Powerful Owl Roost Tree
68	Stag	0	1	1	Dead	1.1	T,T	
69	Stag	1	0	2	Dead	1.1	T,T	Powerful Owl Roost Tree
70	*Eucalyptus punctata*	1	3	0	Alive	1.0	CB,CB	
71	*Eucalyptus punctata*	0	1	1	Alive	1.3	CB,T	
72	*Eucalyptus piperita*	3	0	0	Alive	1.0	T,CB	
73	*Corymbia maculata*	1	0	1	Alive	2.0	CB, T	Powerful Owl Roost Tree
74	*Corymbia maculata*	3	0	0	Alive	1.8	T	
75	*Eucalyptus umbra*	1	1	0	Alive	0.8	CB,T	
76	*Eucalyptus piperita*	0	1	0	Alive	0.8	T	
77	*Corymbia maculata*	0	0	1	Alive	1.2	T	Powerful Owl Roost Tree
78	*Corymbia maculata*	2	0	1	Alive	1.1	T,T	Powerful Owl Roost Tree

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
79	*Corymbia maculata*	0	1	2	Alive	1.2	T,CB	Powerful Owl Roost Tree
80	*Eucalyptus punctata*	4	0	0	Alive	1.8	CB	
81	*Eucalyptus resinifera*	1	0	1	Alive	1.0	CB,T	Powerful Owl Roost Tree
82	*Eucalyptus resinifera*	0	0	1	Alive	0.8	CB	Powerful Owl Roost Tree
83	*Angophora costata*	0	0	1	Alive	1.2	T	Powerful Owl Roost Tree
84	*Eucalyptus piperita*	3	1	0	Alive	0.8	CB,T	
85	*Eucalyptus piperita*	2	3	0	Alive	1.0	CB,CB	
86	*Eucalyptus piperita*	0	1	0	Alive	1.1	T	
87	*Eucalyptus resinifera*	0	2	1	Alive	1.2	CB,T	Powerful Owl Roost Tree
88	*Corymbia maculata*	0	1	0	Alive	1.3	CB	
89	*Corymbia maculata*	0	5	0	Alive	1.8	CB	
90	Stag	4	0	0	Dead	1.2	T,CB	
91	Stag	3	0	0	Dead	1.1	CB	
92	Stag	0	0	1	Dead	1.2	T	Powerful Owl Roost Tree
93	*Eucalyptus punctata*	4	0	0	Alive	1.3	CB	
94	*Angophora costata*	0	0	1	Alive	1.3	T	Powerful Owl Roost Tree
95	*Eucalyptus resinifera*	1	0	0	Alive	0.8	CB	
96	Stag	1	0	1	Dead	1.2	T,T	Powerful Owl Roost Tree
97	*Eucalyptus punctata*	3	2	0	Alive	1.0	CB,CB	
98	*Eucalyptus piperita*	0	3	1	Alive	1.1	CB,T	Powerful Owl Roost Tree

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
99	*Eucalyptus punctata*	2	0	0	Alive	0.8	CB	
100	*Angophora costata*	2	1	1	Alive	1.1	CB,CB,T	Powerful Owl Roost Tree
101	*Eucalyptus punctata*	5	1	0	Alive	2.0	CB,T	
102	*Eucalyptus resinifera*	2	0	0	Alive	1.1	T	
103	*Eucalyptus umbra*	0	1	0	Alive	1.0	T	
104	*Angophora costata*	1	1	0	Alive	1.3	CB,T	
105	*Corymbia gummifera*	2	0	0	Alive	1.2	T	
106	*Angophora costata*	0	1	1	Alive	1.3	CB,T	Powerful Owl Roost Tree
107	*Eucalyptus piperita*	0	4	1	Alive	2.4	CB,CB	Powerful Owl Roost Tree
108	Stag	0	3	0	Dead	0.8	CB	
109	*Eucalyptus umbra*	2	0	0	Alive	0.8	CB	Glider scarring on tree
110	Stag	0	0	1	Dead	1.1	T	Powerful Owl Roost Tree
111	*Corymbia maculata*	0	3	0	Alive	1.2	CB	
112	*Angophora costata*	2	3	0	Alive	1.8	CB,CB	
113	*Eucalyptus umbra*	2	3	0	Alive	1.2	CB,CB	
114	Stag	0	2	1	Dead	1.8	CB,CB	Powerful Owl Roost Tree
115	*Angophora costata*	0	1	0	Alive	1.6	CB	
116	*Corymbia maculata*	1	2	0	Alive	1.8	CB	
117	*Angophora costata*	0	1	0	Alive	1.2	CB	
118	*Corymbia maculata*	0	0	2	Alive	1.2	CB	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
119	*Corymbia maculata*	2	3	0	Alive	1.2	CB	
120	*Corymbia maculata*	1	1	0	Alive	1.2	CB,CB	
121	*Corymbia maculata*	1	2	0	Alive	1.1	CB,CB	In Backyard adjoining study area
122	*Angophora costata*	0	2	0	Alive	1.2	CB	
123	*Angophora costata*	0	1	0	Alive	1.3	CB	
124	*Angophora costata*	3	1	0	Alive	1.2	CB,CB	
125	*Eucalyptus punctata*	1	2	0	Alive	1.0	CB,CB	Jesmond Park
126	*Eucalyptus punctata*	2	0	0	Alive	1.2	CB	Jesmond Park
127	*Eucalyptus punctata*	2	3	0	Alive	1.2	CB	Jesmond Park
128	*Corymbia maculata*	2	0	0	Alive	2.0	CB,T	Jesmond Park
129	*Eucalyptus saligna*	0	4	0	Alive	2.0	CB	Jesmond Park
130	*Eucalyptus saligna*	3	6	1	Alive	2.3	CB,CB,CB	Jesmond Park
131	*Eucalyptus acmenoides*	3	0	0	Alive	1.2	T	Jesmond Park
132	*Eucalyptus propinqua*	3	0	0	Alive	1.1	T	Jesmond Park
133	*Corymbia maculata*	3	0	0	Alive	1.0	T	Jesmond Park
134	Stag	2	1	0	Dead	1.1	CB,T	
135	*Angophora costata*	3	0	0	Alive	0.75	CB	
136	*Eucalyptus fergusonii*	1	0	0	Alive	0.80	T	
137	*Eucalyptus fergusonii*	0	1	0	Alive	0.7	T	
138	*Corymbia maculata*	3	0	0	Alive	0.6	CB	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
139	*Eucalyptus punctata*	0	1	0	Alive	0.65	CB	
140	*Eucalyptus umbra*	0	1	0	Alive	0.6	T	
141	*Eucalyptus punctata*	3	0	0	Alive	0.6	CB	
142	*Eucalyptus umbra*	2	2	0	Alive	0.7	CB	
143	*Eucalyptus punctata*	3	0	0	Alive	0.8	CB	
144	*Eucalyptus punctata*	3	0	0	Alive	0.5	CB	
145	*Eucalyptus piperita*	1	0	0	Alive	0.5	CB	
146	*Eucalyptus umbra*	0	1	0	Alive	0.35	T	
147	*Eucalyptus piperita*	1	0	0	Alive	0.65	CB	
148	*Eucalyptus umbra*	0	2	0	Alive	0.6	CB	
149	*Angophora costata*	2	1	0	Alive	0.6	CB,CB	
150	*Angophora costata*	4	1	0	Alive	1.2	CB,CB	
151	*Eucalyptus piperita*	1	0	0	Alive	1.0	CB	
152	*Eucalyptus piperita*	2	0	0	Alive	1.0	CB	
153	*Eucalyptus piperita*	0	1	0	Alive	1.1	T	
154	*Eucalyptus piperita*	0	1	0	Alive	0.8	CB	
155	Stag	3	1	0	Dead	0.8	CB,CB	
156	*Angophora costata*	4	3	0	Alive	1.3	CB,CB	
157	*Angophora costata*	1	2	0	Alive	1.1	CB,CB	
158	*Eucalyptus piperita*	1	0	0	Alive	1.0	T	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
159	*Angophora costata*	1	2	0	Alive	1.1	CB	
160	*Angophora costata*	0	3	3	Alive	2.0	CB,T	Powerful Owl Roost Tree
161	*Eucalyptus piperita*	1	0	0	Alive	1.2	T	
162	*Angophora costata*	1	1	0	Alive	0.7	T	
163	*Eucalyptus piperita*	2	0	0	Alive	0.6	CB	
164	*Eucalyptus umbra*	2	0	0	Alive	0.4	T	
165	*Eucalyptus umbra*	0	1	0	Alive	0.6	T	
166	*Angophora costata*	2	0	0	Alive	1.2	CB	
167	*Eucalyptus piperita*	2	0	1	Alive	0.8	CB,CB	
168	*Eucalyptus piperita*	2	0	1	Alive	0.6	CB,T	
169	*Angophora costata*	0	1	1	Alive	0.8	CB,T	Powerful Owl Roost Tree
170	*Eucalyptus punctata*	3	0	0	Alive	0.65	CB	
171	*Corymbia maculata*	0	1	0	Alive	1.0	CB	
172	*Angophora costata*	1	1	0	Alive	0.8	CB,T	
173	*Eucalyptus piperita*	1	0	0	Alive	1.0	CB	
174	*Angophora costata*	0	2	1	Alive	1.0	CB,T	Powerful Owl Roost Tree
175	*Eucalyptus piperita*	1	3	0	Alive	0.8	CB,CB	
176	*Eucalyptus piperita*	1	2	0	Alive	0.6	T,CB	
177	*Eucalyptus piperita*	2	0	0	Alive	0.6	T,CB	
178	*Eucalyptus piperita*	0	0	1	Alive	1.0	T	Powerful Owl Roost Tree

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
179	*Angophora costata*	2	2	0	Alive	0.7	CB,CB	
180	Stag	1	1	0	Dead	0.5	CB,CB	
181	*Eucalyptus capitellata*	0	1	0	Alive	0.6	T	
182	*Angophora costata*	0	2	3	Alive	0.8	CB, T	Powerful Owl Roost Tree
183	*Eucalyptus resinifera*	0	0	1	Alive	0.7	T	Powerful Owl Roost Tree
184	*Angophora costata*	0	0	1	Alive	1.0	T	Powerful Owl Roost Tree
185	Stag	0	0	1	Dead	0.65	T	Powerful Owl Roost Tree
186	*Corymbia maculata*	0	0	1	Alive	1.1	CB	Powerful Owl Roost Tree
187	*Eucalyptus resinifera*	0	1	0	Alive	0.7	T	
188	*Eucalyptus piperita*	0	1	0	Alive	0.6	T	
189	Stag	0	2	0	Dead	0.9	CB	
190	*Eucalyptus piperita*	0	1	0	Alive	1.0	CB	
191	*Eucalyptus piperita*	0	3	0	Alive	1.0	CB	
192	*Eucalyptus piperita*	2	3	0	Alive	1.0	CB,CB	
193	Stag	0	1	0	Dead	0.9	T	
194	Stag	0	1	0	Dead	0.7	CB	
195	*Corymbia gummifera*	2	0	0	Alive	0.6	CB	
196	*Eucalyptus piperita*	2	1	0	Alive	0.8	CB,CB	
197	*Eucalyptus umbra*	1	1	0	Alive	0.8	T,CB	
198	*Eucalyptus piperita*	1	2	0	Alive	0.7	CB,CB	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
199	*Angophora costata*	3	0	0	Alive	1.2	CB	
200	*Angophora costata*	3	0	0	Alive	1.1	CB	
201	Stag	2	0	0	Dead	0.6	CB	
202	*Angophora costata*	0	1	1	Alive	0.9	CB,CB	Bee Hive present
203	*Angophora costata*	2	3	0	Alive	1.1	CB,CB	
204	*Eucalyptus capitellata*	1	0	0	Alive	0.9	T	
205	*Eucalyptus capitellata*	0	1	1	Alive	0.7	CB,T	Powerful Owl Roost Tree
206	*Eucalyptus capitellata*	0	1	0	Alive	0.6	CB	
207	Stag	0	2	0	Dead	0.7	CB	
208	Stag	0	2	0	Dead	0.6	T	
209	*Angophora costata*	2	0	0	Alive	0.6	CB	
210	*Angophora costata*	1	1	0	Alive	0.7	CB,CB	
211	*Eucalyptus capitellata*	3	2	0	Alive	0.8	CB,CB	
212	*Eucalyptus piperita*	3	1	0	Alive	1.0	CB,T	
213	*Angophora costata*	1	0	0	Alive	0.9	CB	
214	*Eucalyptus piperita*	1	1	0	Alive	0.9	CB,CB	
215	*Eucalyptus piperita*	1	0	0	Alive	0.8	T	
216	Stag	0	1	0	Dead	0.6	T	
217	*Eucalyptus piperita*	0	1	0	Alive	0.8	CB	
218	*Eucalyptus piperita*	2	0	0	Alive	0.7	CB	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
219	*Eucalyptus piperita*	2	0	0	Alive	0.5	CB	
220	*Eucalyptus piperita*	1	2	0	Alive	0.6	CB	
221	Stag	0	1	1	Dead	0.8	CB,T	Powerful Owl Roost Tree
222	Stag	1	0	0	Dead	0.9	CB	
223	*Angophora costata*	0	1	0	Alive	0.9	CB	
224	*Angophora costata*	0	1	0	Alive	0.8	CB	
225	*Eucalyptus piperita*	0	2	0	Alive	1.1	CB	
226	*Eucalyptus resinifera*	1	0	0	Alive	1.1	CB	
227	Stag	2	0	0	Dead	0.6	CB	
228	*Angophora costata*	0	4	1	Alive	1.2	CB,CB	
229	*Eucalyptus piperita*	1	0	0	Alive	0.9	T	
230	*Eucalyptus piperita*	1	1	0	Alive	1.0	CB,T	Fire Scar
231	*Eucalyptus piperita*	1	0	0	Alive	0.8	T	
232	*Eucalyptus piperita*	0	1	0	Alive	0.9	T	Fire Scar
233	Stag	2	0	0	Dead	0.5	CB	
234	*Angophora costata*	1	0	0	Alive	1.1	CB	
235	*Eucalyptus umbra*	1	0	0	Alive	0.8	CB	
236	*Eucalyptus piperita*	1	1	0	Alive	0.8	CB	
237	*Eucalyptus umbra*	2	0	0	Alive	0.7	CB	
238	*Eucalyptus umbra*	0	1	0	Alive	1.1	CB	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
239	*Corymbia gummifera*	2	0	0	Alive	0.7	CB	
240	*Eucalyptus piperita*	0	1	0	Alive	0.7	CB	
241	Stag	2	0	0	Dead	0.5	CB	
242	*Eucalyptus piperita*	2	1	0	Alive	0.6	CB,CB	
243	*Eucalyptus piperita*	1	2	0	Alive	0.7	CB,CB	
244	*Eucalyptus resinifera*	2	0	0	Alive	0.9	CB	
245	Stag	0	1	0	Dead	0.8	T	
246	Stag	1	1	0	Dead	0.5	CB,T	
247	*Eucalyptus umbra*	1	0	0	Alive	0.7	T	
248	*Eucalyptus umbra*	1	0	0	Alive	0.7	T	
249	Stag	0	1	0	Dead	0.5	T	
250	*Angophora costata*	0	2	0	Alive	0.7	T	
251	*Eucalyptus piperita*	0	1	0	Alive	0.8	CB	
252	*Angophora costata*	0	0	1	Alive	0.9	CB	Powerful Owl Roost Tree
253	*Corymbia gummifera*	0	2	0	Alive	0.9	CB	
254	*Eucalyptus punctata*	2	0	1	Alive	1.1	CB,CB	Powerful Owl Roost Tree
255	Stag	0	0	1	Dead	1.2	T	Powerful Owl Roost Tree
256	*Eucalyptus punctata*	0	1	0	Alive	1.0	CB	
257	*Corymbia gummifera*	1	0	0	Alive	0.6	CB	
258	*Corymbia gummifera*	1	0	0	Alive	0.5	T	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
259	*Eucalyptus piperita*	1	1	0	Alive	0.8	CB	
260	*Eucalyptus piperita*	2	0	0	Alive	0.7	T	
261	*Eucalyptus piperita*	1	0	0	Alive	0.7	T	
262	*Angophora costata*	0	1	0	Alive	0.8	T	
263	*Angophora costata*	2	1	0	Alive	0.7	CB	
264	*Eucalyptus piperita*	2	1	0	Alive	0.8	CB	
265	*Angophora costata*	1	0	0	Alive	0.6	CB	
266	*Angophora costata*	1	0	0	Alive	0.8	CB	
267	*Eucalyptus capitellata*	0	1	0	Alive	0.8	T	
268	Stag	0	1	1	Dead	1.4	CB,T	
269	Stag	2	1	0	Dead	0.9	CB,CB	
270	*Angophora costata*	0	2	0	Alive	1.2	CB	
271	*Eucalyptus piperita*	0	0	1	Alive	0.9	T	
272	Stag	1	0	0	Dead	0.7	CB	
273	Stag	1	1	0	Dead	0.7	CB,CB	
274	Stag	0	2	1	Dead	1.0	CB,CB	Powerful Owl Roost Tree
275	Stag	1	2	0	Dead	0.9	CB	
276	*Eucalyptus piperita*	2	1	0	Alive	1.0	CB,CB	
277	*Eucalyptus piperita*	0	2	0	Alive	1.2	T	
278	Stag	0	2	0	Dead	0.9	T	

Tree ID	Species	Hollow Size			Condition	DBH (m)	Position of Hollows[1]	Comments[2]
		Small 2–10 cm	Medium 11–25 cm	Large >25–30 cm				
279	*Angophora costata*	1	0	0	Alive	0.8	CB	
280	*Eucalyptus resinifera*	1	1	0	Alive	0.9	CB,CB	
281	*Eucalyptus resinifera*	2	0	1	Alive	1.0	CB,T	Powerful Owl Roost Tree
282	*Eucalyptus resinifera*	0	1	0	Alive	1.0	CB	Powerful Owl Roost Tree
283	*Eucalyptus resinifera*	1	2	0	Alive	1.1	CB,CB	Powerful Owl Roost Tree
284	*Eucalyptus resinifera*	1	2	0	Alive	1.0	CB,CB	Powerful Owl Roost Tree
285	*Eucalyptus resinifera*	2	0	0	Alive	1.0	CB	
286	*Angophora costata*	0	0	1	Alive	1.2	T	Powerful Owl Roost Tree
287	Stag	0	0	1	Dead	1.0	T	Powerful Owl Roost Tree
288	Stag	0	2	1	Dead	1.1	T	
Totals		320	580	369				

Notes: 1 – T = Hollow in Trunk of tree, CB = Hollow in Crown Branch of Tree

2 – Powerful Owl Roost Tree identifies potential hollow suitable for owl breeding.

Appendix H

Plant species recorded in Lower Hunter Spotted Gum Ironbark Forest

Table H.1 – Plant species recorded within Lower Hunter Spotted Gum Ironbark Forest

Family Name	*Scientific Name*	Common Name	Native (Y/N)	Q2	Q25	Q26	Q29	Species listed on Scientific Determination for Lower Hunter Spotted Gum Ironbark Forest
Fabaceae (Mimosoideae)	*Acacia falcata*		TRUE	1			2	
Fabaceae (Mimosoideae)	*Acacia terminalis*	Sunshine Wattle	TRUE		1			
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses	TRUE			3		
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	TRUE				1	
Myrtaceae	*Angophora costata*	Sydney Red/Rusty Gum	TRUE				1	Y
Poaceae	*Aristida vagans*	Threeawn Speargrass	TRUE	1	2			Y
Proteaceae	*Banksia spinulosa var. collina*		TRUE		1			Y
Pittosporaceae	*Billardiera scandens*	Appleberry	TRUE				1	Y
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush	TRUE		3			Y
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	TRUE	2	1	2	3	Y
Orchidaceae	*Caladenia carnea*	Pink Fingers	TRUE				1	
Lauraceae	*Cassytha glabella*	Slender Dodder-laurel	TRUE		1	2		
Adiantaceae	*Cheilanthes sieberi*	Mulga Fern	TRUE				1	Y
Convolvulaceae	*Convolvulus erubescens*		TRUE	1				
Myrtaceae	*Corymbia maculata*	Spotted Gum	TRUE	4	3	3	3	Y
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	TRUE			2		Y
Fabaceae (Faboideae)	*Daviesia ulicifolia*	Gorse Bitter Pea	TRUE		4		3	Y
Phormiaceae	*Dianella caerulea var. producta*		TRUE			3		Y

Family Name	*Scientific Name*	Common Name	Native (Y/N)	Q2	Q25	Q26	Q29	Species listed on Scientific Determination for Lower Hunter Spotted Gum Ironbark Forest
Phormiaceae	*Dianella revoluta*		TRUE		2		2	Y
Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass	TRUE					
Convolvulaceae	*Dichondra repens*	Kidney Weed	TRUE	2		2		
Poaceae	*Digitaria parviflora*	Small-flowered Finger Grass	TRUE				1	Y
Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	TRUE				1	
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	TRUE			1		
Poaceae	*Entolasia stricta*	Wiry Panic	TRUE	2	3	3	3	Y
Epacridaceae	*Epacris pulchella*	NSW Coral Heath	TRUE				1	
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany	TRUE			3	1	
Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark	TRUE	3	2	3	4	Y
Myrtaceae	*Eucalyptus globoidea*	White Stringybark	TRUE		4			Y
Myrtaceae	*Eucalyptus punctata*	Grey Gum	TRUE		2	2		Y
Myrtaceae	*Eucalyptus umbra*		TRUE	4			2	Y
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	TRUE	2	1	2		Y
Euphorbiaceae	*Glochidion ferdinandi*	Cheese Tree	TRUE		1			
Fabaceae (Faboideae)	*Glycine clandestina*	Twining Glycine	TRUE	2				Y
Fabaceae (Faboideae)	*Glycine tabacina*		TRUE			3		
Haloragaceae	*Gonocarpus tetragynus*	Common Raspwort	TRUE				1	
Goodeniaceae	*Goodenia hederacea*	Ivy Goodenia	TRUE				2	Y

Family Name	*Scientific Name*	Common Name	Native (Y/N)	Q2	Q25	Q26	Q29	Species listed on Scientific Determination for Lower Hunter Spotted Gum Ironbark Forest
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla	TRUE		1	2		Y
Dilleniaceae	*Hibbertia aspera*		TRUE	1		2		
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	FALSE	2				
Poaceae	*Imperata cylindrica*	Bladey Grass	TRUE	4	4		2	
Poaceae	*Joycea pallida*	Silvertop Wallaby Grass	TRUE	6	3	3	4	
Verbenaceae	*Lantana camara*	Lantana	FALSE		2			
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	TRUE		1		4	Y
Myrtaceae	*Leptospermum polygalifolium*		TRUE		4			
Epacridaceae	*Leucopogon juniperinus*	Long-flower Beard-heath	TRUE		1			
Epacridaceae	*Leucopogon lanceolatus*	Lance Beard Heath	TRUE			2		
Lomandraceae	*Lomandra filiformis subsp. filiformis*		TRUE			5		Y
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	TRUE		4			Y
Lomandraceae	*Lomandra multiflora*		TRUE		2	2	3	Y
Zamiaceae	*Macrozamia communis*		TRUE				1	Y
Celastraceae	*Maytenus silvestris*	Narrow-leaved Orangebark	TRUE	1				
Poaceae	*Microlaena stipoides*	Rice Grass	TRUE			1	1	Y
Oleaceae	*Notelaea longifolia*	Large Mock-olive	TRUE	1		1		Y
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	FALSE	2				
Rubiaceae	*Opercularia hispida*	Hairy Stinkweed	TRUE				1	

Family Name	*Scientific Name*	Common Name	Native (Y/N)	Q2	Q25	Q26	Q29	Species listed on Scientific Determination for Lower Hunter Spotted Gum Ironbark Forest
Oxalidaceae	*Oxalis debilis*		TRUE	2				
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	TRUE	1		3	1	
Apocynaceae	*Parsonsia straminea*	Common Silkpod	TRUE			1		
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	TRUE		1	1		Y
Euphorbiaceae	*Phyllanthus hirtellus*	Thyme Spurge	TRUE				3	Y
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	TRUE		2			
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax	TRUE	1		1	2	
Rubiaceae	*Pomax umbellata*	Pomax	TRUE					Y
Lobeliaceae	*Pratia purpurascens*	Whiteroot	TRUE	3	3	3		Y
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower	TRUE	2	2	3		
Fabaceae (Faboideae)	*Pultenaea retusa*	Blunt Bush-pea	TRUE	1				
Myrtaceae	*Syncarpia glomulifera*	Turpentine	TRUE		3	3	1	Y
Orchidaceae	*Thelymitra sp.*		TRUE				1	
Poaceae	*Themeda australis*	Kangaroo Grass	TRUE				3	Y
Total Number of Species								**35**

Appendix D – EPBC Act protected matters search

Australian Government
Department of the Environment

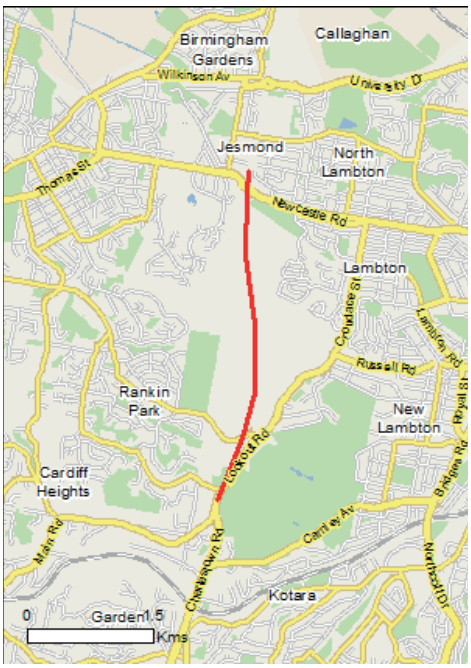
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 27/06/16 16:08:37



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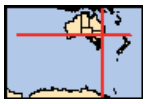

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	72
Listed Migratory Species:	73

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	13
Commonwealth Heritage Places:	None
Listed Marine Species:	97
Whales and Other Cetaceans:	14
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	8
Regional Forest Agreements:	1
Invasive Species:	50
Nationally Important Wetlands:	5
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Hunter estuary wetlands	Within Ramsar site

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Central Hunter Valley eucalypt forest and woodland	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
		to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew [847]	Critically Endangered	Roosting known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur

Name	Status	Type of Presence within area
Plants		
Angophora inopina Charmhaven Apple [64832]	Vulnerable	Species or species habitat likely to occur within area
Asterolasia elegans [56780]	Endangered	Species or species habitat likely to occur within area
Commersonia prostrata Dwarf Kerrawang [87152]	Endangered	Species or species habitat likely to occur within area
Corunastylis insignis Wyong Midge Orchid 1, Variable Midge Orchid 1 [84692]	Critically Endangered	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Diuris praecox Newcastle Doubletail [55086]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus camfieldii Camfield's Stringybark [15460]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus parramattensis subsp. decadens Earp's Gum, Earp's Dirty Gum [56148]	Vulnerable	Species or species habitat likely to occur within area
Grevillea parviflora subsp. parviflora Small-flower Grevillea [64910]	Vulnerable	Species or species habitat known to occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat known to occur within area
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
Pterostylis gibbosa Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat may occur within area
Rutidosis heterogama Heath Wrinklewort [13132]	Vulnerable	Species or species habitat may occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Pocket-less Brush Cherry, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat likely to occur within area
Tetratheca juncea Black-eyed Susan [21407]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or

Name	Status	Type of Presence
		related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Hoplocephalus bungaroides Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat likely to occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Sterna albifrons Little Tern [813]		Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Roosting known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Roosting known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Roosting known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew [847]	Critically Endangered	Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area

Name	Threatened	Type of Presence
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian & Overseas Telecommunications Corporation
Commonwealth Land - Australian Broadcasting Corporation
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Director of War Service Homes
Commonwealth Land - Telstra Corporation Limited
Defence - ADF CAREERS REFERENCE CENTRE

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Roosting known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Roosting known to occur

Name	Threatened	Type of Presence
		within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Roosting known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Roosting known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur

Name	Threatened	Type of Presence
		within area
Himantopus himantopus Black-winged Stilt [870]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew [847]	Critically Endangered	Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stigmatopora olivacea a pipefish [74966]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Awabakal	NSW
Blue Gum Hills	NSW
Glenrock	NSW
Hexham Swamp	NSW
Hunter Wetlands	NSW
Lake Macquarie	NSW
Pambalong	NSW
Tingira Heights	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		

Name	Status	Type of Presence
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Hexham Swamp	NSW
Jewells Wetland	NSW
Kooragang Nature Reserve	NSW
Lake Macquarie	NSW
Shortland Wetlands Centre	NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-32.904658 151.692822,-32.90682 151.692564,-32.912296 151.692393,-32.918565 151.693337,-32.924761 151.693423,-32.928796 151.692049,-32.934415 151.689389

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix E – Biodiversity credit report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 12/04/2016 Time: 12:12:57PM Calculator version: v4.0

Major Project details

Proposal ID:	0082/2015/2218MP
Proposal name:	Newcastle Bypass V2
Proposal address:	Lookout Road New Lampton NSW
Proponent name:	RMS
Proponent address:	59 Darby Stree Newcastle NSW 2300
Proponent phone:	02 49240687
Assessor name:	Daniel Williams
Assessor address:	Level 1, 62 Clarence Street Port Macquarie NSW 2444
Assessor phone:	6586 8714
Assessor accreditation:	0082

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	4.80	333.00
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	19.08	1,167.00
Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	2.23	132.00
Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	14.98	1,057.00
Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	5.12	283.12
Total	46.21	2,972

Credit profiles

1. Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast, (HU782)

Number of ecosystem credits created	333
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast, (HU782) Flooded Gum - Brush Box - Tallowwood mesic tall open forest on ranges of the lower North Coast, (HU783)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803)

Number of ecosystem credits created	1,057
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter, (HU806)

Number of ecosystem credits created	283
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter, (HU806) Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast, (HU802) Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest, (HU804) Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter, (HU807) Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter, (HU814) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815) Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter, (HU816) Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter, (HU822)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833)

Number of ecosystem credits created	1,167
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833) Scribbly Gum - Smooth-barked Apple - Red Bloodwood shrubby forest of the Lower Hunter, Sydney Basin Bioregion, (HU715) Red Bloodwood - Sydney Peppermint - Podocarpus spinulosus shrubby open forest of the southern Central Coast, (HU839) Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast, (HU850) Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast, (HU852)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast, (HU841)

Number of ecosystem credits created	132
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast, (HU841) Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HU595) Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion, (HU622) Scribbly Gum - Smooth-barked Apple - Red Bloodwood shrubby forest of the Lower Hunter, Sydney Basin Bioregion, (HU715) Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands, (HU833) Grey Ironbark - Broad-leaved Mahogany - Smooth-barked Apple coastal headland low open forest of the Central Coast, (HU834) Smooth-barked Apple open forest on coastal lowlands of the Central Coast, (HU835) Narrow-leaved Ironbark - Yellow bloodwood - Rough-barked Apple shrubby open forest on sandstone ranges of the Sydney Basin, (HU837) Smooth-barked Apple - Swamp Mahogany - Red Mahogany - Cabbage Palm open forest on lowlands of the Central Coast, (HU838) Red Bloodwood - Sydney Peppermint - Podocarpus spinulosus shrubby open forest of the southern Central Coast, (HU839) Sydney Peppermint - Silvertop Ash - Gymea Lilly ferny woodland on lowlands of the Central Coast, (HU846) Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast, (HU850) Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast, (HU852) Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast, (HU856) Red Bloodwood - Smooth-barked Apple - Scribbly Gum - Old Man Banksia heathy woodland on sandstone ranges of the Central Coast, (HU857) Smooth-barked Apple - Cabbage Palm - Broad-leaved Mahogany woodland on Wallarah Peninsular, (HU895)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Black-eyed Susan	Tetratheca juncea	846.00	12,690

Appendix F – Plot/transect data

Development site plot/transect data

Veg Type ID	Plot ID	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Over storey regeneration	Total length of fallen logs	Easting	Northing	GDA Zone
HU637	Q1	41	44	32	29	0	71	0	1	1.0	41.1	377292	6356879	56
HU629	Q2	24	27.5	0	2	22	6	0	0	1.0	1	377570	6357891	56
HU622	Q3	35	24	11	10	16	22	22	0	1.0	0	377602	6357989	56
HU631	Q4	36	34	67	24	22	20	2	3	1.0	9.2	377869	635590	56
HU621	Q5	33	41.5	44.5	34	10	32	0	4	1.0	44.5	377986	6356200	56
HU631	Q6	41	32	24	32	0	50	14	7	1.0	31.9	377833	6356240	56
HU631	Q7	33	51	6.2	58	0	22	2	3	1.0	31.1	377777	6356301	56
HU637	Q8	32	50	25	34	6	42	2	5	1.0	0	377541	6356286	56
HU621	Q9	35	34.5	30	58	12	30	0	2	1.0	31.3	377242	6356672	56
HU621	Q10	42	27.5	14	46	16	24	0	0	1.0	2	377351	6356731	56
HU621	Q11	39	29.5	5.5	34	6	16	0	0	1.0	9	377447	6856686	56
HU622	Q12	43	32	60	26	32	26	0	0	1.0	4	377465	6356569	56
HU621	Q13	35	27.5	9	74	4	10	0	1	1.0	4	377145	6356371	56
HU621	Q14	31	33.5	4.5	38	8	46	5	1	1.0	38	377134	6356239	56
HU631	Q15	47	41	6	8	6	76	0	2	1.0	38.4	377444	6355808	56
HU637	Q16	38	40	5	8	6	26	44	4	1.0	25.2	377418	6355738	56
HU637	Q17	31	45	2	2	2	30	68	2	1.0	23.1	377522	6355704	56
HU637	Q18	35	28	5	2	4	54	30	2	1.0	20.9	377611	6355621	56
HU631	Q19	46	40.5	17	22	4	44	10	1	1.0	7.3	377625	6355690	56
HU621	Q20	34	36	10	68	0	26	0	2	1.0	0	377634	6355701	56
HU631	Q21	27	34	17.5	30	12	48	0	8	1.0	46.9	377535	6355896	56
HU631	Q22	10	0.5	0	0	0	96	4	3	0.0	0	377453	6356070	56
HU637	Q23	33	36	26	28	4	52	16	2	1.0	24.7	377097	6356585	56

Veg Type ID	Plot ID	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Over storey regeneration	Total length of fallen logs	Easting	Northing	GDA Zone
N/A	Q24	11	25.5	0	6	0	0	94	4	1.0	0	377738	6358232	56
HU629	Q25	27	39	15.5	62	6	32	0	0	1.0	0	377752	6358112	56
HU629	Q26	27	27	10.5	46	16	28	0	0	1.0	26.8	377576	6357763	56
HU631	Q27	34	38.5	18	38	6	56	0	0	1.0	38.2	377490	6357587	56
HU631	Q28	35	29	45	50	4	18	0	2	1.0	50.9	377121	6357215	56
HU629	Q29	29	20	9.5	54	10	36	0	0	0.3	22.3	377442	6357280	56
HU622	Q30	34	40	31	40	0	48	0	4	1.0	22.8	377236	6357095	56

Appendix G – Parsons Brinckerhoff (2015b), *Newcastle Inner City Bypass: Rankin Park to Jesmond, Additional Powerful Owl and Hollow-bearing Tree Surveys.*



Roads and Maritime Services

Newcastle Inner City Bypass: Rankin Park to Jesmond Additional Powerful Owl and Hollow-bearing Tree Surveys

21 August 2015

Document information
Client: Roads and Maritime Services Title: Newcastle Inner City Bypass: Rankin Park to Jesmond Subtitle: Additional Powerful Owl and Hollow-bearing Tree Surveys Document No: 2106581B-ENV-REP-001 RevA Date: 21 August 2015

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A	03/07/2015	Draft
B	21/08/2015	Final

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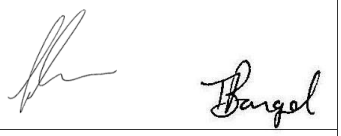
Prepared by:	Kim Lentz, Tanya Bangel, Nathan Cooper	Date: 21/08/2015	Signature: 
Reviewed by:	Allan Richardson	Date: 21/08/2015	Signature: 
Approved by:	Nathan Cooper	Date: 21/08/2015	Signature: 

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Roads and Maritime Services, GHD, Parsons Brinckerhoff file

Document owner
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1. Introduction

Parsons Brinckerhoff was engaged by Roads and Maritime Services (Roads and Maritime), to undertake additional hollow-bearing tree and Powerful Owl surveys (the survey) for the proposed final stage of the Newcastle Inner City Bypass (Highway 23) from Rankin Park to Jesmond. The project consists of an approximate 3.4 km dual lane carriageway highway between the intersection with McCaffrey Drive and Lookout Road, Rankin Park and the interchange with Newcastle Road at Jesmond (the project). The locality of the project is provided in Figure 1.1.

A biodiversity survey was undertaken within the proposal area in 2014 to describe and detail the ecological characteristics of the study area (Parsons Brinckerhoff 2014). However, as a result of design changes, additional areas within an expanded study area were identified as requiring further ecological survey. This report details the results of additional hollow-bearing tree and targeted Powerful Owl surveys completed in late June and early July 2015, and will support the Newcastle Inner City Bypass – Rankin Park to Jesmond Environmental Impact Statement.

1.1 Background

Biodiversity surveys were completed in the project study area in 2014 to describe and detail the ecological characteristics therein (Parsons Brinckerhoff 2014), including hollow-bearing tree surveys and targeted stag watches of potential roosting/ nesting trees of the Powerful Owl. In total 289 hollow-bearing trees, from 12 tree species, were identified in the project study area during these surveys; comprising 320 small hollows, 264 medium hollows and 105 large hollows (Figure 2.1, Appendix A). The most important tree species identified in the project study area for provision of hollow resources included *Angophora costata* (Smooth-barked Apple), *Eucalyptus piperita* (Sydney Peppermint), dead trees (stags), *Eucalyptus punctata* (Grey Gum) and *Corymbia maculata* (Spotted Gum) in order of numerical scale. The combined results of hollow-bearing tree surveys are provide in Figure 2.1 and Appendix A.

1.2 Study objectives

The objectives of this study were to:

- undertake a hollow-bearing tree assessment in the extended proposal area
- identify and detail habitat trees potentially suitable for the Powerful Owl
- complete targeted stag watch surveys during the winter breeding period.

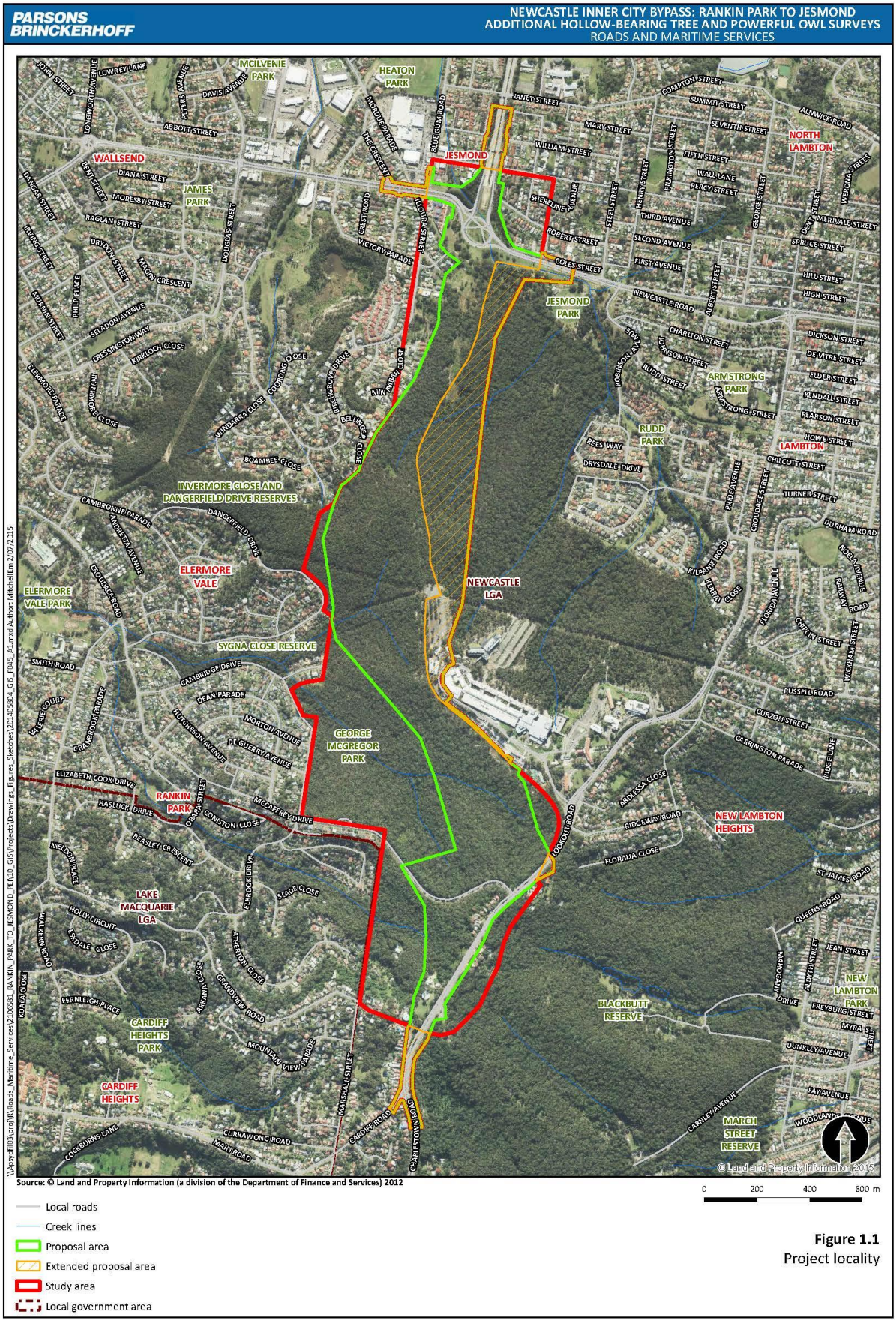

Figure 1.1
Project locality

2. Methods

For the purposes of this study the following definitions apply:

- **Proposal area** is defined by a 20 m boundary from the proposed strategic design alignment of the project footprint between Jesmond and Rankin Park as displayed in 2007 (Figure 1.1).
- **Extended proposal area** is defined as an extension of proposal area along the eastern, northern and southern sections of the original proposal area, which were not included in the original study area (Figure 1.1).
- **Study area** is the area of bushland between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital, Lookout Road and both northern and southern sides of McCaffrey Drive (Figure 1.1).
- **Locality** is defined as an approximate 10 km radius around the proposal area.

2.1 Personnel

The contributors to the preparation of this report, their qualification and roles are provided in Table 2.1.

Table 2.1 Contributors and their roles

Name	Qualifications	Role
Alex Cockerill	BSc (Hons)	Principal ecologist – lead ecologist
Nathan Cooper	BEnvSc, Grad Dip Ornith	Senior ecologist – project manager, fauna survey, report preparation
Allan Richardson	BEnvSc (Hons)	Senior ecologist – Fauna survey, report preparation
Tanya Bangel	BEnvScMgt (Hons)	Ecologist – Fauna survey, report preparation
Kim Lentz	BSc	Ecologist – Fauna survey, report preparation
Nathan Ottley	BEnvScMgt	Environmental Scientist – Fauna survey
Emily Mitchell	BDvptSt, Cert 4 SIS	Mapping and data management – GIS operator

All work were carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the *National Parks and Wildlife Regulations 2002* and Section 132C of the *National Parks and Wildlife Act 1974*, Animal Research Authority issued by the Department of Industries and Investment NSW (Agriculture).

2.2 Field survey

2.2.1 Hollow-bearing tree survey

A hollow-bearing tree survey was undertaken within the extended proposal area to identify hollow tree resources. Hollow-bearing trees were recorded from parallel transects at 50 m intervals, with their location marked using a handheld GPS unit (Garmin Dakota 20/ Trimble Juno). The following information was recorded for each hollow tree observed:

- GPS location
- tree species

- diameter breast height (DBH)
- number of hollows
- hollow size class
- hollow location (e.g. branch, trunk)
- potential suitability for the Powerful Owl.

Large hollows are a critically limiting resource within remnant woodland and forest habitats within Australia (Goldingay 2009). Accordingly, and due to their importance as a potential breeding resource for the Powerful Owl (and other large forest owls), special consideration was afforded to trees that retained large hollows. The size class of tree hollows were determined primarily according to fauna size guilds and included:

- small hollows (2 – 10 cm) suited to microchiropteran bats, small arboreal mammals and small birds
- medium hollows (11–25 cm) suited to larger arboreal mammals and medium sized birds
- large hollows (>25 cm) suitable for large birds and forest owls.

A summary of survey effort for hollow-bearing tree surveys within the extended proposal area is provided in Table 2.2. Hollow tree data is further discussed in Section 3.1, whilst the location and data of hollow tree resources is provided in Figure 2.1 and Appendix A respectively.

2.2.2 Targeted Powerful Owl surveys

Due to the limited availability of hollows considered to be suitable as nesting sites for the Powerful Owl, targeted Powerful Owl surveys were completed both within the extended proposal area and adjacent habitat in the wider study area. Powerful Owl surveys were completed during the breeding season between 22 June 2015 and 2 July 2015. In total, 20 large hollow-bearing trees that were considered potentially suitable for use by the Powerful Owl were stag watched (Figure 2.2). Stag watching consisted of an observer watching a pre-determined potential nesting hollow (based on hollow-bearing tree surveys) for an approximate 2 hour period encompassing 1 hour prior to and after sunset. Trees were also inspected for the presence of Powerful Owl pellets, scratchings and white wash to determine if the identified hollow trees were being utilised for Powerful Owl breeding.

A summary of survey effort for the additional surveys is provided in Table 2.2.

Table 2.2 Summary survey effort

Survey type	Description	Survey effort	Survey date	Area surveyed
Hollow-bearing tree survey	Parallel transects at 50 m intervals	2 days	15 – 16 June 2015	Extended proposal area and areas immediately adjacent
Targeted Powerful Owl survey	Stag watch of potential Powerful Owl habitat trees	34 person hours	22 – 24 June 2015 29 – 30 June 2015 1 – 2 July 2015	Extended proposal area and areas immediately adjacent
Opportunistic sightings	-	7 days	15 – 16 June 2015 22 – 24 June 2015 29 – 30 June 2015 1 – 2 July 2015	-

2.3 Weather conditions

The weather conditions during the June/ July period generally consisted of cool to warm days and cool evenings with occasional light showers (Table 2.3).

Table 2.3 Weather conditions

Date	Survey type	Temp. °C (min)(1)	Temp. °C (max)(1)	Rain (mm)(1)	Wind (max speed (km/ph)/direction)(2)
15 June 2015	Hollow-bearing tree survey	8.4	18.7	0	43/ ENE
16 June 2015	Hollow-bearing tree survey	11.2	18.4	1.3	30/ NE
22 June 2015	Powerful Owl survey	5.4	17.6	0	26/ NW
23 June 2015	Powerful Owl survey	5.8	18.7	0	33/ NW
24 June 2015	Powerful Owl survey	8.6	18.2	0	28/ NW
29 June 2015	Powerful Owl survey	7.9	19.8	0	20/ NW
30 June 2015	Powerful Owl survey	7.3	15.2	0.2	33/ NW
1 July 2015	Powerful Owl survey	8.2	17.2	0	31/ NW
2 July 2015	Powerful Owl survey	5.6	15.5	0	43/ NW

(1) Data obtained from Bureau of Meteorology Newcastle University (Station 061390)
(2) Data obtained from Bureau of Meteorology Newcastle Nobbys Signal Station AWS (Station 061055)

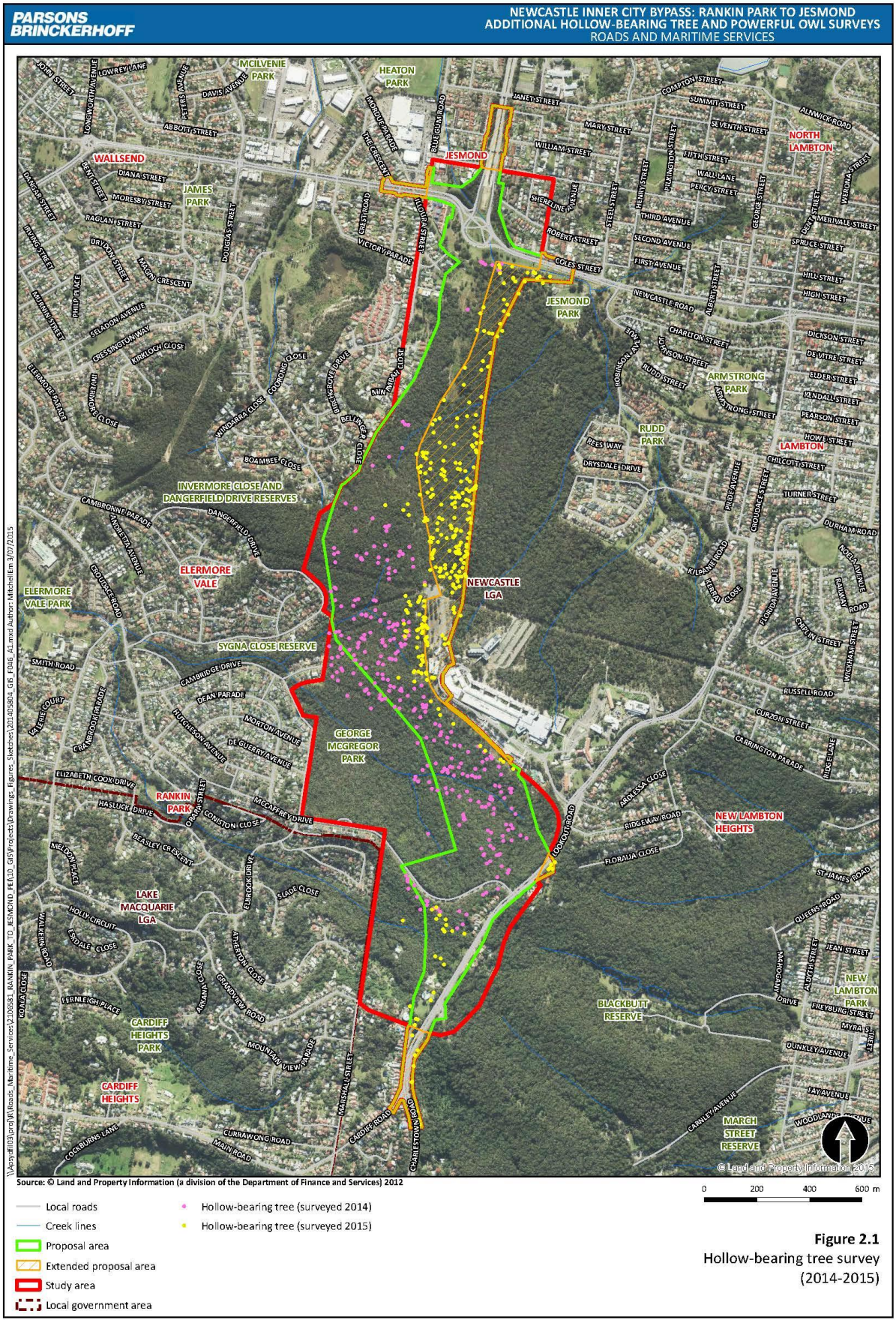

Figure 2.1
Hollow-bearing tree survey (2014-2015)

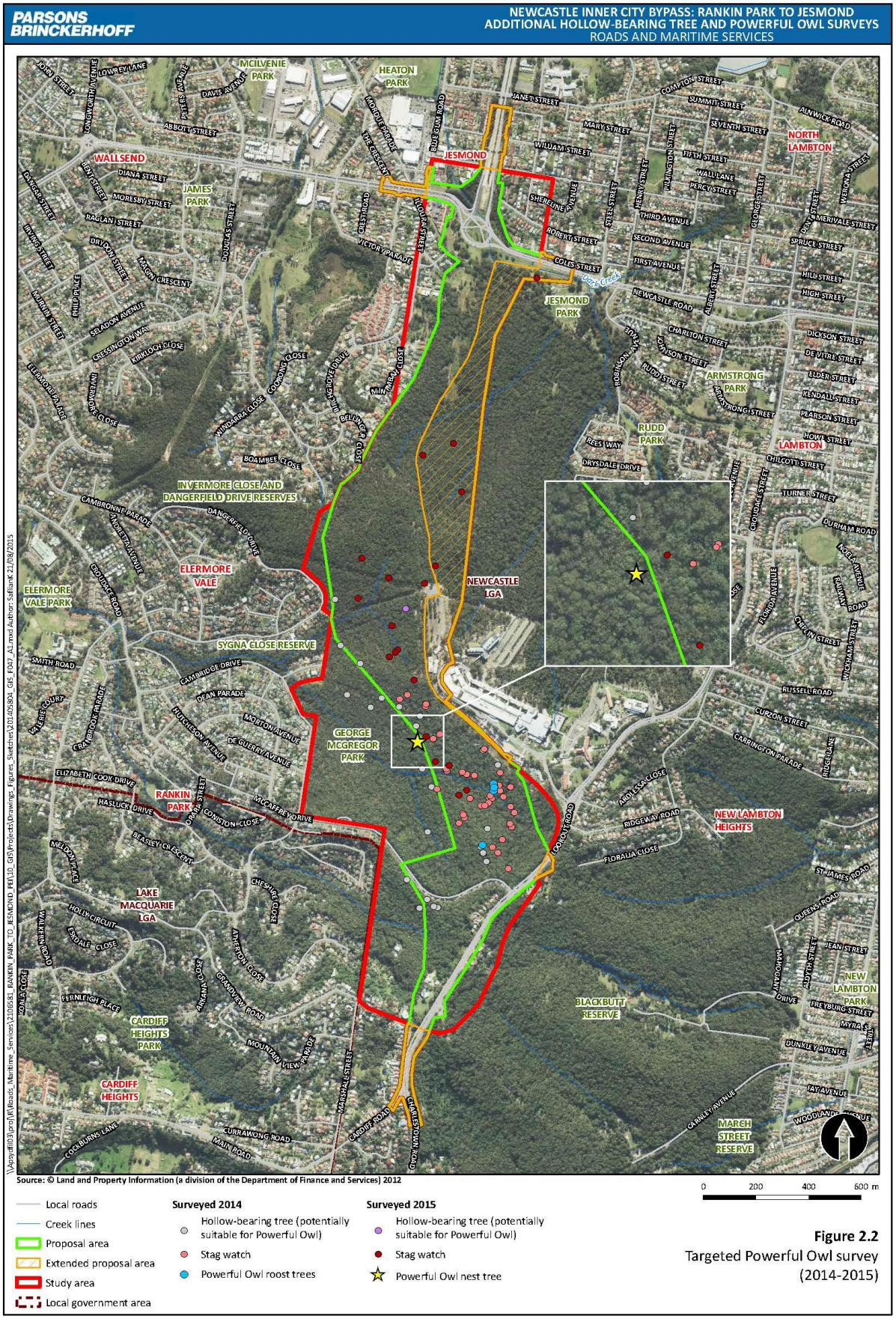

Figure 2.2
Targeted Powerful Owl survey (2014-2015)

3. Results

3.1 Hollow tree resources

Eleven of the 22 threatened fauna species that are considered to have potential habitat in the study area use hollow tree resources for breeding and roosting. While many attributes of tree hollows may be selected by hollow using species, such as hollow depth, entrance size and hollow type (Goldingay 2009), hollows are more likely to occur and be used by wildlife in large trees that are many decades or even centuries old (Goldingay 2009).

A total of 450 hollow-bearing trees, containing approximately 1,312 tree hollows, were identified within the extended proposal area during current surveys (Figure 2.1, Figure 3.1 and Appendix A). Tree hollows were separated into three distinct size classes based on their propensity to provide habitat for different fauna guilds as detailed in Section 2.2.1. In total 567 small hollows, 642 medium hollows and 103 large hollows were recorded from 13 different tree species, inclusive of dead stags. Due to the height of canopy layer, small hollows were difficult to observe in the crowns of trees. Therefore, it is likely that hollow density is underestimated. The most important tree species within the extended survey area were *Eucalyptus punctata* (Grey Gum), dead trees (stags), *Angophora costata* (Smooth-barked Apple), *Corymbia maculata* (Spotted Gum), *E. umbra* (Broad-leaved Mahogany) and *E. piperita* (Sydney Peppermint) (Figure 3.1, Appendix A).

The hollow-bearing tree survey returned a high density of trees with hollows within the extended study area. Small to medium sized hollows on site may be used as roosting or maternity sites by hollow-dwelling microchiropteran bats, possums and birds. Of particular importance was the provision of large hollows, which are important structures within the landscape for shelter and breeding purposes of large hollow-dependent animals, including large forest owls.

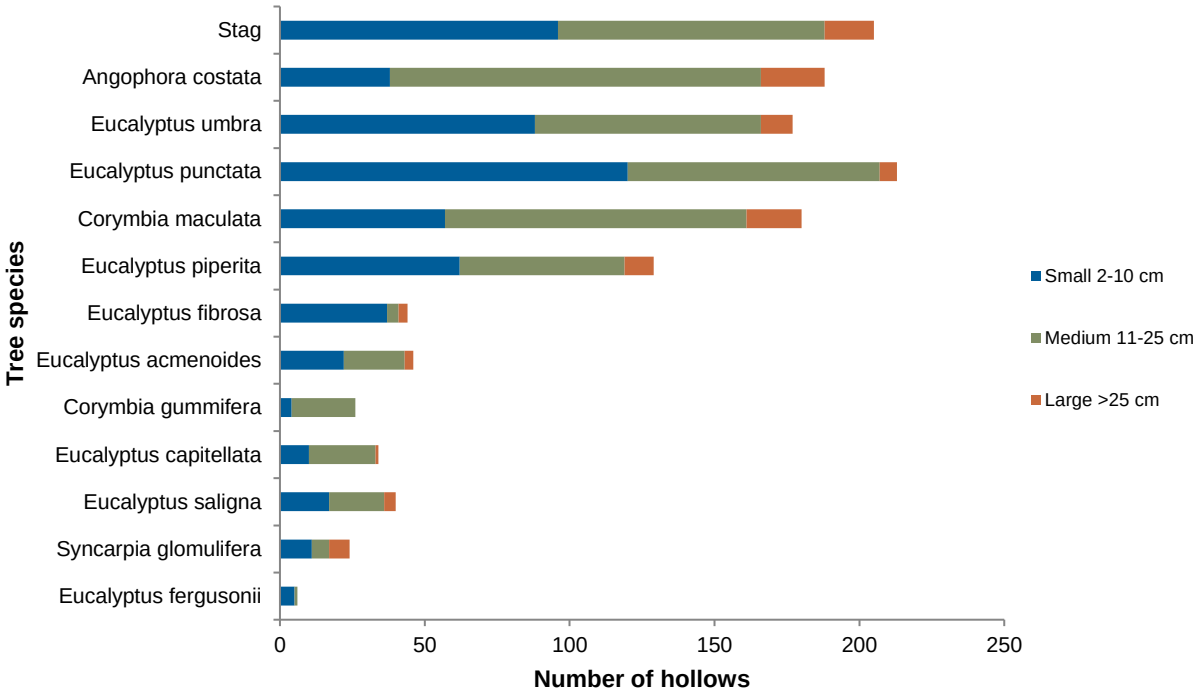

Figure 3.1 Hollow tree resources within the extended proposal area

3.2 Targeted Powerful Owl surveys

Twenty large hollow-bearing trees that were considered potentially suitable for use by the Powerful Owl were stag watched during the current survey (Figure 2.2), including seven trees located in or immediately adjacent to the extended proposal area. No Powerful Owl activity was recorded in the extended proposal area. However, Powerful Owls were observed in the proposal area, with initial observations indicating that the pair had commenced the breeding cycle, which generally occurs from late autumn to mid-winter (Heritage 2015). The male commenced to call in the early evening around sunset from the gully in the south of the study area, through which the project traverses. The female joined the male (from a nesting hollow: Latitude -32.923705 Longitude 151.689839) (Figure 2.2) in the canopy of large eucalypts at his calling location to feed on a Common Ringtail Possum. Upon leaving the male's calling location in the gully, the male Powerful Owl followed the observers through the canopy until they left the immediate area of the nest hollow. A follow up survey was completed the following night, which confirmed the nest tree and location of the nest hollow. Photo 3.1 and Photo 3.2 show the large *Angophora costata* nest tree and the identified nesting hollow respectively.

Photo 3.1 Powerful Owl nest tree

Photo 3.2 Powerful Owl nest hollow

4. Conclusion

This ecological survey report comprises the findings from hollow-bearing tree and targeted Powerful Owl surveys completed within the extended proposal area and adjacent habitats.

The hollow-bearing tree survey identified 450 hollow trees that contained approximately 1,320 hollows; comprising 567 small hollows, 642 medium hollows and 103 large hollows. The most important tree species for the provision of hollow resources within the extended proposal area were *Eucalyptus punctata* (Grey Gum), dead trees (stags), *Angophora costata* (Smooth-barked Apple), *Corymbia maculata* (Spotted Gum), *E. umbra* (Broad-leaved Mahogany) and *E. piperita* (Sydney Peppermint).

A total of 20 large hollow-bearing trees that were considered potentially suitable for use by the Powerful Owl were stag watched during the current survey, including seven trees located in or immediately adjacent to the extended proposal area. Whilst no Powerful Owl activity was observed within the 'extended proposal area', a pair of Powerful Owls was observed within the 'proposal area' exhibiting behaviours that indicated the breeding cycle had commenced. The male Powerful Owl was observed to call the female from the nest for provision of food, with the female observed exiting a nesting hollow in a large *A. costata* on two consecutive nights. The nest tree was located to the north of the gully in the southern section of the study area, immediately adjacent to the western boundary of the proposal area.

Hollow-bearing trees are a critically limiting resource within remnant forested habitats within Australia (Goldingay 2009), whereby the density of large hollows (>30 cm) across the landscape is proportionately less than small hollows due to the time-lag involved in their formation. Powerful Owls (and other large forest owls) are dependent on large hollows that meet specific requirements (aspect, entrance width, internal temperature etcetera) within their home range to fulfil critical life history traits, including breeding and providing habitat for their favoured prey of arboreal mammals. Accordingly, data collated from targeted Powerful Owl surveys during the winter breeding period in 2014 and 2015 suggest that the gully in the southern section of the project study area and large senescent trees in its proximity play an important role in Powerful Owl habitat use of the larger bushland remnant.

5. References

Department of Environment and Conservation 2006, 'Recovery Plan for the Large Forest Owls: Powerful Owl *(Ninox strenua),* Sooty Owl *(Tyto tenebricosa),* Masked Owl *(Tyto novaehollandiae).*'.

Goldingay, RL 2009, 'Characteristics of tree hollows used by Australian birds and bats', *Wildlife Research*, no. 36, pp. 394-409.

Heritage, OoEa 2015, *Powerful Owl Species Profile* viewed 11/08/15 <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10562>.

Parsons Brinckerhoff 2014, *Newcastle Inner City Bypass, Rankin Park to Jesmond, Preliminary Environmental Investigation*, An unpublished report prepared for the Roads and Maritime Services, Newcastle, NSW.



Appendix A

Hollow-bearing tree data (2014-2015)

A1. Hollow-bearing tree data

Table A1.1 Hollow bearing tree survey results (2014-2015)

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
2014											
1	*Angophora costata*	377579.4702	6355779.452	0	1	1	Alive	160	B, T	Moderate	
2	*Corymbia maculata*	377564.4254	6355782.904	0	1	1	Alive	120	B, B	Moderate	
3	*Corymbia maculata*	377539.7914	6355809.694	2		1	Alive	120	B, T	Moderate	
4	*Corymbia gummifera*	377751.7065	6355983.507	1	0	3	Alive	130	B, B	Moderate	
5	*Corymbia gummifera*	377752.1245	6355988.105	0	0	1	Alive	90	T	Moderate	
6	*Angophora costata*	377742.433	6356010.218	3	0	1	Alive	90	B, B	Moderate	
7	Stag	377680.9157	6356120.657	1	1	1	Dead	50	B, B, B	Moderate	Stag watched (2014)
8	*Angophora costata*	377660.8879	6356207.31	0	0	3	Alive	80	B, B, B	Moderate	Stag watched (2015)
9	*Angophora costata*	377555.9041	6356237.395	0	0	1	Alive	160	T	Moderate	
10	*Angophora costata*	377501.3984	6356410.643	2	4	3	Alive	160	B, B, B	High	Stag watched (2014). **Confirmed Powerful Owl nest tree (2015)**
11	*Angophora costata*	377497.7636	6356470.616	0	0	1	Alive	50	B	Moderate	
12	Stag	377324.1178	6356541.127	0	0	1	Dead	50	T	Moderate	
13	*Eucalyptus piperita*	377235.1335	6356589.646	3	0	3	Alive	170	B,B	Moderate	
14	*Angophora costata*	377284.117	6356708.645	1	8	3	Alive	200	B,B,B	Moderate	
15	*Eucalyptus punctata*	377689.9555	6356285.666	3	0	1	Alive	180	B, B	High	Stag watched (2014)
16	*Corymbia maculata*	377672.7549	6356294.204	0	0	2	Alive	200	B	High	Stag watched (2014)
17	*Eucalyptus punctata*	377775.4423	6356196.923	0	0	1	Alive	70	T	Moderate	Stag watched (2014)
18	Stag	377785.0407	6356195.123	0	0	1	Dead	90	T	Moderate	Stag watched (2014)
19	*Eucalyptus acmenoides*	377817.4252	6356224.511	0	1	1	Alive	90	B, T	Moderate	Stag watched (2014)
20	*Eucalyptus acmenoides*	377829.402	6356200.558	0	1	1	Alive	80	B, T	Moderate	Stag watched (2014)

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
21	*Eucalyptus acmenoides*	377856.6864	6356162.449	1	0	1	Alive	80	B,B	Moderate	Stag watched (2014)
22	*Corymbia maculata*	377861.2936	6356086.193	0	0	1	Alive	100	B	Moderate	Stag watched (2014)
23	*Eucalyptus piperita*	377512.4249	6356508.23	0	0	2	Alive	90	T, B	Moderate	
24	*Eucalyptus piperita*	377531.1244	6356529.507	2	0	0	Alive	130	B		
25	*Angophora costata*	377532.601	6356545.449	1	4	3	Alive	140	B,B,B	High	Stag watched (2014)
26	*Eucalyptus piperita*	377568.8761	6356484.078	2	0	0	Alive	100	B		
27	*Corymbia maculata*	377584.1145	6356477.363	1	2	0	Alive	110	B,B		
28	*Eucalyptus resinifera*	377629.5712	6356452.568	2	1	0	Alive	90	B,B		
29	*Eucalyptus umbra*	377591.9171	6356452.006	0	1	0	Alive	80	B		
30	*Angophora costata*	377589.3385	6356442.268	0	0	1	Alive	120	T	Moderate	Stag watched (2014)
31	*Eucalyptus resinifera*	377586.6241	6356438.536	0	1	1	Alive	100	B,T	Moderate to low	Stag watched (2014)
32	*Angophora costata*	377613.4288	6356430.393	0	1	0	Alive	90	B		
33	*Eucalyptus resinifera*	377612.5594	6356411.65	2	0	0	Alive	100	B		
34	Stag	377641.749	6356402.012	1	1	0	Dead	60	B, T		
35	*Eucalyptus punctata*	377662.4597	6356398.876	1	0	0	Alive	50	B		
36	Stag	377693.4484	6356376.682	2	4	0	Dead	130	B,B		
37	*Corymbia maculata*	377732.3625	6356397.199	2	1	0	Alive	110	B		
38	*Corymbia maculata*	377752.1266	6356377.853	1	0	1	Alive	90	B,B	Moderate to low	
39	*Eucalyptus umbra*	377778.3509	6356360.625	1	0	0	Alive	80	B		
40	Stag	377781.9794	6356351.554	4	0	0	Dead	70	B		
41	*Eucalyptus punctata*	377762.6273	6356349.135	0	2	0	Alive	110	B		
42	Stag	377745.6941	6356340.063	3	1	0	Dead	90	B,T		
43	Stag	377719.3537	6356313.189	0	4	0	Dead	60	T, B		
44	*Eucalyptus punctata*	377707.6248	6356287.839	2	0	0	Alive	130	B		
45	*Eucalyptus umbra*	377719.2275	6356281.534	1	0	1	Alive	140	B,T	Moderate	Stag watched (2014)
46	*Corymbia maculata*	377734.9921	6356279.894	2	0	0	Alive	110	B		
47	Stag	377755.5596	6356310.979	3	1	0	Dead	100	B,B		
48	*Corymbia maculata*	377808.4185	6356321.327	0	0	1	Alive	90	T	Moderate to low	
49A	Stag	377817.0808	6356291.917	0	1	0	Dead	90	T	Low	Stag watched (2014)
49B	*Angophora costata*	377851.8764	6356237.523	0	0	1	Alive	110	T	Moderate to low	Stag watched (2014)

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
50	*Eucalyptus punctata*	377856.4327	6356237.894	1	2	1	Alive	160	B,B,T	Moderate to low	Stag watched (2014)
51	*Corymbia maculata*	377855.5214	6356221.593	2	1	0	Alive	100	B,B		
52	Stag	377871.1068	6356140.368	0	4	0	Dead	110	B	Low	Stag watched (2014)
53	*Eucalyptus umbra*	377837.1536	6356101.209	0	1	0	Alive	100	B		
54	*Corymbia gummifera*	377763.3014	6355953.789	0	0	1	Alive	0.8	B	Moderate	
55	*Eucalyptus piperita*	377775.3271	6355962.162	3	0	0	Alive	1.1	B		
56	*Eucalyptus resinifera*	377803.0277	6355900.803	3	0	0	Alive	0.5	B		
57	*Eucalyptus punctata*	377842.1818	6355917.465	4	0	0	Alive	1.1	B, T		
58	*Eucalyptus punctata*	377847.4556	6355927.807	0	1	1	Alive	1.4	B,B	Moderate to low	Stag watched (2014)
59	*Eucalyptus punctata*	377820.5282	6355943.228	2	1	0	Alive	0.7	B,T		
60	Stag	377808.8785	6355987.134	0	0	1	Dead	1.0	T	Moderate	Stag watched (2014)
61	*Angophora costata*	377812.9581	6355989.642	2	1	0	Alive	1.1	B		
62	*Corymbia gummifera*	377801.3564	6355983.681	3	0	0	Alive	1.0	B		
63	Stag	377787.9125	6356009.134	0	0	1	Dead	0.9	T	Moderate to low	Stag watched (2014)
64	*Corymbia gummifera*	377774.9856	6356020.214	2	1	0	Alive	0.8	T, B		
65	*Corymbia gummifera*	377771.4535	6356042.739	2	0	1	Alive	2.0	B,B		
66	*Angophora costata*	377779.8591	6356069.245	3	1	0	Alive	0.8	B,B		
67	*Corymbia gummifera*	377768.1183	6356078.566	2	0	1	Alive	1.2	B,B	Moderate to low	
68	Stag	377823.4855	6356056.682	0	1	1	Dead	1.1	T,T		
69	Stag	377825.2498	6356037.834	1	0	2	Dead	1.1	T,T	Moderate	Stag watched (2014)
70	*Eucalyptus punctata*	377890.5641	6356059.578	1	3	0	Alive	1.0	B,B		
71	*Eucalyptus punctata*	377914.2258	6356049.006	0	1	1	Alive	1.3	B,T		
72	*Eucalyptus piperita*	377857.4271	6356041.637	3	0	0	Alive	1.0	T,B		
73	*Corymbia maculata*	377854.3631	6356098.856	1	0	1	Alive	2.0	B, T	High	Stag watched (2014)
74	*Corymbia maculata*	377844.0844	6356081.412	3	0	0	Alive	1.8	T		
75	*Eucalyptus umbra*	377790.2458	6356162.542	1	1	0	Alive	0.8	B,T		
76	*Eucalyptus piperita*	377787.6671	6356140.858	0	1	0	Alive	0.8	T		
77	*Corymbia maculata*	377771.9225	6356177.933	0	0	1	Alive	1.2	T	High	Stag watched (2014)
78	*Corymbia maculata*	377758.707	6356168.106	2	0	1	Alive	1.1	T,T	High	Stag watched (2014)
79	*Corymbia maculata*	377743.6802	6356168.008	0	1	2	Alive	1.2	T,B	High	Stag watched (2014)
80	*Eucalyptus punctata*	377730.917	6356186.648	4	0	0	Alive	1.8	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
81	*Eucalyptus resinifera*	377700.8634	6356193.871	1	0	1	Alive	1.0	B,T	High	Stag watched (2014)
82	*Eucalyptus resinifera*	377688.7721	6356226.106	0	0	1	Alive	0.8	B	Low	Stag watched (2015)
83	*Angophora costata*	377651.5639	6356235.352	0	0	1	Alive	1.2	T	High	Fallen over
84	*Eucalyptus piperita*	377631.5262	6356232.942	3	1	0	Alive	0.8	B,T		
85	*Eucalyptus piperita*	377607.327	6356239.362	2	3	0	Alive	1.0	B,B		
86	*Eucalyptus piperita*	377611.8511	6356220.468	0	1	0	Alive	1.1	T		
87	*Eucalyptus resinifera*	377576.8618	6356230.786	0	2	1	Alive	1.2	B,T	High	Stag watched (2014)
88	*Corymbia maculata*	377545.7817	6356262.953	0	1	0	Alive	1.3	B		
89	*Corymbia maculata*	377502.7952	6356264.889	0	5	0	Alive	1.8	B		
90	Stag	377491.3456	6356272.41	4	0	0	Dead	1.2	T,B		
91	Stag	377493.5191	6356282.673	3	0	0	Dead	1.1	B		
92	Stag	377520.3489	6356307.125	0	0	1	Dead	1.2	T	Moderate	
93	*Eucalyptus punctata*	377538.0032	6356325.577	4	0	0	Alive	1.3	B		
94	*Angophora costata*	377569.2169	6356333.666	0	0	1	Alive	1.3	T	Moderate	Stag watched (2015)
95	*Eucalyptus resinifera*	377594.8132	6356300.821	1	0	0	Alive	0.8	B		
96	Stag	377614.0193	6356298.052	1	0	1	Dead	1.2	T,T	Moderate	Stag watched (2014)
97	*Eucalyptus punctata*	377602.7632	6356315.094	3	2	0	Alive	1.0	B,B		
98	*Eucalyptus piperita*	377612.2741	6356307.298	0	3	1	Alive	1.1	B,T	High	Stag watched (2014)
99	*Eucalyptus punctata*	377605.5132	6356309.523	2	0	0	Alive	0.8	B		
100	*Angophora costata*	377623.3958	6356320.122	2	1	1	Alive	1.1	B,B,T	High	Stag watched (2015)
101	*Eucalyptus punctata*	377632.3189	6356318.087	5	1	0	Alive	2.0	B,T		
102	*Eucalyptus resinifera*	377638.9469	6356288.161	2	0	0	Alive	1.1	T		
103	*Eucalyptus umbra*	377665.0433	6356332.761	0	1	0	Alive	1.0	T		
104	*Angophora costata*	377657.464	6356318.551	1	1	0	Alive	1.3	B,T		
105	*Corymbia gummifera*	377630.0933	6356352.065	2	0	0	Alive	1.2	T		
106	*Angophora costata*	377562.2758	6356421.001	0	1	1	Alive	1.3	B,T	Moderate	Stag watched (2015)
107	*Eucalyptus piperita*	377534.2649	6356430.8	0	4	1	Alive	2.4	B,B	Moderate	Stag watched (2015)
108	Stag	377456.4755	6355906.898	0	3	0	Dead	0.8	B		
109	*Eucalyptus umbra*	377463.0871	6355895.113	2	0	0	Alive	0.8	B		Glider scarring on tree
110	Stag	377461.8654	6355884.466	0	0	1	Dead	1.1	T	Low	
111	*Corymbia maculata*	377464.5009	6355856.16	0	3	0	Alive	1.2	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
112	*Angophora costata*	377486.8426	6355869.8	2	3	0	Alive	1.8	B,B		
113	*Eucalyptus umbra*	377497.3585	6355826.463	2	3	0	Alive	1.2	B,B		
114	Stag	377510.3386	6355777.273	0	2	1	Dead	1.8	B,B	Moderate	
115	*Angophora costata*	377534.8294	6355793.795	0	1	0	Alive	1.6	B		
116	*Corymbia maculata*	377534.1274	6355810.499	1	2	0	Alive	1.8	B		
117	*Angophora costata*	377585.2287	6355769.31	0	1	0	Alive	1.2	B		
118	*Corymbia maculata*	377659.4759	6355772.318	0	0	2	Alive	1.2	B		
119	*Corymbia maculata*	377761.9449	6355841.876	2	3	0	Alive	1.2	B		
120	*Corymbia maculata*	377748.5038	6355834.506	1	1	0	Alive	1.2	B,B		
121	*Corymbia maculata*	377804.426	6355856.426	1	2	0	Alive	1.1	B,B		
122	*Angophora costata*	377685.1501	6355758.882	0	2	0	Alive	1.2	B		
123	*Angophora costata*	377671.4181	6355720.873	0	1	0	Alive	1.3	B		
124	*Angophora costata*	377650.1451	6355706.27	3	1	0	Alive	1.2	B,B		
125	*Eucalyptus punctata*	377739.7345	6358238.499	1	2	0	Alive	1.0	B,B		
126	*Eucalyptus punctata*	377749.123	6358233.552	2	0	0	Alive	1.2	B		
127	*Eucalyptus punctata*	377755.9744	6358228.794	2	3	0	Alive	1.2	B		
128	*Corymbia maculata*	377783.3797	6358226.7	2	0	0	Alive	2.0	B,T		
129	*Eucalyptus saligna*	377818.6366	6358231.302	0	4	0	Alive	2.0	B		
130	*Eucalyptus saligna*	377814.7495	6358230.688	3	6	1	Alive	2.3	B,B,B		
131	*Eucalyptus acmenoides*	377808.9187	6358210.536	3	0	0	Alive	1.2	T		
132	*Eucalyptus propinqua*	377808.9187	6358205.013	3	0	0	Alive	1.1	T		
133	*Corymbia maculata*	377812.9082	6358201.432	3	0	0	Alive	1.0	T		
134	Stag	377690.4589	6358056.84	2	1	0	Dead	1.1	B,T		
135	*Angophora costata*	377466.6418	6357619.029	3	0	0	Alive	0.75	B		
136	*Eucalyptus fergusonii*	377452.9829	6357620.736	1	0	0	Alive	0.80	T		
137	*Eucalyptus fergusonii*	377444.8693	6357631.403	0	1	0	Alive	0.7	T		
138	*Corymbia maculata*	377442.106	6357530.292	3	0	0	Alive	0.6	B		
139	*Eucalyptus punctata*	377393.1169	6357498.726	0	1	0	Alive	0.65	B		
140	*Eucalyptus umbra*	377330.5765	6357464.319	0	1	0	Alive	0.6	T		
141	*Eucalyptus punctata*	377228.5808	6357319.435	3	0	0	Alive	0.6	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
142	*Eucalyptus umbra*	377266.1374	6357300.949	2	2	0	Alive	0.7	B		
143	*Eucalyptus punctata*	377331.1367	6357263.446	3	0	0	Alive	0.8	B		
144	*Eucalyptus punctata*	377392.9882	6357237.491	3	0	0	Alive	0.5	B		
145	*Eucalyptus piperita*	377384.2144	6357229.702	1	0	0	Alive	0.5	B		
146	*Eucalyptus umbra*	377378.8026	6357232.489	0	1	0	Alive	0.35	T		
147	*Eucalyptus piperita*	377383.0665	6357216.91	1	0	0	Alive	0.65	B		
148	*Eucalyptus umbra*	377265.4036	6357215.633	0	2	0	Alive	0.6	B		
149	*Angophora costata*	377336.9261	6357157.768	2	1	0	Alive	0.6	B,B		
150	*Angophora costata*	377377.6795	6357161.519	4	1	0	Alive	1.2	B,B		
151	*Eucalyptus piperita*	377435.1157	6357139.672	1	0	0	Alive	1.0	B		
152	*Eucalyptus piperita*	377429.6284	6357122.716	2	0	0	Alive	1.0	B		
153	*Eucalyptus piperita*	377444.6689	6357127.466	0	1	0	Alive	1.1	T		
154	*Eucalyptus piperita*	377483.2957	6357109.018	0	1	0	Alive	0.8	B		
155	Stag	377484.6108	6357080.035	3	1	0	Dead	0.8	B,B		
156	*Angophora costata*	377528.8703	6357019.182	4	3	0	Alive	1.3	B,B		
157	*Angophora costata*	377386.5109	6357104.856	1	2	0	Alive	1.1	B,B		
158	*Eucalyptus piperita*	377352.2195	6357115.048	1	0	0	Alive	1.0	T		
159	*Angophora costata*	377351.5633	6357095.757	1	2	0	Alive	1.1	B		
160	*Angophora costata*	377289.8687	6357108.065	0	3	3	Alive	2.0	B,T	High	Stag watched (2015)
161	*Eucalyptus piperita*	377285.783	6357113.08	1	0	0	Alive	1.2	T		
162	*Angophora costata*	377286.7526	6357108.68	1	1	0	Alive	0.7	T		
163	*Eucalyptus piperita*	377307.1126	6357130.647	2	0	0	Alive	0.6	B		
164	*Eucalyptus umbra*	377269.7725	6357121.323	2	0	0	Alive	0.4	T		
165	*Eucalyptus umbra*	377198.6558	6357134.234	0	1	0	Alive	0.6	T		
166	*Angophora costata*	377184.0866	6357150.699	2	0	0	Alive	1.2	B		
167	*Eucalyptus piperita*	377185.0349	6357127.337	2	0	1	Alive	0.8	B,B		
168	*Eucalyptus piperita*	377189.0414	6357097.27	2	0	1	Alive	0.6	B,T		
169	*Angophora costata*	377392.8418	6357033.512	0	1	1	Alive	0.8	B,T	Moderate	Stag watched (2015)
170	*Eucalyptus punctata*	377414.8589	6357063.247	3	0	0	Alive	0.65	B		
171	*Corymbia maculata*	377390.0045	6357055.189	0	1	0	Alive	1.0	B		
172	*Angophora costata*	377334.4931	6356953.569	1	1	0	Alive	0.8	B,T		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
173	*Eucalyptus piperita*	377341.7074	6356950.22	1	0	0	Alive	1.0	B		
174	*Angophora costata*	377275.9503	6356957.017	0	2	1	Alive	1.0	B,T	Moderate	Stag watched (2015)
175	*Eucalyptus piperita*	377263.0145	6356952.589	1	3	0	Alive	0.8	B,B		
176	*Eucalyptus piperita*	377257.1108	6356932.968	1	2	0	Alive	0.6	T,B		
177	*Eucalyptus piperita*	377210.7718	6356929.868	2	0	0	Alive	0.6	T,B		
178	*Eucalyptus piperita*	377187.834	6356952.368	0	0	1	Alive	1.0	T	Low	
179	*Angophora costata*	377186.8318	6357001.727	2	2	0	Alive	0.7	B,B		
180	Stag	377190.7494	6356997.851	1	1	0	Dead	0.5	B,B		
181	*Eucalyptus capitellata*	377171.6851	6356985.992	0	1	0	Alive	0.6	T		
182	*Angophora costata*	377674.1574	6356138.055	0	2	3	Alive	0.8	B, T	High	Stag watched (2014)
183	*Eucalyptus resinifera*	377676.2326	6356130.712	0	0	1	Alive	0.7	T	High	Stag watched (2014)
184	*Angophora costata*	377660.4962	6356099.54	0	0	1	Alive	1.0	T	High	Stag watched (2014)
185	Stag	377779.0677	6356205.056	0	0	1	Dead	0.65	T	Moderate	Stag watched (2014)
186	*Corymbia maculata*	377811.7668	6356245.205	0	0	1	Alive	1.1	B	Moderate	Stag watched (2014)
187	*Eucalyptus resinifera*	377794.9861	6356248.82	0	1	0	Alive	0.7	T		
188	*Eucalyptus piperita*	377675.711	6356119.339	0	1	0	Alive	0.6	T		
189	Stag	377259.5013	6356882.491	0	2	0	Dead	0.9	B		
190	*Eucalyptus piperita*	377287.3768	6356898.334	0	1	0	Alive	1.0	B		
191	*Eucalyptus piperita*	377305.3254	6356898.836	0	3	0	Alive	1.0	B		
192	*Eucalyptus piperita*	377305.7265	6356894.624	2	3	0	Alive	1.0	B,B		
193	Stag	377324.8784	6356887.906	0	1	0	Dead	0.9	T		
194	Stag	377339.6183	6356915.08	0	1	0	Dead	0.7	B		
195	*Corymbia gummifera*	377375.9093	6356900.16	2	0	0	Alive	0.6	B		
196	*Eucalyptus piperita*	377359.8946	6356877.254	2	1	0	Alive	0.8	B,B		
197	*Eucalyptus umbra*	377359.8946	6356876.795	1	1	0	Alive	0.8	T,B		
198	*Eucalyptus piperita*	377359.557	6356873.509	1	2	0	Alive	0.7	B,B		
199	*Angophora costata*	377239.9965	6356808.842	3	0	0	Alive	1.2	B		
200	*Angophora costata*	377210.6703	6356819.369	3	0	0	Alive	1.1	B		
201	Stag	377203.1508	6356833.656	2	0	0	Dead	0.6	B		
202	*Angophora costata*	377189.9916	6356831.024	0	1	1	Alive	0.9	B,B		Bee Hive present
203	*Angophora costata*	377164.4252	6356828.016	2	3	0	Alive	1.1	B,B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
204	*Eucalyptus capitellata*	377164.8011	6356777.259	1	0	0	Alive	0.9	T		
205	*Eucalyptus capitellata*	377209.1664	6356775.756	0	1	1	Alive	0.7	B,T	Moderate	
206	*Eucalyptus capitellata*	377207.2865	6356767.108	0	1	0	Alive	0.6	B		
207	Stag	377216.3099	6356751.317	0	2	0	Dead	0.7	B		
208	Stag	377242.6283	6356764.852	0	2	0	Dead	0.6	T		
209	*Angophora costata*	377277.2181	6356791.923	2	0	0	Alive	0.6	B		
210	*Angophora costata*	377275.7142	6356788.163	1	1	0	Alive	0.7	B,B		
211	*Eucalyptus capitellata*	377274.5863	6356773.5	3	2	0	Alive	0.8	B,B		
212	*Eucalyptus piperita*	377287.3695	6356808.09	3	1	0	Alive	1.0	B,T		
213	*Angophora costata*	377297.8969	6356805.834	1	0	0	Alive	0.9	B		
214	*Eucalyptus piperita*	377299.7767	6356821.249	1	1	0	Alive	0.9	B,B		
215	*Eucalyptus piperita*	377322.3353	6356829.52	1	0	0	Alive	0.8	T		
216	Stag	377366.7006	6356802.45	0	1	0	Dead	0.6	T		
217	*Eucalyptus piperita*	377377.2361	6356779.252	0	1	0	Alive	0.8	B		
218	*Eucalyptus piperita*	377397.7635	6356801.455	2	0	0	Alive	0.7	B		
219	*Eucalyptus piperita*	377412.4258	6356807.32	2	0	0	Alive	0.5	B		
220	*Eucalyptus piperita*	377414.7299	6356837.274	1	2	0	Alive	0.6	B		
221	Stag	377405.9325	6356852.355	0	1	1	Dead	0.8	B,T	Low	Stag watched (2015)
222	Stag	377390.4323	6356848.166	1	0	0	Dead	0.9	B		
223	*Angophora costata*	377392.7364	6356870.159	0	1	0	Alive	0.9	B		
224	*Angophora costata*	377411.588	6356861.362	0	1	0	Alive	0.8	B		
225	*Eucalyptus piperita*	377424.9936	6356858.848	0	2	0	Alive	1.1	B		
226	*Eucalyptus resinifera*	377423.7368	6356863.875	1	0	0	Alive	1.1	B		
227	Stag	377448.0719	6356875.854	2	0	0	Dead	0.6	B		
228	*Angophora costata*	377466.8943	6356868.488	0	4	1	Alive	1.2	B,B		
229	*Eucalyptus piperita*	377467.7127	6356837.39	1	0	0	Alive	0.9	T		
230	*Eucalyptus piperita*	377467.7127	6356820.205	1	1	0	Alive	1.0	B,T		
231	*Eucalyptus piperita*	377449.2994	6356818.159	1	0	0	Alive	0.8	T		
232	*Eucalyptus piperita*	377455.028	6356806.702	0	1	0	Alive	0.9	T		
233	Stag	377435.7964	6356788.288	2	0	0	Dead	0.5	B		
234	*Angophora costata*	377453.8004	6356785.015	1	0	0	Alive	1.1	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
235	*Eucalyptus umbra*	377441.525	6356777.65	1	0	0	Alive	0.8	B		
236	*Eucalyptus piperita*	377360.5068	6356740.823	1	1	0	Alive	0.8	B		
237	*Eucalyptus umbra*	377301.1753	6356757.6	2	0	0	Alive	0.7	B		
238	*Eucalyptus umbra*	377259.8478	6356743.278	0	1	0	Alive	1.1	B		
239	*Corymbia gummifera*	377264.758	6356724.456	2	0	0	Alive	0.7	B		
240	*Eucalyptus piperita*	377262.3029	6356724.456	0	1	0	Alive	0.7	B		
241	Stag	377198.0612	6356737.959	2	0	0	Dead	0.5	B		
242	*Eucalyptus piperita*	377175.147	6356733.867	2	1	0	Alive	0.6	B,B		
243	*Eucalyptus piperita*	377173.9162	6356707.596	1	2	0	Alive	0.7	B,B		
244	*Eucalyptus resinifera*	377178.768	6356662.544	2	0	0	Alive	0.9	B		
245	Stag	377198.1749	6356648.682	0	1	0	Dead	0.8	T		
246	Stag	377195.4025	6356680.565	1	1	0	Dead	0.5	B,T		
247	*Eucalyptus umbra*	377210.6508	6356694.427	1	0	0	Alive	0.7	T		
248	*Eucalyptus umbra*	377215.1647	6356686.708	1	0	0	Alive	0.7	T		
249	Stag	377257.9726	6356674.552	0	1	0	Dead	0.5	T		
250	*Angophora costata*	377305.537	6356695.692	0	2	0	Alive	0.7	T		
251	*Eucalyptus piperita*	377350.6168	6356713.503	0	1	0	Alive	0.8	B		
252	*Angophora costata*	377394.0447	6356732.618	0	0	1	Alive	0.9	B	High	Stag watched (2015)
253	*Corymbia gummifera*	377404.2208	6356730.684	0	2	0	Alive	0.9	B		
254	*Eucalyptus punctata*	377418.8542	6356750.363	2	0	1	Alive	1.1	B,B	High	Stag watched (2015)
255	Stag	377425.1617	6356759.193	0	0	1	Dead	1.2	T	Moderate	Stag watched (2015)
256	*Eucalyptus punctata*	377418.8542	6356727.656	0	1	0	Alive	1.0	B		
257	*Corymbia gummifera*	377369.3898	6356707.818	1	0	0	Alive	0.6	B		
258	*Corymbia gummifera*	377366.8167	6356670.39	1	0	0	Alive	0.5	T		
259	*Eucalyptus piperita*	377370.5595	6356654.483	1	1	0	Alive	0.8	B		
260	*Eucalyptus piperita*	377348.1028	6356672.261	2	0	0	Alive	0.7	T		
261	*Eucalyptus piperita*	377285.2568	6356634.229	1	0	0	Alive	0.7	T		
262	*Angophora costata*	377307.9337	6356614	0	1	0	Alive	0.8	T		
263	*Angophora costata*	377301.5699	6356608.432	2	1	0	Alive	0.7	B		
264	*Eucalyptus piperita*	377315.0929	6356598.09	2	1	0	Alive	0.8	B		
265	*Angophora costata*	377338.1617	6356637.069	1	0	0	Alive	0.6	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
266	*Angophora costata*	377358.4463	6356593.715	1	0	0	Alive	0.8	B		
267	*Eucalyptus capitellata*	377356.8554	6356581.783	0	1	0	Alive	0.8	T		
268	Stag	377365.6056	6356575.419	0	1	1	Dead	1.4	B,T	Moderate to low	
269	Stag	377377.5377	6356578.601	2	1	0	Dead	0.9	B,B		
270	*Angophora costata*	377392.254	6356609.227	0	2	0	Alive	1.2	B		
271	*Eucalyptus piperita*	377397.0268	6356626.727	0	0	1	Alive	0.9	T		
272	Stag	377434.4141	6356610.818	1	0	0	Dead	0.7	B		
273	Stag	377439.9824	6356609.227	1	1	0	Dead	0.7	B,B		
274	Stag	377434.8119	6356572.237	0	2	1	Dead	1.0	B,B	Moderate	Stag watched (2014)
275	Stag	377438.5553	6356616.071	1	2	0	Dead	0.9	B		
276	*Eucalyptus piperita*	377411.0075	6356623.18	2	1	0	Alive	1.0	B,B		
277	*Eucalyptus piperita*	377388.3472	6356651.172	0	2	0	Alive	1.2	T		
278	Stag	377488.7633	6356617.404	0	2	0	Dead	0.9	T		
279	*Angophora costata*	377516.3111	6356628.956	1	0	0	Alive	0.8	B		
280	*Eucalyptus resinifera*	377525.1975	6356586.302	1	1	0	Alive	0.9	B,B		
281	*Eucalyptus resinifera*	377534.5282	6356553.866	2	0	1	Alive	1.0	B,T	Moderate	Stag watched (2014)
282	*Eucalyptus resinifera*	377522.9926	6356545.008	0	1	0	Alive	1.0	B	Moderate	
283	*Eucalyptus resinifera*	377520.3711	6356556.804	1	2	0	Alive	1.1	B,B	Moderate	
284	*Eucalyptus resinifera*	377491.0435	6356538.718	1	2	0	Alive	1.0	B,B	Moderate	
285	*Eucalyptus resinifera*	377486.1034	6356532.88	2	0	0	Alive	1.0	B		
286	*Angophora costata*	377462.8448	6356589.028	0	0	1	Alive	1.2	T	Moderate	Stag watched (2014)
287	Stag	377432.1806	6356542.62	0	0	1	Dead	1.0	T	Moderate	
288	Stag	377414.0254	6356547.159	0	2	1	Dead	1.1	T		
2015											
301	*Eucalyptus saligna*	377955.7045	6358175.551	1	3		Alive	95	T, B	Moderate	Stag watched (2015)
302	*Eucalyptus saligna*	377940.4452	6358200.059	8	9		Alive	100	T, B		
303	*Eucalyptus saligna*	377946.4366	6358195.931		4		Alive	95	B		
304	*Eucalyptus saligna*	377917.7091	6358196.888	5	3		Alive	85	T, B		
305	*Eucalyptus punctata*	377910.8464	6358194.494	3			Alive	95	B		
306	*Eucalyptus saligna*	377813.2641	6358215.837	3	8	1	Alive	105	T, B,		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
307	*Eucalyptus saligna*	377808.6292	6358226.791	1	6		Alive	90	B, B/T		
308	*Corymbia maculata*	377813.1478	6358195.16	5	1		Alive	80	T,T		
309	Stag	377781.1515	6358136.408				Dead	20			Decorticating bark
310	Stag	377766.0495	6358107.309				Dead	25			Decorticating bark
311	*Eucalyptus umbra*	377737.0663	6358051.64	2			Alive	25	T/B		
312	Stag	377738.726	6358042.409	10	3		Dead	85	B, T		
313	*Eucalyptus fibrosa*	377726.3678	6357980.887		1		Alive	75	T		
314	Stag	377752.4572	6357976.087	7	1		Dead	30	B, T		
315	*Eucalyptus fibrosa*	377732.2481	6357955.217	3			Alive	60	B		
316	*Eucalyptus punctata*	377728.4702	6357913.587	2			Alive	55	B		Decorticating bark
317	*Eucalyptus punctata*	377705.7602	6357894.401				Alive	30			Decorticating bark
318	*Eucalyptus punctata*	377706.1407	6357899.296				Alive	35			Decorticating bark
319	*Eucalyptus punctata*	377700.7761	6357889.477	1			Alive	25	B		Decorticating bark
320	*Eucalyptus fibrosa*	377690.9518	6357871.544	3			Alive	70	B		Bee hive
321	*Eucalyptus fibrosa*	377679.8345	6357835.244	3	1		Alive	65	B, T		Decorticating bark
322	*Eucalyptus fibrosa*	NA	NA	5			Alive	30	B		
323	*Eucalyptus fibrosa*	NA	NA	2			Alive	70	B		
324	*Eucalyptus punctata*	377666.7286	6357793.83	2			Alive	25	B		
325	*Eucalyptus umbra*	377648.577	6357804.433	2			Alive	90	B		
326	*Eucalyptus fibrosa*	377574.1265	6357691.291	3			Alive	75	B		
327	*Eucalyptus punctata*	NA	NA	1			Alive	65	B		
328	*Corymbia maculata*	377584.8704	6357644.734	5	1		Alive	80	B		
329	*Eucalyptus punctata*	377558.3343	6357620.822	2	3		Alive	80	B, T/B		
330	*Eucalyptus punctata*	377572.5269	6357605.738	1			Alive	70	B		
331	*Eucalyptus acmenoides*	377561.5767	6357589.085	1	4		Alive	90	B, B/T		
332	*Eucalyptus acmenoides*	377560.6603	6357566.657	3			Alive	95	B		
333	*Eucalyptus punctata*	377631.9819	6357525.637	2			Alive	85	B		
334	*Eucalyptus punctata*	377648.8271	6357521.944	1			Alive	95	B		
335	*Eucalyptus umbra*	377647.1921	6357487.762	2			Alive	85	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
336	*Corymbia maculata*	377643.7492	6357474.792	4	3		Alive	120	B, B		
337	Stag	377659.9605	6357473.494	1	4		Dead	95	T, B		
338	*Eucalyptus punctata*	377651.8609	6357451.581	1	1		Alive	85	B, B		
339	*Eucalyptus punctata*	377666.44	6357450.911	2			Alive	70	B		
340	*Eucalyptus punctata*	377671.0929	6357429.044	3			Alive	90	B		
341	*Eucalyptus umbra*	377645.1391	6357418.293	4			Alive	75	B		
342	*Corymbia maculata*	377665.8875	6357402.907			1	Alive	100	T		
343	*Corymbia maculata*	377710.2261	6357413.327	7	2		Alive	95	B		
344	*Eucalyptus fibrosa*	NA	NA	2		1	Alive	110	B		
345	Stag	377721.0343	6357387.176	3	3		Dead	115	B, B		
346	*Corymbia maculata*	377713.396	6357389.176	3			Alive	95	B		
347	*Corymbia maculata*	NA	NA		1		Alive	95	B		
348	Stag	377686.8548	6357373.74	9	1	1	Dead	90	B, B,		
349	*Corymbia maculata*	377707.4529	6357373.339		3		Alive	95	B		
350	*Corymbia maculata*	377720.112	6357376.444	5	1		Alive	95	B		
351	*Corymbia maculata*	377715.9374	6357380.811	3			Alive	95	B		
352	*Eucalyptus acmenoides*	377744.3824	6357563.058	2			Alive	75	B		
353	*Corymbia maculata*	377725.2305	6357576.563	5	1		Alive	95	B, B		
354	*Eucalyptus acmenoides*	377716.0906	6357608.589	2	3		Alive	90	B, B		
355	*Eucalyptus umbra*	377725.9758	6357633.238	4			Alive	75	B		
356	*Eucalyptus acmenoides*	377714.4113	6357639.957	3			Alive	65	B		
357	*Eucalyptus acmenoides*	377722.254	6357655.706	3			Alive	80	B		
358	*Corymbia maculata*	377724.8682	6357648.735	1	1		Alive	90	B, B		
359	*Eucalyptus fibrosa*	377719.6398	6357672.263	5			Alive	85	B		
360	*Eucalyptus fibrosa*	377747.5245	6357711.475	2			Alive	85	B		
361	*Eucalyptus fergusonii*	377758.7805	6357757.048	2			Alive	70	B		
362	*Corymbia maculata*	377760.9385	6357774.328	1			Alive	95	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
363	*Corymbia maculata*	377751.4356	6357793.576	3			Alive	110	B		
364	*Eucalyptus punctata*	377769.9014	6357809.176	1			Alive	45	B		
365	*Corymbia maculata*	377766.1829	6357834.667	1			Alive	130	B		
366	*Eucalyptus fergusonii*	377778.3387	6357872.855	2			Alive	55	B		
367	*Eucalyptus fibrosa*	377775.9318	6357892.11	2			Alive	100	B		
368	*Eucalyptus umbra*	377781.6482	6357897.826	2	2	1	Alive	110	B, T/B		
369	Stag	377778.5167	6357907.447	1	1		Dead	30			
370	*Eucalyptus fibrosa*	377686.8548	6357373.74	2			Alive	110	B		Decorticating bark
371	*Angophora costata*	377802.036	6357954.378	10	4	1	Alive	140	B, B, T		
372	Stag	377815.5383	6357970.358	3			Dead	25	T		
373	*Corymbia maculata*	377825.4799	6358021.744	5			Alive	105	B		
374	*Eucalyptus umbra*	377845.3156	6358039.034	3		1	Alive	100	B, T		
375	*Corymbia maculata*	377860.3039	6358092.329	6			Alive	95	B		
376	*Corymbia gummifera*	377840.9675	6358075.982		1		Alive	110	B		
377	*Eucalyptus piperita*	377651.0372	6357091.51	4			Alive	50	B		
378	*Eucalyptus piperita*	377664.4467	6357106.748	1	1		Alive	110	B, B		
379	*Angophora costata*	377676.0277	6357095.167	2	2		Alive	85	B, T		
380	*Angophora costata*	377670.542	6357076.882		1		Alive	120	B		
381	*Eucalyptus piperita*	377683.9515	6357070.786	2			Alive	95	B		
382	*Eucalyptus piperita*	377697.9642	6357070.371	1			Alive	60	B		
383	*Eucalyptus piperita*	377679.7717	6357109.757	3			Alive	85	B		
384	*Eucalyptus piperita*	377678.3475	6357117.827		1		Alive	45	T		
385	*Eucalyptus piperita*	377681.1958	6357121.151	1			Alive	95	B		
386	*Eucalyptus piperita*	377691.1652	6357128.272	3	1		Alive	95	B, B		
387	*Angophora costata*	377682.1453	6357121.151	5	5		Alive	135	B, B		
388	Stag	377685.5135	6357163.383		1		Dead	135	T		
389	*Corymbia gummifera*	377691.2103	6357189.018	1	1		Alive	100	B, B		
390	Stag	377697.3487	6357206.628	1	3		Dead	55	B, T		
391	*Eucalyptus capitellata*	377666.0165	6357215.648		1		Alive	95	B		
392	*Eucalyptus capitellata*	377687.0829	6357234.206	1			Alive	95	B		
393	*Eucalyptus capitellata*	377702.4094	6357246.628	1	1		Alive	65	B, T		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
394	*Corymbia maculata*	377698.9368	6357264.859	1	2		Alive	130	B, B		
395	Stag	377689.3872	6357258.782	4			Dead	55	B		
396	*Angophora costata*	NA	NA		2	1	Alive	100	B, B		
397	*Angophora costata*	377696.5494	6357284.176	3	5		Alive	110	B, B		
398	*Eucalyptus punctata*	377707.2998	6357320.637	1	2		Alive	95	B, B		
399	Stag	377694.9089	6357330.892	4	2		Alive	95	B, B		
400	*Syncarpia glomulifera*	378004.0599	6358181.769		2		Alive	100	B		
401	*Syncarpia glomulifera*	378001.5382	6358166.328	2			Alive	80	B		
402	*Eucalyptus punctata*	377975.2657	6358157.461		2	1	Alive	120	B,T		
403	*Eucalyptus saligna*	377906.9095	6358163.604	3	2		Alive	140	B,T		
404	*Eucalyptus umbra/ acmenoides*	377904.478	6358148.489	2			Alive	120	B		
405	*Eucalyptus punctata*	377894.9037	6358166.337	2			Alive	110	B		
406	*Eucalyptus saligna*	377858.7965	6358219.119		3		Alive	140	T		
407	*Eucalyptus capitellata*	377863.1778	6358174.922		1		Alive	80	T		
408	*Eucalyptus punctata*	377862.6672	6358178.801		5		Alive	130	T		
409	*Eucalyptus punctata*	377871.5461	6358163.938		5		Alive	150	T		
410	*Corymbia maculata*	377870.8865	6358141.864	3			Alive	130	B		
411	*Eucalyptus punctata*	377885.1345	6358116.983	4	1		Alive	120	T,B		
412	*Eucalyptus punctata*	377827.8565	6358157.299	3	1		Alive	130	B		
413	Stag	377815.6119	6358133.753	5			Dead	120	B		
414	*Eucalyptus umbra*	377751.1602	6358066.527		1		Alive	130	B		
415	Stag	377782.8032	6358011.478	1			Dead	120	B		
416	*Eucalyptus umbra*	377783.3818	6358009.709	3			Alive	120	B		
417	*Corymbia maculata*	377813.036	6358001.87	3	1		Alive	150	B,T		
418	*Syncarpia glomulifera*	377772.1154	6357967.986	1		1	Alive	160	B		
419	*Eucalyptus umbra*	377783.3763	6357965.245		1		Alive	150	B		
420	Stag	377741.9135	6357929.579	1			Dead	80	B		
421	Stag	377749.9164	6357917.707	1			Dead	60	B		
422	Stag	377696.7037	6357804.156	2			Dead	70	B		
423	Stag	377674.5262	6357766.74	1			Dead	40	B		
424	Stag	377675.873	6357771.302		1		Dead	60	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
425	*Eucalyptus umbra*	377602.2522	6357712.279	2	1		Alive	180	B,B		
426	*Eucalyptus acmenoides*	377569.5857	6357646.45	1			Alive	120	T		Termite nest
427	Stag	377568.0147	6357637.229	1			Dead	100	T		
428	Stag	377650.2027	6357639.466	2			Dead	120	B		
429	Stag	377650.4275	6357643.466		1		Dead	150	T		
430	*Eucalyptus acmenoides*	377649.033	6357613.065	1	3		Alive	180	B, B		
431	*Corymbia maculata*	377639.6731	6357545.415		2		Alive	190	B	High	Stag watched (2015)
432	*Eucalyptus punctata*	377654.8771	6357518.659	2			Alive	120	B		
433	*Eucalyptus umbra*	377696.0674	6357493.331	2			Alive	130	B		
434	*Syncarpia glomulifera*	377683.5893	6357443.832		1		Alive	140	B		
435	*Eucalyptus punctata*	377688.4374	6357414.512	4	2		Alive	190	T,B		
436	*Eucalyptus acmenoides*	377698.8709	6357403.219		1		Alive	150	B		
437	Stag	377711.8524	6357412.135	2			Dead	60	B		
438	*Eucalyptus punctata*	377714.8434	6357457.306		1		Alive	110	B		
439	*Eucalyptus punctata*	377724.6973	6357514.869		1		Alive	120	T		
440	*Eucalyptus umbra*	377722.5542	6357522.055	2	1		Alive	140	T,B		Termite nest
447	*Syncarpia glomulifera*	377724.1796	6357549.019		2		Alive	80	T		
448	*Eucalyptus punctata*	377711.2447	6357536.33		2		Alive	110	T		
449	*Eucalyptus umbra*	377709.8386	6357551.723	1			Alive	70	T		
450	*Eucalyptus punctata*	377708.7489	6357541.616		2		Alive	100	T		
451	*Eucalyptus umbra*	377744.0708	6357552.036		2		Alive	140	T		
452	Stag	377740.7748	6357568.734	3			Dead	60	T		
453	*Syncarpia glomulifera*	377741.2114	6357593.584		1		Alive	160	B		
454	*Eucalyptus umbra*	377718.599	6357584.316		3		Alive	160	T,T		
455	*Eucalyptus umbra*	377690.1692	6357652.166		2		Alive	130	B		
456	*Eucalyptus umbra*	377700.3756	6357666.151	2			Alive	120	B		
457	Stag	377697.4628	6357705.04		2		Dead	120	B		
458	*Eucalyptus umbra*	377724.2432	6357710.14	2			Alive	130	B		
459	*Eucalyptus umbra*	377744.0586	6357726.242		1		Alive	120	T		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
460	*Corymbia maculata*	377743.376	6357826.809		4		Alive	160	T,B		
461	*Eucalyptus punctata*	377767.4342	6357840.297	4	2		Alive	130	B,T		
462	Stag	377748.834	6357861.471		2		Dead	110	T		
463	*Eucalyptus umbra*	377767.4177	6357924.467	2			Alive	120	B		Termite nest
464	*Eucalyptus umbra*	377822.6137	6357976.159	2	5		Alive	130	B,T		Termite nest
465	*Corymbia maculata*	377827.1013	6358051.835		5		Alive	170	B,T		
466	*Eucalyptus umbra*	377831.7282	6358078.948	2			Alive	110	B		
467	*Eucalyptus umbra*	377828.4418	6358094.875	1	3		Alive	160	B,T		
468	*Eucalyptus umbra*	377831.0373	6358104.332	4			Alive	120	B		
469	*Eucalyptus umbra*	377825.5872	6358129.109	3			Alive	130	B		
501	*Eucalyptus punctata*	377985.6583	6355923.817	3			Alive	140	B		
502	*Corymbia maculata*	377982.4675	6355922.627	2			Alive	110	B		
503	*Eucalyptus punctata*	377996.2929	6355930.392		4		Alive	140	T,B		
504	*Eucalyptus punctata*	378007.9404	6355929.161	1			Alive	120	B		
505	*Eucalyptus punctata*	378011.9063	6355931.604		9		Alive	130	B,T		
506	*Corymbia maculata*	378003.3297	6355937.364		5		Alive	140	T		
507	*Eucalyptus umbra*	378018.1289	6355949.301	1			Alive	130	B		
508	*Corymbia maculata*	378023.7095	6355955.014	1			Alive	110	B		
509	*Eucalyptus punctata*	378022.3303	6355957.152	4	1		Alive	110	B,B		
510	*Eucalyptus punctata*	378023.4336	6355965.013	1			Alive	40	B		
511	*Eucalyptus punctata*	378019.6651	6355975.76	4			Alive	170	B		Heavily trimmed
512	*Eucalyptus punctata*	378006.5433	6355948.108	7	3		Alive	150	B		
513	*Angophora costata*	377502.3034	6355243.787		4		Alive	100	B		
514	*Eucalyptus umbra*	377491.2087	6355225.583	2	7		Alive	130	B		
515	*Corymbia maculata*	377486.6657	6355183.903		3		Alive	120	B,T		
516	*Eucalyptus umbra*	377476.3159	6355149.302	2			Alive	110	B		
517	*Eucalyptus umbra*	377477.3721	6355121.845		1		Alive	110	T		
518	*Eucalyptus umbra*	377480.6797	6355124.405		1		Alive	110	T		
519	*Corymbia maculata*	377497.4656	6355010.257		2		Alive	150	B		
520	*Corymbia maculata*	377506.1887	6354978.917		2		Alive	120	B		
521	*Corymbia maculata*	377509.4595	6354962.564		4		Alive	180	B,T		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
522	*Corymbia maculata*	377480.3251	6355300.431		3		Alive	190	B		
523	*Corymbia maculata*	377480.7173	6355284.92	2			Alive	120	B		
524	*Corymbia maculata*	377472.1059	6355409.666	2	1		Alive	150	B,T		
525	*Eucalyptus umbra*	377521.3924	6355432.107	1			Alive	110	B		
526	*Corymbia maculata*	377550.4475	6355433.664		8		Alive	140	B		
527	*Corymbia maculata*	377562.8164	6355462.668	2	3		Alive	160	B		
528	*Corymbia maculata*	377574.0469	6355467.236		2		Alive	160	T		
529	*Corymbia maculata*	377495.8692	6355362.488		2		Alive	230	T		
530	*Eucalyptus capitellata*	377498.536	6355350.932	3			Alive	80	B		
531	*Corymbia maculata*	377491.4244	6355338.486		1		Alive	120	B		
532	*Angophora costata*	377488.9457	6356644.958		3		Alive	130	T,B	Low	Potential vertical hollow; Stag watched (2015)
533	*Angophora costata*	377516.3884	6356676.364	1			Alive	100	NB		Nest box
534	*Eucalyptus umbra*	377504.2286	6356682.371	1			Alive	110	NB		Nest box
535	*Angophora costata*	377533.4541	6356678.153		3		Alive	170	B		
536	*Eucalyptus piperita*	377534.5365	6356672.42	1			Alive	80	NB		Nest box
537	*Corymbia maculata*	377553.6478	6356658.883	1			Alive	100	NB		Nest box
538	*Eucalyptus piperita*	377563.3857	6356659.418	1	3		Alive	190	NB,B,B		Nest box
539	*Angophora costata*	377535.9024	6356649.474		1		Alive	140	NB		Nest box
540	*Eucalyptus piperita*	377540.5693	6356649.474	2			Alive	120	NB,B		Nest box
541	*Eucalyptus fibrosa/ fergusonii*	377514.3859	6356700.841	1			Alive	130	B		
542	*Angophora costata*	377512.9122	6356707.227	1			Alive	80	NB		Nest box
543	Stag	377521.7451	6356720.044	1	2		Dead	130	NB,B		Nest box
544	*Eucalyptus piperita*	377506.0617	6356723.454	2			Alive	140	B		
545	*Eucalyptus umbra*	377505.6071	6356737.546		2		Alive	150	NB		Nest box
546	*Eucalyptus piperita*	377518.7902	6356726.636	1	3		Alive	160	NB,B,B		Nest box
547	*Eucalyptus piperita*	377519.6994	6356741.637		4		Alive	160	NB,B		Nest box
548	*Angophora costata*	377536.9857	6356781.772	1			Alive	120	NB		Nest box
549	*Eucalyptus umbra*	377538.3495	6356789.955		1		Alive	170	NB		Nest box
550	*Eucalyptus umbra*	377531.5306	6356797.683		4		Alive	150	B		Lorikeet nesting

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
551	*Eucalyptus piperita*	377529.3399	6356807.367	1			Alive	130	NB		Nest box
552	*Eucalyptus piperita*	377535.8336	6356813.618		2		Alive	120	B		Lorikeets nesting
553	*Corymbia maculata*	377532.1699	6356818.215	1			Alive	110	B		
554	*Angophora costata*	377533.5344	6356827.767	1			Alive	60	B		
555	*Corymbia gummifera*	377518.3705	6356833.206		3		Alive	180	NB,B		Nest box
556	*Eucalyptus punctata*	377517.5543	6356828.723		2		Alive	200	B		
557	*Eucalyptus umbra*	377516.7125	6356848.084	1			Alive	70	NB		Nest box
558	*Eucalyptus umbra*	377521.0899	6356850.301		3		Alive	130	B,B		
559	*Eucalyptus piperita*	377528.2733	6356855.24		1		Alive	120	NB		Nest box
560	*Eucalyptus punctata*	377538.5994	6356846.261	2			Alive	140	NB,B		Nest box
561	*Eucalyptus punctata*	377531.9585	6356857.122	1			Alive	70	NB		Nest box
562	*Eucalyptus umbra*	377518.7665	6356862.03	1			Alive	130	NB		Nest box
563	*Eucalyptus umbra*	377525.5159	6356878.29	1			Alive	90	NB		Nest box
564	*Angophora costata*	377529.5175	6356886.666		1		Alive	80	NB		Nest box
565	*Eucalyptus umbra*	377524.1961	6356887.294	2			Alive	90	NB,B		Nest box
566	*Eucalyptus punctata*	377509.1496	6356881.9	1			Alive	130	B		
567	*Angophora costata*	377507.4463	6356898.933		1		Alive	140	T		
568	*Eucalyptus umbra*	377525.8153	6356930.199	2	1		Alive	120	B,NB		
569	*Eucalyptus piperita*	377525.8153	6356950.072	1	5		Alive	180	NB,B,B		
570	*Angophora costata*	377504.2392	6356946.665	2			Alive	140	B		
571	*Eucalyptus capitellata*	377507.6459	6356953.479	1	2		Alive	140	T,B		
572	*Eucalyptus capitellata*	377511.6205	6356964.835		1		Alive	160	B		
573	Stag	377498.5613	6356968.809	1			Dead	130	B		
574	Stag	377503.2968	6356975.964	1			Dead	110			Decorticating bark
575	*Angophora costata*	377529.2086	6357012.427	2	8		Alive	210	B,B,B	Moderate	Stag watched (2015)
576	*Eucalyptus punctata*	377594.9636	6356818.698	3	2		Alive	70	B		
577	*Corymbia maculata*	377606.1908	6356807.656	2	1		Alive	130	B,B		
578	*Eucalyptus punctata*	377603.8769	6356785.674	2	1		Alive	110	T,B		
579	*Eucalyptus punctata*	377617.7602	6356789.145	3	2		Alive	150	B,B		
580	*Eucalyptus umbra*	377636.379	6356828.802	3			Alive	140	B		
581	Stag	377647.5364	6356898.418	1			Dead	70	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
582	Stag	377640.2477	6356905.403		3		Dead	110	T		
583	*Angophora costata*	377637.1575	6356917.969	3	4		Alive	140	B,B		
584	Stag	377638.3722	6356926.169		3		Dead	110	T,B		
585	*Angophora costata*	377665.4013	6356907.947	2			Alive	110	B		
586	*Angophora costata*	377663.1881	6356894.951		3		Alive	140	B		
587	Stag	377666.8415	6356926.708	1			Dead	60	B		
588	*Angophora costata*	377653.4968	6356928.999	2			Alive	70	B		
589	Stag	377655.5231	6356931.827	2			Dead	60	B		
590	Stag	377659.6407	6356937.18	1			Dead	30	T		
591	*Eucalyptus umbra*	377653.0525	6356941.71	2			Alive	50	T		
592	Stag	377646.0526	6356937.18	1			Dead	60	T		
593	Stag	377631.2291	6356941.298	1			Dead	60			Decorticating bark
594	Stag	377630.4056	6356945.416	2			Dead	70	T		
595	Stag	377678.9541	6356994.164	1			Dead	80	T		
596	*Angophora costata*	377660.8898	6357004.453		2		Alive	160	T		
597	*Angophora costata*	377644.5707	6356998.423		1		Alive	140	B		
598	*Angophora costata*	377632.2531	6356982.144		3		Alive	140	T,B		
599	Stag	377635.0314	6357008.002		1		Dead	120	T		
600	Stag	377637.9836	6357014.529	2	1		Dead	130	T,B		
601	*Angophora costata*	377652.169	6357023.412	6	2		Alive	150	T,B		
602	*Angophora costata*	377653.335	6357038.531		5		Alive	160	B		
603	*Angophora costata*	377654.2972	6357042.38		3		Alive	160	B		
604	*Angophora costata*	377664.4	6357045.266	1			Alive	130	B		
605	*Angophora costata*	377668.2486	6357043.342		4		Alive	130	B		
606	*Angophora costata*	377684.8721	6357043.781		2		Alive	130	B		
607	*Angophora costata*	377680.4702	6357050.139		5		Alive	110	B,T		
608	*Eucalyptus umbra*	377658.5829	6357061.755		3		Alive	110	B		
609	*Angophora costata*	377643.6653	6357047.572		3		Alive	130	T		
610	*Angophora costata*	377626.8814	6357043.338	3			Alive	140	B		
611	Stag	377623.4311	6357037.671		1		Dead	110	T		
612	*Eucalyptus piperita*	377612.7549	6357052.81		4		Alive	150	T,B		
613	*Eucalyptus piperita*	377599.49	6357043.153		3		Alive	150	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
614	*Eucalyptus piperita*	377586.2758	6357042.492		1		Alive	150	T		
615	*Angophora costata*	377589.5794	6357067.599		2		Alive	150	T		
616	*Angophora costata*	377586.9365	6357074.206		1		Alive	80	T		
617	*Angophora costata*	377604.115	6357086.76		2		Alive	120	B		
618	*Eucalyptus umbra*	377605.4364	6357074.867		3		Alive	110	B,T		
619	*Eucalyptus piperita*	377623.2756	6357081.474	5			Alive	130	B		
620	*Angophora costata*	377624.597	6357068.26	2			Alive	120	B		
621	*Angophora costata*	377629.8827	6357062.313		5		Alive	140	T,B		
622	*Angophora costata*	377637.8112	6357076.849		8		Alive	150	T,B		
623	*Eucalyptus piperita*	377641.8124	6357086.975		3		Alive	100	B		
624	*Eucalyptus piperita*	377656.4239	6357071.668	3			Alive	110	B		
625	Stag	377620.7036	6357129.688	2			Dead	80	B		
626	*Angophora costata*	377621.7906	6357140.009	3	2		Alive	120	B,B		
627	*Eucalyptus piperita*	377636.9647	6357153.507	2			Alive	90	B		
628	*Angophora costata*	377645.8678	6357136.655		4		Alive	150	T,B		
629	*Angophora costata*	377647.1429	6357132.451	3	2		Alive	150	B,B		
630	*Angophora costata*	377657.9271	6357130.15		3		Alive	180	T		
631	*Angophora costata*	377662.5849	6357131.314	3	4		Alive	190	B,T		
632	Stag	377655.2454	6357142.199		3		Dead	140	B		
633	Stag	377658.7806	6357144.13	5	5		Dead	160	B,B		
634	*Eucalyptus piperita*	377647.4228	6357154.743		2		Alive	120	B		
635	*Angophora costata*	377659.6882	6357161.327		2		Alive	140	B		
636	*Angophora costata*	377666.4813	6357171.728		3		Alive	130	T,B		Vertical hollow
637	*Eucalyptus piperita*	377687.9135	6357155.357		4		Alive	140	B,B		
638	*Eucalyptus piperita*	377684.0879	6357139.565		5		Alive	130	B,B		
639	Stag	377637.2552	6357190.103		1		Dead	120	T		Vertical hollow
640	*Corymbia gummifera*	377644.1685	6357198.396		3		Alive	150	B		
641	*Corymbia gummifera*	377636.0641	6357195.749		1		Alive	80	B		
642	Stag	377646.0042	6357216.608		1		Dead	90	T		Vertical hollow
643	*Corymbia gummifera*	377649.1017	6357222.855		1		Alive	90	B		
644	*Corymbia gummifera*	377631.7532	6357226.627		3		Alive	90	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
645	*Angophora costata*	377626.3824	6357237.426		1		Alive	130	T		
646	*Eucalyptus punctata*	377641.0735	6357267.109	2	5		Alive	120	B,B		
647	*Syncarpia glomulifera*	377643.3993	6357305.84		1		Alive	120	T		
648	*Corymbia maculata*	377643.7275	6357324.247	1	4		Alive	200	B,T		Obstructed entrance
649	*Corymbia gummifera*	377632.8526	6357318.675		5		Alive	130	B,T		Termite nest
650	*Eucalyptus punctata*	377631.7014	6357343.839		5		Alive	120	B		
651	*Eucalyptus punctata*	377646.005	6357344.128		2		Alive	110	B		
652	*Eucalyptus punctata*	377659.1263	6357342.404	1	5		Alive	110	B,B		
653	*Eucalyptus fibrosa/ fergusonii*	377656.6601	6357352.245		3		Alive	150	B		
654	*Eucalyptus piperita*	377644.3038	6357361.181		2		Alive	110	T		
655	Stag	377607.5878	6357410.07		2		Dead	100	T		Bat roost
656	*Angophora costata*	377602.1673	6357424.865		3		Alive	110	T		
657	Stag	377591.0548	6357431.484	2	3		Dead	110	T,B		
658	*Eucalyptus punctata*	377603.642	6357441.845		4		Alive	150	B		
659	*Eucalyptus punctata*	377595.6058	6357448.837		4		Alive	130	B		
660	*Eucalyptus punctata*	377598.9165	6357483.37	3	5		Alive	180	B,B		
661	*Eucalyptus piperita*	377551.6022	6357474.687	2	3		Alive	190	B,B		
662	*Eucalyptus piperita*	377549.4615	6357451.378	2	3		Alive	170	B,B		
663	*Eucalyptus piperita*	377543.6611	6357459.503	4			Alive	120	B		
664	*Angophora costata*	377536.129	6357403.197	4			Alive	100	B		
665	Stag	377555.3748	6357374.827	1	2		Dead	80	T,T		
666	Stag	377559.5663	6357353.586		3		Dead	80	B		
667	*Corymbia maculata*	377591.1642	6357316.605		1		Alive	200	T		
668	*Corymbia gummifera*	377577.5938	6357295.152	3			Alive	110	B		
669	*Eucalyptus punctata*	377562.248	6357280.323	4			Alive	150	B		
670	*Syncarpia glomulifera*	377582.445	6357265.6	4	2		Alive	200	B,B		
671	*Eucalyptus umbra*	377596.1846	6357258.902		4		Alive	130	B		
672	*Eucalyptus umbra*	377596.5866	6357249.259	1			Alive	110	T		
673	*Corymbia maculata*	377577.1743	6357246.239		4		Alive	130	B,T		
674	*Eucalyptus umbra*	377526.3905	6357253.156		2		Alive	120	B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
675	Stag	377529.4962	6357266.941		1		Dead	50	B		
676	Stag	377522.0775	6357276.608	3			Dead	100	B		
677	*Corymbia maculata*	377550.6868	6357345.157		1		Alive	170	T		
678	*Corymbia maculata*	377538.3078	6357362.858		1		Alive	170	T		
679	*Eucalyptus piperita*	377509.9823	6357354.745	1			Alive	130	T		
680	*Eucalyptus piperita*	377526.7739	6357327.674		1		Alive	100	T		Termite nest
681	*Eucalyptus umbra*	377576.5573	6357220.179		1		Alive	100	B		
682	Stag	377590.9213	6357201.062	5			Dead	120	T		
683	Stag	377617.1084	6357208.368		1		Dead	80	T		
684	*Eucalyptus umbra*	377612.0083	6357189.79	2			Alive	100	B		
685	*Eucalyptus umbra*	377580.9191	6357140.394	3			Alive	90	B		
686	Stag	377578.2254	6357146.457		5		Dead	160	B,B	Moderate	Stag watched (2015)
687	*Angophora costata*	377570.9335	6357078.396		1		Alive	80	B		
688	*Angophora costata*	377586.504	6357074.481		3		Alive	130	B		
689	*Eucalyptus piperita*	377584.5119	6357061.928	2			Alive	130	B		
690	*Angophora costata*	377580.5769	6357039.814		3		Alive	130	B		
691	*Angophora costata*	377549.7322	6357068.597	2			Alive	130	B		
692	*Eucalyptus piperita*	377551.1409	6356568.08	2			Alive	140	NB,B		Nest box
693	*Corymbia gummifera*	377573.0606	6356546.481	1			Alive	130	B		
694	*Eucalyptus umbra*	377578.9571	6356539.301	1			Alive	100	NB		Nest box
695	*Eucalyptus piperita*	377585.8709	6356516.255		1		Alive	100	NB		Nest box
696	*Angophora costata*	377614.6786	6356497.818	1			Alive	100	T		
697	*Eucalyptus umbra*	377636.9236	6356484.279	1			Alive	110	NB		Nest box
698	*Corymbia maculata*	377681.7034	6356459.781	2			Alive	110	B		
699	*Corymbia maculata*	377738.2982	6356399.249	1	2		Alive	180	B,B		Vertical entrance
701	*Corymbia maculata*	377674.1112	6357313.487		2		Alive	115	B, B	Low	
702	*Angophora costata*	377670.6092	6357312.128	1			Alive	115	B		
703	*Eucalyptus punctata*	377682.9529	6357334.392	2	3	1	Alive	100	B, B, B		
704	*Corymbia maculata*	377671	6357360			4	Alive	120	B	High	Stag watched (2015); Southern Boobook observed exiting hollow
706	*Eucalyptus punctata*	377687.4936	6357352.554	3			Alive	65			

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
707	Stag	377696.575	6357366.177	4	1	1	Dead	80	B, B, B		
708	*Eucalyptus punctata*	377603.9597	6357480.684	2			Alive	150	B		
709	*Eucalyptus umbra*	377611.2275	6357517.693	2			Alive	75	B		
710	*Eucalyptus punctata*	377603.7515	6357534.781	1	1		Alive	50	B, B		
711	*Eucalyptus punctata*	377584.5275	6357524.101	4			Alive	95	B		
712	*Eucalyptus fergusonii*	377541.8075	6357484.585	3			Alive	80	B		
713	Stag	377532.0557	6357492.079	2			Alive	65	B		
714	*Eucalyptus punctata*	377590.3334	6357542.211	4			Alive	75	B		
715	*Eucalyptus punctata*	377583.9596	6357552.409		3		Alive	80	B		
716	*Corymbia maculata*	377561.0138	6357542.211	1			Alive	95	B		
717	Stag	377530.4194	6357533.288	2			Dead	80	B		
718	*Eucalyptus fibrosa*	377528.6544	6357512.907	1	1		Alive	95	B, B		
719	*Corymbia maculata*	377537.6267	6357513.169	2	2		Alive	100	B, B		
720	Stag	377520.4089	6357515.454		2		Dead	85	T		
721	*Eucalyptus acmenoides*	377522.5841	6357500.228	9	3	1	Alive	110	B, B, T	Moderate	Stag watched (2015)
722	*Eucalyptus umbra*	377496.5365	6357507.491	3	1		Alive	90	B, B		
723	*Eucalyptus umbra*	377501.1083	6357479.708	2			Alive	85	B		
724	Stag	377510.2518	6357467.048	1			Dead	15	B		
725	*Angophora costata*	377514.2594	6357461.596	2	3		Alive	95	B, B/T		
726	*Eucalyptus punctata*	377503.6474	6357455.439	3	1		Alive	60	B, B		
727	*Eucalyptus punctata*	377503.17	6357450.369	2			Alive	60	B		
728	Stag	377512.0716	6357442.209	1			Dead	55	B		
729	*Corymbia maculata*	377512.0012	6357440.371	3		1	Alive	85	B, T		
730	Stag	377521.5201	6357407.148	2			Dead	105	B		
731	*Eucalyptus umbra*	377517.9537	6357421.91	2			Alive	95	B		
732	*Eucalyptus punctata*	377531.1785	6357435.135	2	2		Alive	110	B, B/T		
733	*Eucalyptus umbra*	377541.3557	6357311.477	2			Alive	90	B		
734	Stag	377529.4311	6357267.252	2			Dead	30	B/T		
735	*Eucalyptus umbra*	377537.4063	6357257.019	2	1		Alive	85	B, B		
736	*Angophora costata*	377557.8316	6357189.732	4	2		Alive	40	B, B		

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
737	Stag	377551.443	6357191.537			1	Dead	95	T		
738	Stag	377553.5499	6357173.382			1	Dead	70	T		
739	*Eucalyptus capitellata*	377547.1648	6357176.846	7	3		Alive	90	B, B		
740	*Eucalyptus capitellata*	377579.1432	6357173.471		1	1	Alive	90	B, T		
741	*Eucalyptus capitellata*	377563.3249	6357142.995	1	1		Alive	50	B, T		
742	*Corymbia gummifera*	377567.6142	6357137.455	1			Alive	80	B		
743	Stag	377557.8949	6357135.342		3		Dead	70	B		Fallen. Suspended on nearby tree
744	*Eucalyptus capitellata*	377554.0917	6357126.89	3			Alive	65	B		
745	*Eucalyptus piperita*	377556.5158	6357110.889	1	1		Alive	85	B, B		
800	*Corymbia maculata*	377756.2603	6356381.287		2	1	Alive	180	B, T	High	Stag watched (2014)
801	*Eucalyptus punctata*	377815.3271	6356346.734		2		Alive	120	B		
802	*Eucalyptus umbra*	377826.4858	6356338.512		4		Alive	130	B/T		
803	*Eucalyptus punctata*	377863.0362	6356312.786		4		Alive	140	B/T		
804	*Angophora costata*	377555.0804	6355778.613		1		Alive	130	T		
805	*Corymbia maculata*	377570.8961	6355786.173		2		Alive	140	T		
806	*Angophora costata*	377584.2294	6355756.84		2		Alive	180	B		
807	*Angophora costata*	377572.2294	6355742.173		2			140	B		
808	*Angophora costata*	377596.2294	6355702.173	1	2		Alive	130	B, B		
809	Stag	377601.6975	6355694.105		3		Dead	120	B		
810	Stag	377608.7407	6355719.461		1		Dead	80	T		Vertical pipe
811	Stag	377607.332	6355740.59	1			Dead	140	T		Vertical pipe
812	*Corymbia maculata*	377631.2787	6355696.923		1		Alive	110	T		
813	Stag	377677.7633	6355685.654		1		Dead	80	T		Vertical pipe
814	Stag	377600.3027	6355568.353		1		Dead	60	T		Vertical pipe
815	*Eucalyptus acmenoides*	377588.4172	6355591.262	3	1		Alive	110	B, T		
816	Stag	377566.9167	6355599.489		1		Dead	100	B		
817	Stag	377444.2728	6355735.85		3		Dead	140	B		
818	Stag	377526.6196	6355723.799	1			Dead	110	T		Vertical pipe
819	Stag	377427.8112	6356659.065			2	Dead	90	B		
820	*Eucalyptus piperita*	377487.7307	6356684.695		3		Alive	210	B		
821	Stag	377485.8875	6356679.847	3	2		Dead	100	B, B		
822	*Eucalyptus umbra*	377498.6867	6356773.938		1		Alive	110	NB		Nest box

Tree ID	Tree Species	Coordinates (GDA 94 Zone 56)[1]		Hollow Size			Condition	DBH (cm)	Hollow position[2]	Powerful Owl suitability[3]	Comments
		Easting	Northing	Small 2–10 cm	Medium 11–25 cm	Large >25 cm					
823	*Eucalyptus umbra*	377500.7056	6356811.98		2		Alive	130	T		
824	*Eucalyptus punctata*	377502.7279	6356843.234		2		Alive	130	B		
825	*Corymbia maculata*	377499.4679	6356838.265		2		Alive	130	T		
826	*Eucalyptus umbra*	377462.0513	6356833.496		2	1	Alive	170	B, B		
827	*Eucalyptus umbra*	377453.2749	6356815.944	1		1	Alive	170	B		
828	*Eucalyptus piperita*	377442.4686	6356832.897	3			Alive	170	B		
829	*Eucalyptus piperita*	377454.4742	6356835.722		1		Alive	130	B		
830	*Angophora costata*	377449.553	6356863.316		2		Alive	120	B		
831	*Angophora costata*	377458.1103	6356915.517			1	Alive	110	T	Moderate	
832	*Angophora costata*	377463.7807	6356905.657		1		Alive	130	B		Bees
833	*Eucalyptus umbra*	377473.2313	6356933.616	2	3		Alive	130	B, B		
834	Stag	377467.0462	6356947.753		1	1	Dead	110	T, T		Vertical pipe
835	*Eucalyptus capitellata*	377455.5594	6356968.959		1		Alive	110	B		
836	*Eucalyptus punctata*	377467.9346	6357277.38		3		Alive	160	B		
837	*Eucalyptus piperita*	377446.6756	6357295.368		1	1	Alive	130	B		
838	*Angophora costata*	377378.0267	6357314.054		1		Alive	150	B		
839	Stag	377464.0789	6357317.575	4		2	Dead	140	B, T		Vertical pipe
Totals				**887**	**1,222**	**472**					

Notes:
1. NA: Coordinates not available
2. T = trunk, B = branch, NB = nest box
3. Potentially suitable for Powerful Owl breeding. Not all identified trees were stag watched due to the varying quality of hollows identified such as hollow size, orientation and position. Refer to "Comments" column for stag watching status.

Appendix H – Parsons Brinckerhoff (2015c), Newcastle Inner City Bypass: Rankin Park to Jesmond, Nest Box Assessment

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Memo

Date	9 March 2016
To	Simon Pearce
Copy	Matthew Mate, Alex Cockerill
From	Nathan Cooper
Ref	2106581C-ENV-MEM-003 RevB
Subject	Newcastle Inner City Bypass - Rankin Park to Jesmond - Nest Box Inspections

1. Introduction

Parsons Brinckerhoff has been engaged by Roads and Maritime Services (Roads and Maritime) to inspect nest boxes for the proposed fifth stage of the Newcastle Inner City Bypass (Highway 23) from Rankin Park to Jesmond (the project). The nest boxes were installed as part of the John Hunter Hospital expansion and due to amendments of the proposed project alignment, nest boxes positioned along the western extremity of the John Hunter Hospital were identified for inspection due to their potential for disturbance.

The primary aim of the nest box inspections (apart from determining faunal use) was to determine the potential presence a locally occurring threatened species, Squirrel Glider (*Petaurus norfolcensis*), which is listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*.

2. Methodology

To ascertain utilisation by native fauna or pest species, an approximate 4.8 m extension pole with a specifically designed wireless inspection camera was used to inspect the internal cavity of each nest box. This method is considered to have a low impact on native animals using nest boxes whilst allowing for identification of any animal observed.

The following data was collected from each identified nest box:

- nest box number
- nest box type
- nest box location (fixed by handheld GPS)
- host tree species and diameter at breast height (DBH)
- nest box height
- nest box orientation

- evidence of fauna occupancy
- presence of pest activity.

Within the confines of a nest box, accurate identification between a Squirrel Glider and Sugar Glider (*Petaurus breviceps*) can be problematic. Accordingly, stag watch surveys were propositioned as a secondary technique to aid positive identification should a glider be observed in a nest box.

2.1 Date of inspection

Nest box monitoring was completed on 7 October 2015 by one Parsons Brinckerhoff ecologist. Surveys were completed in overcast conditions with a maximum temperature of 21.2°C recorded (Bureau of Meteorology 2015, Newcastle University: Station 061390).

3. Results

A total of 38 nest boxes were inspected along the western extremity of the John Hunter Hospital (Figure 1), with one nest box (#33) utilised by a Common Brushtail Possum (*Trichosurus vulpecula*) (Photo 1). The remaining 37 nest boxes were observed with no fauna occupancy and were not observed to contain any nest material (Photo 2). Notwithstanding this, all nest boxes were in good to moderate condition.

Photo 1 Common Brushtail Possum recorded in nest box 33

Photo 2 An example of an unoccupied nest box (#26)

4. Conclusion

A total of 38 nest boxes were inspected along the western extremity of the John Hunter Hospital on 7 October 2015. One nest box was observed to be occupied by a Common Brushtail Possum (nest box 33). The remaining 37 nest boxes were observed with no fauna occupancy and were not observed to contain any nest material.

Due to the current paucity of nest box use, stag watching was not required. Similarly, the results of this current inspection (lack of observed occupancy and nest material during the spring breeding period) indicate that a follow-up inspection is not warranted.

Yours sincerely

Nathan C

Nathan Cooper
Senior Ecologist

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Source: © Land and Property Information 2015

0 25 50 75 m

Local roads
Creek lines
Proposal area
Extended proposal area

Nest box
Occupied
Unoccupied

Figure 1
Nest box locations

Table 1 Nest box inspection data

Nest box number	Type	Easting	Northing	Tree species	DBH (~cm)	Box height (~m)	Box orientation	Fauna use	Nest box condition
1	Glider	377504	6356670	*Eucalyptus piperita*	40	3.0 – 3.5	SE	Empty	Moderate
2	Glider	377534	6356637	*Angophora costata*	60	4.0	ENE	Empty	Moderate
3	Parrot	377554	6356658	*Angophora costata*	50	4.0 – 4.5	ESE	Empty	Moderate
4	Possum	377564	6356657	*Eucalyptus piperita*	90	4.0	NE	Empty	Moderate
5	Glider	377547	6356641	*Corymbia gummifera*	35	3.0	E	Empty	Moderate
6	Microbat	377530	6356674	*Eucalyptus piperita*	30	3.5	SE	Empty	Moderate
7	Possum	377508	6356683	*Eucalyptus umbra*	60	4.0	SE	Empty	Moderate
8	Microbat	377512	6356674	*Angophora costata*	40	0.7	E	Empty	Moderate
9	Microbat	377516	6356700	*Angophora costata*	30	4.5	NW	Empty	Moderate
10	Glider	377516	6356716	*Eucalyptus piperita*	70	4.5	SE	Empty	Moderate
11	Microbat	377502	6356714	*Eucalyptus piperita*	75	4.0	ENE	Empty	Moderate
12	Glider	377524	6356726	*Corymbia gummifera*	60	3.5	NW	Empty	Moderate
13	Possum	377509	6356738	*Eucalyptus capitellata*	90	4.0	E	Empty	Moderate
14	Glider	377501	6356731	*Eucalyptus capitellata*	75	4.0 - 4.5	NW	Empty	Moderate
15	Microbat	377501	6356731	*Eucalyptus capitellata*	55	3.5 – 4.0	SW	Empty	Moderate
16	Possum	377513	6356769	*Eucalyptus capitellata*	55	3.5	SE	Empty	Moderate
17	Glider	377544	6356787	*Corymbia gummifera*	60	3.0	E	Empty	Moderate
18	Microbat	377541	6356778	*Angophora costata*	55	4.5	E	Empty	Moderate
19	Parrot	377529	6356809	*Corymbia gummifera*	55	4.0	E	Empty	Moderate
20	Possum	377522	6356842	*Corymbia gummifera*	100	4.0	SW	Empty	Moderate
21	Parrot	377513	6356844	*Eucalyptus capitellata*	50	3.5	S	Empty	Moderate

Nest box number	Type	Easting	Northing	Tree species	DBH (~cm)	Box height (~m)	Box orientation	Fauna use	Nest box condition
22	Parrot	377508	6356849	*Eucalyptus punctata*	65	4.5	SSW	Empty	Good to moderate
23	Glider	377533	6356868	*Eucalyptus capitellata*	50	4.0 – 4.5	S	Empty	Moderate
24	Parrot	377537	6356844	*Eucalyptus punctata*	70	4.0	NE	Empty	Moderate
25	Parrot	377508	6356849	*Eucalyptus punctata*	65	4.0	WNW	Empty	Good to moderate
26	Parrot	377533	6356865	*Eucalyptus punctata*	40	3.5	SE	Empty	Moderate
27	Parrot	377526	6356856	*Eucalyptus capitellata*	70	4.0	W	Empty	Moderate
28	Microbat	377522	6356860	*Eucalyptus capitellata*	90	3.5	N	Empty	Moderate
29	Parrot	377558	6356553	*Angophora costata*	40	4.5	SE	Empty	Moderate
30	Parrot	377529	6356890	*Angophora costata*	35	5.0	S	Empty	Moderate
31	Microbat	377524	6356894	*Eucalyptus capitellata*	55	3.0	ENE	Empty	Moderate
32	Glider	377527	6356952	*Eucalyptus piperita*	85	4.5	SE	Empty	Moderate
33	Possum	377562	6356559	*Eucalyptus piperita*	80	4.0	N	Common Brushtail Possum	Moderate
34	Glider	377529	6356933	*Eucalyptus capitellata*	65	5.0	NNW	Empty	Moderate
35	Glider	377583	6356531	*Eucalyptus capitellata*	85	3.5	NE	Empty	Moderate
36	Glider	377597	6356514	*Eucalyptus piperita*	60	6.0	NE	Empty	Moderate
37	Parrot	377597	6356522	*Angophora costata*	50	3.5	S	Empty	Moderate
38	Glider	377633	6356468	*Eucalyptus capitellata*	55	5.0	W	Empty	Moderate

Appendix I – Parsons Brinckerhoff (2015d), Newcastle Inner City Bypass: Additional *Diuris praecox* and *Corybas dowlingii* targeted surveys

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Memo

Date	9 March 2016
To	Simon Pearce GHD
Copy	Alex Cockerill Team Manager, Environment, Hunter Region Parsons Brinckerhoff
From	Deborah Landenberger
Ref	2106581B-NRM-MEM-001 RevC
Subject	Newcastle Inner City Bypass: Rankin Park to Jesmond - Additional Diuris praecox and Corybas dowlingii targeted surveys

1. Introduction

Parsons Brinckerhoff was engaged by Roads and Maritime Services (Roads and Maritime), to undertake additional targeted threatened flora surveys for *Diuris praecox* (Rough Doubletail) and *Corybas Dowlingii* (Red Helmet Orchid) (the survey) for the proposed fifth stage of the Newcastle Inner City Bypass (Highway 23) from Rankin Park to Jesmond. The project consists of an approximate 3.4 km dual lane carriageway highway generally between the intersection with McCaffrey Drive and Lookout Road, Rankin Park and the interchange with Newcastle Road at Jesmond (the project). The locality of the project is provided in Figure 1.1.

A biodiversity survey was undertaken within the proposal area in 2014 to describe and detail the ecological characteristics of the study area (Parsons Brinckerhoff 2014). However, as a result of design changes, additional areas within an expanded study area were identified as requiring further ecological survey. This report details the results of additional targeted threatened flora surveys for *Diuris praecox* and *Corybas dowlingii* completed in late July and early August 2015, and will support the Newcastle Inner City Bypass – Rankin Park to Jesmond Environmental Impact Statement (Parsons Brinckerhoff 2014).

This memo provides the details the general methodology (including personnel, consultation, reference sites and field survey methodology), results and conclusions drawn from the targeted threatened flora surveys for *Diuris praecox* and *Corybas dowlingii*.

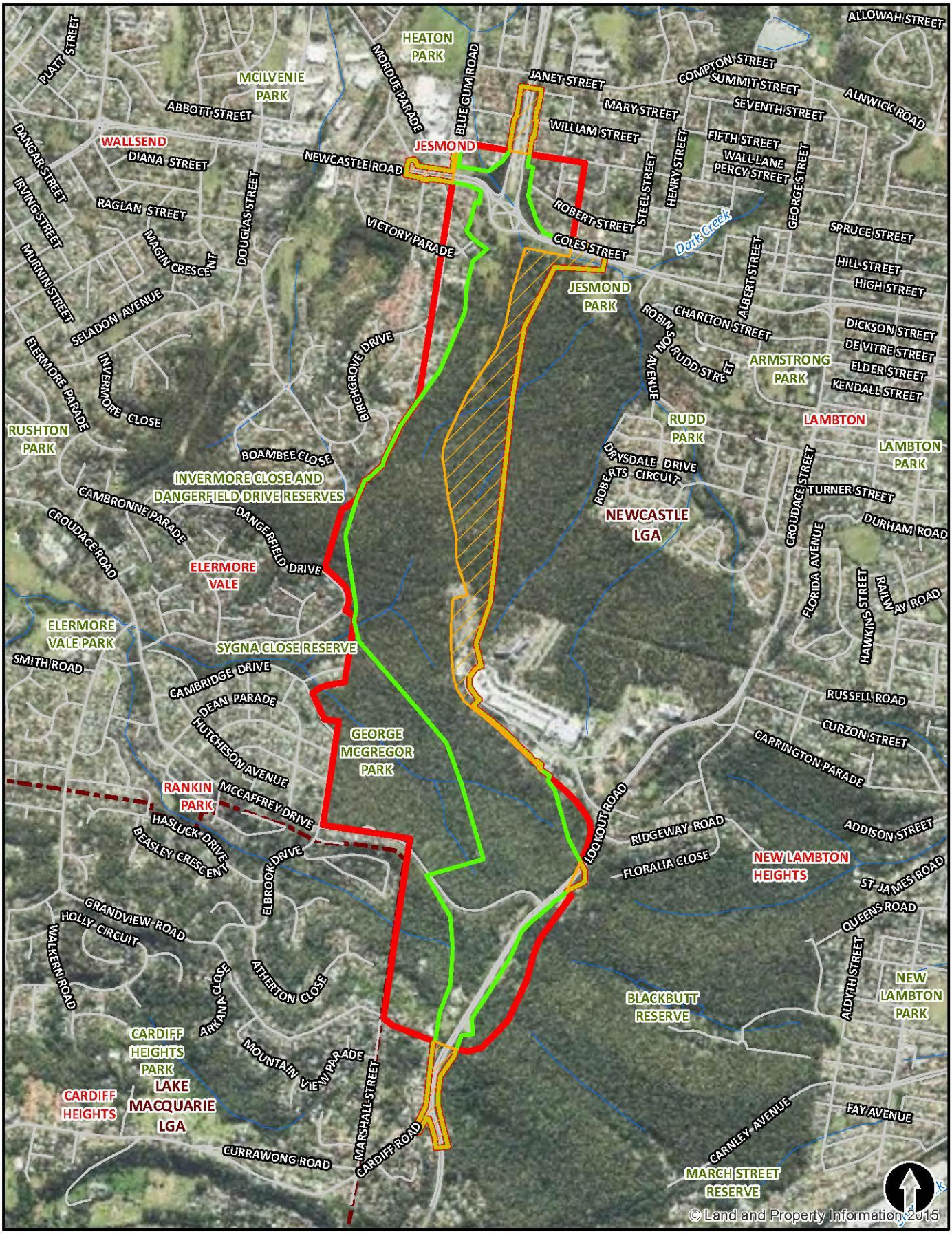

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Figure 1.1
Project locality

2. Methodology

2.1 Definitions

For the purposes of this study the following definitions apply:

- **Proposal area** is defined by a 20 m boundary from the proposed design alignment of the strategic design that was displayed in 2007 (Figure 1.1).
- **Extended proposal area** is defined as an extension of proposal area along the eastern, northern and southern sections of the original proposal area, which were not included in the original study area (Figure 1.1).
- **Proposal areas** is defined as the combined Proposal area and Extended proposal area.
- **Study area** is the area of bushland between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital, Lookout Road and both northern and southern sides of McCaffrey Drive (Figure 1.1).
- **Locality** is defined as an approximate 10 km radius around the proposal area.

2.2 Personnel

The contributors to the preparation of this memo, their qualification and roles is provided in Table 2.1.

Table 2.1 Contributors and their roles

Name	Qualifications	Role
Alex Cockerill	BSc (Hons)	Principal ecologist – Lead ecologist, Technical Review
Debbie Landenberger	BSc (Hons)	Senior ecologist – Field survey, report preparation
Tanya Bangel	BEnvScMgt (Hons)	Ecologist – Field survey, report preparation
Emily Mitchell	BDvptSt, Cert 4 SIS	Mapping and data management – GIS operator

All work were carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the *National Parks and Wildlife Regulations 2002* and Section 132C of the *National Parks and Wildlife Act 1974*, Animal Research Authority issued by the Department of Industries and Investment NSW (Agriculture).

2.3 Consultation

Roads and Maritime received the Secretary's Environmental Assessment Requirements (SEARS) for the project on 3 March 2015. The Office of Environment and Heritage (OEH) comments included a requirement to include targeted surveys for *Corybas dowlingii* as OEH has previously received photographic evidence that this species has been recorded within George McGregor Park in 2013. This species is similar to *Corybas barbarae* and confirmation from the Royal Botanical Gardens, Sydney would be required to confirm the presence of this species.

As a result of the SEARS and consultation with Roads and Maritime and GHD, Parsons Brinckerhoff was requested to undertake further targeted surveys for *Corybas dowlingii* within the proposal areas to determine if this species could be located. Correspondence received from Mr Steve Lewer of OEH on 10 June 2015 advised that an ecologist, Mr Daryl Harman had potentially previously located *Corybas dowlingii* within George McGregor Park on 16 June 2013 (location shown on Figure 2.1). A sample of the *Corybas dowlingii*

recorded by My Daryl Harman was not collected nor was one sent to the Royal Botanic Gardens for confirmation.

One Parsons Brinckerhoff ecologist (Debbie Landenberger) and Mr Daryl Harman visited the George McGregor Park potential reference site on 12 June 2015. The site adjoined a walking track, however no *Corybas dowlingii* were observed. During the site visit discussions were undertaken regarding observations made about the potential reference population. It was noted that the potential reference population had only been observed on 16 June 2013 and had not been observed since. Mr Daryl Harman is a member of the local land care group and regularly visited the site to check if it was flowering. Therefore, it is likely that the potential George McGregor Park *Corybas dowlingii* population may not flower annually and is dependent on seasonal variations, however it is not known if this is the case. In addition, it was noted that where the species was previously recorded it was growing in amongst a population of *Acianthus fornicatus* (Pixie Orchids). Thus during subsequent visits to the reference site a wide area was searched focusing on habitat and where Pixie Orchids were also located.

After these discussions it was decided to revisit the site weekly to see if the species was in flower, if it was not detected by July 2015, then the reference population at Stoney Creek Reserve will be visited to determine if flower was occurring in this population.

2.4 Reference populations

A further two references populations consisting of one for *Diuris praecox* and one for *Corybas dowlingii* were visited to identify whether the two species were flowering prior to commencing the targeted surveys within the Proposal areas. The survey effort and results of the reference site surveys are provided in Table 2.2.

Table 2.2 Reference site survey effort

Reference site	Dates surveyed	Survey Effort person hours	Result
***Diuris praecox* (Rough Doubletail)**			
Glenrock State Conservation Area, Mereweather Heights	21 June 2015	1 hour	Not in Flower
	28 June 2015	1 hour	Not in Flower
	5 July 2015	1 hour	Not in Flower
	15 July 2015	1 hour	Not in Flower
	21 July 2015	1 hour	In bud but not in flower
	3 August 2015	2 hours	*Diuris praecox* specimen was recorded flowering on the 3 August 2015 (Enclosure A).
***Corybas dowlingii* (Red Helmet Orchid)**			
George McGregor Park, Rankin Park	12, June 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
	15 June 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
	19 June 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).

Reference site	Dates surveyed	Survey Effort person hours	Result
	26 June 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
	7 July 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
	15 July 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
	23 July 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
	5 August 2015	1 hour	No *Corybas dowlingii* were recorded within the reference site (Figure 2.1).
Stoney Ridge Reserve, Soldiers Point	20 July 2015	2 hours	Numerous *Corybas dowlingii* were recorded flowering within the site (Enclosure A).

The potential reference site for *Corybas dowlingii* at George McGregor Park is located adjoining to a walking track which is regularly used by walkers, motorbike riders and bicycle riders. Therefore, as this species has not been recorded since 2013, the potential population may have been destroyed. Numerous *Acianthus fornicatus* (Pixie Orchids) were recorded in the vicinity flowering and many basal leaves without flowers were recorded. A wide area was searched at each visit in the vicinity of the reference site, particularly along the creekline where *Acianthus fornicatus* (Pixie Orchid) species were observed.

2.5 Field survey

The targeted flora species were undertaken on two dates, as *Corybas dowlingii* was recorded flowering on 20 July 2015 at Soldiers Point and therefore targeted surveys were undertaken on the 23 July 2015 for this species. *Diuris praecox* was not detected flowering until 3 August 2015 and therefore the surveys for this species was undertaken on the 5 August 2015.

Targeted flora surveys were undertaken within the Proposal area and Extended proposal area by two ecologists on 23 July 2015 and 5 August 2015.

The weather conditions during the survey period varied from cool to warm temperatures (4.0-18.7^{O}C), dry to slight rainfall (0-1.4 mm) and from calm to moderately windy (Calm -19km/ph) (Table 2.3).

Table 2.3 Weather conditions

Date	Temperature ^{O}C (min)[1]	Temperature ^{O}C (max)[1]	Rain (mm)[1]	Wind (max speed (km/ph)/direction)[1]
23 July 2015	7.0	18.7	1.4	Calm
5 August 2015	4.0	15.5	0	19/NW

[1] Data obtained from Bureau of Meteorology Newcastle University NSW AWS Station (Station 061390).

Random meander surveys were completed within areas considered to contain potential habitat for the two targeted threatened flora species (*Diuris praecox* and *Corybas dowlingii*). Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by

Cropper (1993), whereby the recorder walks in a random manner throughout the site recording all species observed, boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

The survey effort for *Corybas dowlingii* was composed of a random meanders, however particular effort was focused adjoining creeklines, gullies and south facing slopes. When *Acianthus fornicatus* (Pixie Orchid) was observed the survey effort was widened to complete detailed survey effort within these areas to detect any flowering species.

The survey effort where the random meander surveys were undertaken is shown in Figure 2.1 with a summary of the survey effort outlined in Table 2.4. A general flora list of native flora species that were in flower or were threatened species were also recorded during the field surveys. The list of native plant species recorded is provided in Enclosure B.

Table 2.4 Targeted Flora survey effort

Species	Date of survey	Survey effort (person hours)
Corybas dowlingii	23 July 2015	16.0.
Diuris praecox	5 August 2015	16.0
Total survey effort		**32.0**

2.5.1 Survey guidelines

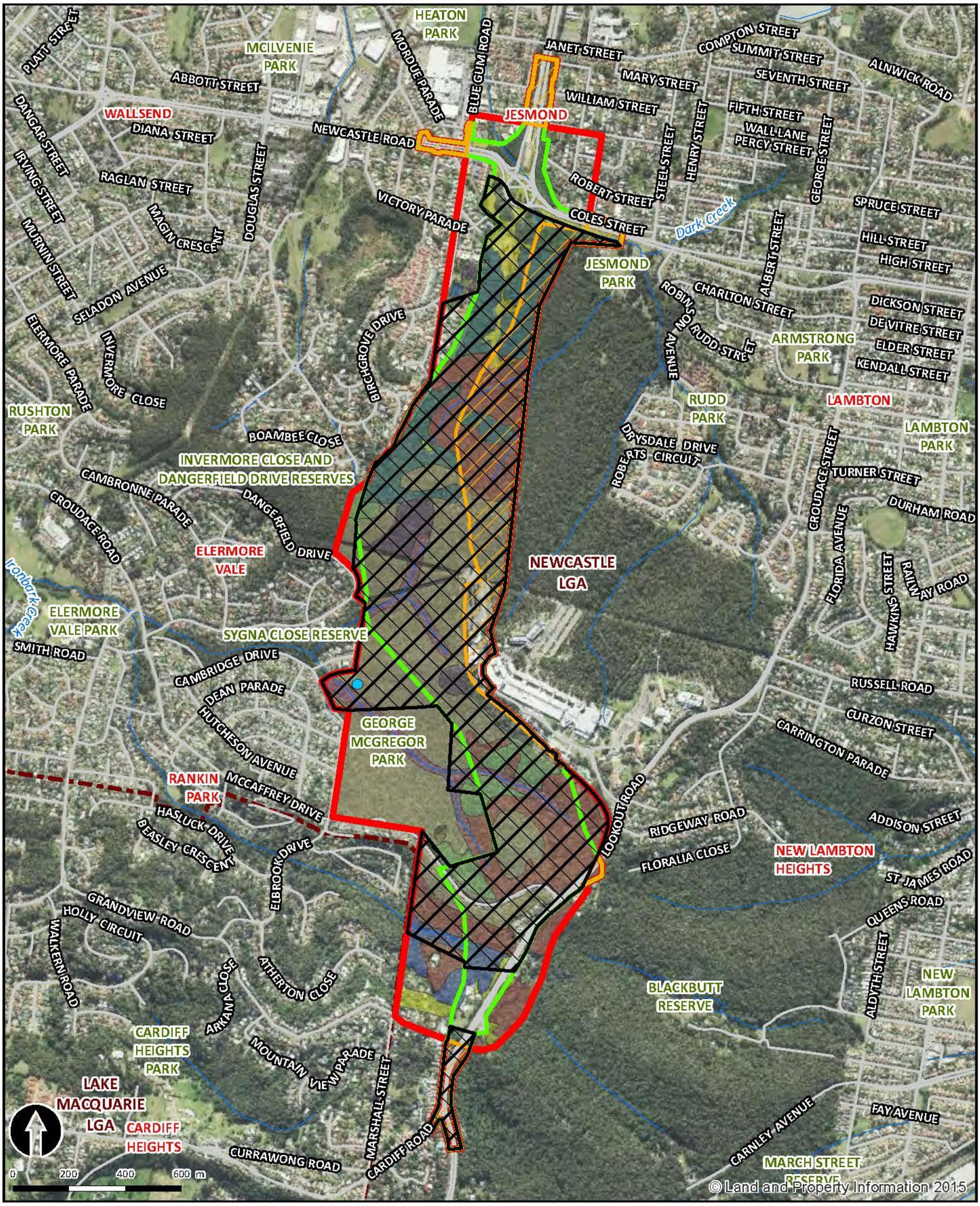
There are no specific survey guidelines for either *Diuris praecox* or *Corybas dowlingii*. *Diuris praecox* is however listed within the '*Survey Guidelines for Surveying Australia's Threatened Orchids listed under the EPBC Act*' (Commonwealth of Australia 2013). Surveys for two species were undertaken in accordance with these guidelines including:

- Determining the optimum flowering period for the species using Table 1 within the guidelines document – optimum flowering period for *Diuris praecox* is between late July and early September. Further effort was undertaken to identify two reference sites in order to identify whether the species was flowering in a known population.
- Determining optimum locations of surveys - undertaken across the study area using the existing vegetation mapping and knowledge of the study area to identify areas of 'potential' and 'known' habitat to target survey efforts.
- Minimal survey requirements – surveys involved random meander transects (Cropper 1993) were undertaken during the known flowering period for the species. Records of the survey effort were recorded using a hand-held GPS. No *Diuris praecox* individuals were recorded and therefore no thorough searches were required in the vicinity of detected plants. No *Corybas dowlingii* were recorded within the Proposal areas. Although not recorded during the surveys the species was potentially recorded within George McGregor Park in June 2013 by Mr Daryl Harman. The potential population that may occur within George McGregor Park was visited on numerous occasions (Table 2.2) however the species was not recorded.

2.6 Limitations

Limited surveys were completed south of Jesmond Park and north of the study area due to access issues (high volumes of traffic and thickets of *Lantana camara**) and lack of suitable habitat for the target species.

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.



Local roads
Creek lines
Proposal area
Extended proposal area
Study area
Local government area
Corybas dowlingii reference site
Diuris praecox and *Corybas dowlingii* survey area

Vegetation communities

- Dam
- Exotic vegetation
- HU621 - Smooth-barked Apple - Red Bloodwood open forest
- HU621 - Smooth-barked Apple - Red Bloodwood open forest - Gahnia clarkei variant
- HU622 - Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest
- HU629 - Spotted Gum - Broad-leaved Ironbark grassy open forest (EEC)
- HU629 - Spotted Gum - Broad-leaved Ironbark grassy open forest - Canopy only (EEC)
- HU631 - Spotted Gum - Grey Ironbark open forest - atypical variant
- HU631 - Spotted Gum Grey Ironbark open forest - Eucalyptus fergusonii variant
- HU631 - Spotted Gum Grey Ironbark open forest - Eucalyptus fergusonii variant - Canopy only
- HU637 - Sydney Blue Gum - White Mahogany shrubby tall open forest - atypical variant
- HU637 - Sydney Blue Gum - White Mahogany tall open forest - Syncarpia glomulifera variant
- Planted and parkland vegetation

Figure 2.1
Diuris praecox and *Corybas dowlingii* survey area

3. Results

3.1 Vegetation communities

Desktop analysis of the vegetation mapping and ground-truthing during the 2014 surveys (Parsons Brinckerhoff) found nine vegetation communities present within the study area Table 3.1.

Table 3.1 Vegetation communities identified in the study area

Plant Community Type[1]	LHCCREMS Broad Scale Vegetation Mapping[2]	Threatened Ecological Community on the TSC Act
HU 629 Spotted Gum – Broad-leaved Ironbark grassy open forest	Lower Hunter Spotted Gum Ironbark Forest	Yes – Lower Hunter Spotted Gum Ironbark Forest[3]
HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant	Coastal Foothills Spotted Gum – Ironbark Forest	No
HU 631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	Hunter Valley Moist Forest	No
HU 621 Smooth-barked Apple – Red Bloodwood open forest	Coastal Plains Smooth-barked Apple Woodland	No
HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Coastal Sheltered Apple – Peppermint Forest	No
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant[1]	Alluvial Tall Moist Forest	No
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Alluvial Tall Moist Forest	No
Planted and parkland vegetation	–	No
Exotic Vegetation	–	No
Dam	–	No

(1) Office of Environment and Heritage vegetation types database (Office of Environment and Heritage 2012) as used in BioMetric 2.0 (Office of Environment and Heritage 2015a).

(2) Lower Hunter and Central Coast Regional Environmental Management Strategy (2003).

(3) Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion listed as endangered under the TSC Act.

3.2 Habitat for targeted threatened flora species

The vegetation communities that contained suitable habitat for *Diuris praecox* or *Corybas Dowlingii* were targeted upon during the surveys. Vegetation communities identified as having habitat for these species is detailed in Table 3.2 and **Error! Reference source not found.**.

Table 3.2 Vegetation communities with habitat for targeted species

Vegetation Community	*Diuris praecox*	*Corybas Dowlingii*
HU 629 Spotted Gum – Broad-leaved Ironbark grassy open forest	Y	-
HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant	Y	-
HU 631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	Y	Y

Vegetation Community	*Diuris praecox*	*Corybas Dowlingii*
HU 621 Smooth-barked Apple – Red Bloodwood open forest	Y	-
HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Y	Y
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant[1]	Y	Y
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Y	Y
Planted and parkland vegetation	-	-
Exotic Vegetation	-	-
Dam	-	-

(1) Office of Environment and Heritage vegetation types database (Office of Environment and Heritage 2012) as used in BioMetric 2.0 (Office of Environment and Heritage 2015a).

3.3 Species of plant

A total of 34 native plant species were recorded in the Proposal areas (Enclosure B). The most diverse family recorded was Fabaceae with 10 species, followed by Orchidaceae with 5 species (Enclosure B). Exotic species were not recorded as part of this field survey, however numerous exotic species were observed occurred adjoining the existing road corridors, including several noxious weeds.

3.4 Targeted threatened flora species

3.4.1 *Diuris praecox* (Rough Doubletail)

Status

Diuris praecox is listed as Vulnerable under both the TSC Act and EPBC Act.

Description

Diuris praecox is a terrestrial herb with linear leaves. The species produces nodding flowers that are yellow with dark brown markings that occur on a raceme approximately 20-40 cm high with 6-10 flowers on each (Enclosure A – Photo A.4). The species flowers in winter, peak flowering between late July and early September (Commonwealth of Australia 2013; Office of Environment and Heritage 2015c).

Species is known between Bateau Bay and Smiths Lake occurring on hills and slopes in near-coastal locations in open forests with a grassy to fairly dense understorey (Office of Environment and Heritage 2015c).

Habitat

Habitat for this species occurs on hills and slopes of near-coastal districts in open heathy forest that have a grassy to moderately dense understorey on well drained soil (Department of the Environment 2008). It has been recorded within mowed power easements adjoining Coastal Foothills Spotted Gum Ironbark Forest at Merewether, NSW (Personal Observation by author).

Occurrence within Proposal areas

No *Diuris praecox* were recorded within the Proposal areas. Although no individuals were recorded within the proposal area the species was recorded in flower from the known Glenrock State Conservation Area reference site on the on 3 August 2015 (Enclosure A). Therefore, it is highly unlikely that this species occurs within the Proposal areas.

3.4.2 *Corybas dowlingii* (Red Helmet Orchid)

Status

Corybas dowlingii is listed as endangered under the TSC Act.

Description

The species is a tuberous orchid which grows in clonal colonies and as a solitary dark green heart-shaped to circular leaf (15-35 mm long and wide) that ends at a point. The dark purplish red flower that is produced occurs low to the ground as a solitary erect hood or 'helmet' (Enclosure A – Photo A.2). The species flowering period is between June and August (Office of Environment and Heritage 2015b).

Corybas dowlingii is located within the central coast and Hunter region of NSW known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. This species has been recorded in large numbers at Stoney Ridge Reserve in Soldiers Point (over 14,000 individuals) being recorded (Okada 2006).

Habitat

Habitat for this species is creeklines, gullies, south facing slopes and other sheltered areas on well-drained gravelly soil at elevations between 10-100 m (Office of Environment and Heritage 2015b). It has also been noted it prefers the lower slopes and grows in moist areas under fallen logs (Okada 2006).

Occurrence within Proposal areas

No *Corybas Dowlingii* (Red Helmet Orchid) were recorded within the Proposal areas despite targeted surveys being completed during the peak flowering of the species at the Soldiers Point reference site on 20 July 2015 (Enclosure A).

No individuals were recorded within the potential reference site within George McGregor Park (refer to Section 23 for more details). The potential reference site was located close to a walking track it may have been removed as a result of anthropogenic factors.

3.5 Other threatened flora species recorded

Although the targeted species were not recorded within the Proposal areas, three threatened species were recorded that have previously recorded as part of the initial biodiversity survey (Parsons Brinckerhoff 2014a). The threatened flora species recorded are outlined in Table 3.3.

Table 3.3 Threatened flora recorded within the Proposal areas

Scientific name	Common name	EPBC act status[1]	TSC act status[2]	Flowering status
Tetratheca juncea	Black-eyed Susan	Vulnerable	Vulnerable	Occasional flowers and buds observed on isolated individuals
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	Vulnerable	Vulnerable	Not in flower or bud
Syzygium paniculatum	Magenta Lily Pilly	Vulnerable	Endangered	Not in flower or bud

(1) Listed as Vulnerable (V) under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act)
(2) Listed as Vulnerable (V) or Endangered (E) under the *Threatened Species Conservation Act 1995* (TSC Act).

For details regarding the abundance and distribution of these species refer to Section 4.3, Figure 4.1 and Figure 4.2 of the biodiversity survey report (Parsons Brinckerhoff, 2014a).

It was observed that the several of the *Syzygium paniculatum* individuals within the creekline in George McGregor Park, had been washed away in the recent severe storm events that occurred in Newcastle in April 2015.

4. Discussions and conclusions

Seasonal targeted flora surveys of the areas of the Newcastle Inner City Bypass – Rankin Park to Jesmond were completed over two days in late July and early August 2015. The ecological survey area included surveying the Proposal area and Extended proposal areas of the project.

No *Diuris praecox* (Rough Doubletail) or *Corybas dowlingii* (Red Helmet Orchid) were recorded within the Proposal areas during the 2015 targeted surveys.

It is considered unlikely that *Diuris praecox* occurs within the Proposal areas due to the extensive survey effort undertaken, and the fact that the species was not observed despite flowering at a known reference site located in Glenrock State Conservation Area.

Although *Corybas dowlingii* was not recorded during the targeted surveys this species was potentially recorded within the study area by Mr Daryl Harmen on 16 June 2013. The population potentially recorded in 2013 within George McGregor Park was located in proximity to a walking track (Refer to Figure 2.1 for location). As a result of the potential populations location it is a possibility that it may have been destroyed due to a high usage of the track by motorbikes, cyclists and bushwalkers. However, due to the extensive survey effort undertaken within the Proposal areas, and the fact that the species was not observed despite the species flowering at a known reference site location in Stoney Ridge Reserve, it is considered unlikely that this species occurs within the Proposal areas.

Although none of the targeted species were recorded three additional species were recorded during the survey; *Tetratheca juncea* (isolated flowering individuals), *Grevillea parviflora* subsp. *parviflora* (not in flower) and *Syzygium paniculatum* (not in flower). These species were previously recorded during the 2014 biodiversity assessment which outlines their abundance and distribution throughout the Proposal area (Parsons Brinckerhoff 2014a).

Yours sincerely

D Landenberger

Deborah Landenberger
Senior Ecologist

Enclosures:

Enclosure A – Reference site photos

Enclosure B – Plant species recorded

5. References

Commonwealth of Australia 2013, *Survey Guidelines for Australia's Threatened Orchids - Guidelines for Detecting Orchids listed as 'Threatened' under the Environment Protection and Biodiversity Conservation Act 1999*.

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Office of Environment and Heritage 2015c, *Rough Doubletail - Diuris praecox Profile*, viewed 6 August 2015, <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10240#>.

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Parsons Brinckerhoff 2014, *Newcastle Inner City Bypass, Rankin Park to Jesmond, Preliminary Environmental Investigation*, An unpublished report prepared for the Roads and Maritime Services, Newcastle, NSW.

Parsons Brinckerhoff 2014a, *Newcastle Inner City Bypass, Rankin Park to Jesmond, Biodiversity Survey Report.*

Enclosure A – Reference site photos

Photo A.1. *Corybas dowlingii* at Soldiers Point reference site amongst leaf litter.

Photo A.2. *Corybas dowlingii* at Soldiers Point reference site.

Photo A.3. *Corybas dowlingii* at Soldiers Point reference site.

Photo A.4. *Diuris praecox* at Glen State Conservation Reserve reference site.

Enclosure B –Plant species recorded

Table B-1 Native plant species recorded in flower or threatened

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine			Y
Dilleniaceae	*Hibbertia aspera*				Y
Dilleniaceae	*Hibbertia dentata*	Twining Guinea Flower			Y
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V	V	Y
Epacridaceae	*Leucopogon lanceolata*				Y
Fabaceae (Faboideae)	*Daviesia genistifolia*				Y
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla			Y
Fabaceae (Faboideae)	*Hovea linearis*				Y
Fabaceae (Faboideae)	*Pultenaea spinosa*	Grey Bush-pea			Y
Fabaceae (Faboideae)	*Pultenaea villosa*				Y
Fabaceae (Mimosoideae)	*Acacia fimbriata*	Fringed Wattle			Y
Fabaceae (Mimosoideae)	*Acacia linearis*				Y
Fabaceae (Mimosoideae)	*Acacia linifolia*	Flax-leaved Wattle			Y
Fabaceae (Mimosoideae)	*Acacia longifolia subsp. longifolia*	Sydney Golden Wattle			Y
Fabaceae (Mimosoideae)	*Acacia maidenii*	Maidens Wattle			Y
Fabaceae (Mimosoideae)	*Acacia myrtifolia*	Red-stemmed Wattle			Y
Fabaceae (Mimosoideae)	*Acacia terminalis subsp. augustifolia*	Sunshine Wattle			Y
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses			Y
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			Y
Myrtaceae	*Corymbia maculata*	Spotted Gum			Y
Myrtaceae	*Eucalyptus fergusonii subsp. dorsiventralis*				Y

Family Name	Scientific Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Native
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	E	Y
Orchidaceae	*Acianthus fornicatus*	Pixie Caps			Y
Orchidaceae	*Caladenia catenata*	White Caladenia			Y
Orchidaceae	*Pterostylis baptistii*	King Greenhood			Y
Orchidaceae	*Pterostylis nutans*	Nodding Greenhood			Y
Orchidaceae	*Pterostylis longifolia*	Tall Greenhood			Y
Poaceae	*Themeda australis*	Kangaroo Grass			Y
Polygalaceae	*Comesperma ericinum*	Heath Milkwort			Y
Proteaceae	*Banksia spinulosa var. collina*	Hairpin Banksia			Y
Proteaceae	*Grevillea parviflora* subsp. *parviflora*		V	V	Y
Proteaceae	*Hakea bakeriana*				Y
Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris			Y
Thymelaeaceae	*Pimelea linifolia*	Slender Rice-flower			Y

(1) Vulnerable (V), Endangered (E) as listed on the EPBC Act

(2) Vulnerable (V) as listed on the TSC Act

Appendix J – Parsons Brinckerhoff (2016), Newcastle Inner City Bypass: Rankin Park to Jesmond, Additional *Cryptostylis hunteriana* and Threatened Frogs targeted surveys

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Memo

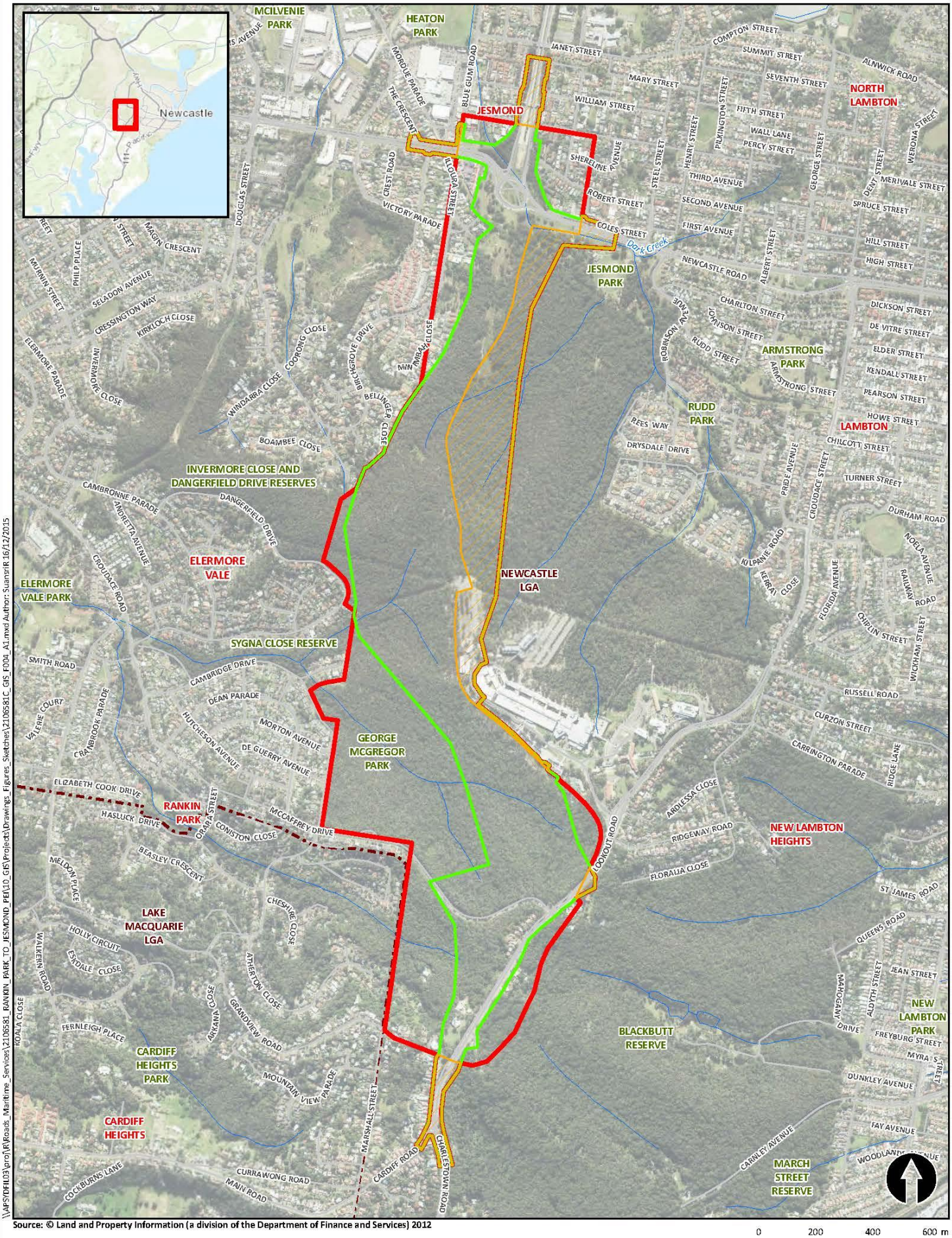
Date	9 March 2016
To	Simon Pearce GHD
Copy	Alex Cockerill Team Manager, Environment, Hunter Region Parsons Brinckerhoff
From	Alex Cockerill
Ref	2106581B-NRM-MEM-002 RevB
Subject	Newcastle Inner City Bypass: Rankin Park to Jesmond - Additional Cryptostylis hunteriana and Threatened Frogs targeted surveys

1. Introduction

Parsons Brinckerhoff was engaged by Roads and Maritime Services (Roads and Maritime), to undertake additional targeted threatened flora surveys for *Cryptostylis hunteriana* (Leafless Tongue-orchid) and targeted surveys for three threatened frog species: *Litoria brevipalmata* (Green-thighed Frog), *Litoria aurea* (Green and Golden Bell Frog) and *Pseudophryne australis* (Red-crowned Toadlet) (the survey) for the proposed fifth stage of the Newcastle Inner City Bypass (Highway 23) from Rankin Park to Jesmond. The project consists of an approximate 3.4 km dual lane carriageway highway generally between the intersection with McCaffrey Drive and Lookout Road, Rankin Park and the interchange with Newcastle Road at Jesmond (the project). The locality of the project is provided in Figure 1.1.

A biodiversity survey was undertaken within the proposal area in 2014 to describe and detail the ecological characteristics of the study area (Parsons Brinckerhoff 2014). However, as a result of design changes, additional areas within an expanded study area were identified as requiring further ecological survey. This report details the results of additional targeted threatened flora surveys for *Cryptostylis hunteriana* and threatened frog species completed in early October and late November 2015, and will support the Newcastle Inner City Bypass – Rankin Park to Jesmond Environmental Impact Assessment (Parsons Brinckerhoff 2014).

This memo details the general methodology (including personnel, consultation, reference sites and field survey methodology), results and conclusions drawn from the targeted threatened flora surveys for *Cryptostylis hunteriana* and the three threatened frogs, *Litoria aurea*, *Litoria brevipalmata* and *Pseudophryne australis*.



Source: © Land and Property Information (a division of the Department of Finance and Services) 2012

0 200 400 600 m

- Local roads
- Creek lines
- Proposal area
- Extended proposal area
- Study area
- Local government area

Figure 1.1
Project locality

2. Methodology

2.1 Definitions

For the purposes of this study the following definitions apply:

- **Proposal area** is defined by a 20 m boundary from the strategic design that was displayed in 2007 (Figure 1.1).
- **Extended proposal area** is defined as an extension of proposal area along the eastern, northern and southern sections of the original proposal area, which were not included in the original study area (Figure 1.1).
- **Study area** is the area of bushland between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital, Lookout Road and both northern and southern sides of McCaffrey Drive (Figure 1.1).
- **Locality** is defined as an approximate 10 km radius around the proposal area.

2.2 Personnel

The contributors to the preparation of this memo, their qualification and roles is provided in Table 2.1.

Table 2.1 Contributors and their roles

Name	Qualifications	Role
Alex Cockerill	BSc (Hons)	Principal ecologist – Lead ecologist,
Debbie Landenberger	BSc (Hons)	Senior botanist – Field survey, Technical Review
Allan Richardson	BEnvSc (Hons)	Senior ecologist – Field Survey, report preparation
Nathan Cooper	BEnvSc, GradDipOrnith	Senior ecologist – Field survey, reporting
Clementine Watson	BEnvSc	Graduate Ecologist - Field survey
Robert Suansri	BSc; BEc	GIS operator - mapping and data management

All works were carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the *National Parks and Wildlife Regulations 2002* and Section 132C of the *National Parks and Wildlife Act 1974*, Animal Research Authority issued by the Department of Industries and Investment NSW (Agriculture).

2.3 Weather

The weather conditions during the survey period were moderately cool to very warm temperatures (14.3-38.0ºC). Good rainfall was experienced leading up to the survey period, with 25 mm, 11 mm and 4 mm recorded at the University of Newcastle on November 14, 15 and 16 respectively. Wind values were relatively calm throughout the survey period with stronger winds locally on November 30 (19km/hr), which were not experienced to their full extent within the sheltered drainage lines of the proposal and extended proposal area (Table 2.2).

Frog surveys were conducted during moderate to warm spring conditions under climatic patterns conducive to frog activity. December 1, in particular, was a very warm day (Table 2.3) followed by a southerly change producing low atmospheric pressure values and storm producing conditions, which encourage frog activity.

Table 2.2 Weather conditions

Date	Temperature °C (min)[1]	Temperature °C (max)[1]	Rain (mm)[1]	Wind (max speed (km/ph)/direction)[1]
19 November 2015	17.6	31.8	0	Calm
26 November 2015	20.0	40.5	0	9
30 November 2015	19.0	27.7	0	19
1 December 2015	17.2	38.0	0	9
3 December 2015	15.8	23.0	2.8	9
4 December 2015	14.3	24.4	0	9

[1] Data obtained from Bureau of Meteorology Newcastle University NSW AWS Station (Station 061390).

2.4 Reference populations

A reference population for *Cryptostylis hunteriana* was visited on November 24 2015, but no individuals were found flowering at that time. *Cryptostylis hunteriana* individuals do not always flower during every flowering season, as was the case at this site, although reference site visitation was undertaken during the flowering period for this species. At the reference site both *Cryptostylis subulata and Cryptostylis erecta* were in flower, these two species have the same flowering period as *Cryptostylis hunteriana*. Targeted surveys were conducted throughout the proposal and extended proposal area (Figure 2.1) within vegetation communities with greatest potential for onsite occurrences and seasonal suitability was confirmed by numerous flowering individuals of closely related species, particularly *Cryptostylis subulata*, but also more sparsely occurring *Cryptostylis erecta*. The survey effort and results of the reference site surveys are provided in Table 2.3.

Table 2.3 Reference site survey effort

Reference site	Dates surveyed	Survey effort (person hours)	Result
***Cryptostylis hunteriana* (Leafless Tongue-orchid)**			
Rankin Park Survey site	19 November 2015	2 hrs	Closely related species *Cryptostylis subulata* and *Cryptostylis erecta* flowering, which flower at the same time as *Cryptostylis hunteriana*
Wallarah Peninsula	24 November 2015	1 hrs	Not in Flower. Closely related species *Cryptostylis subulata* and *Cryptostylis erecta* flowering, which flower at the same time as *Cryptostylis hunteriana*
Rankin Park Survey site	1 December 2015	11 hrs	Closely related species *Cryptostylis subulata* and *Cryptostylis erecta* flowering, which flower at the same time as *Cryptostylis hunteriana*
***Litoria aurea* (Green and golden Bell Frog)**			
Reference Population sites at Kooragang Island	3 December 2015	1 hour	One individual observed sitting in *Juncus acutus*, no calling individuals heard

A reference site for Green and Golden Bell Frog was visited on December 3 2015, and although conditions were cool, one individual was observed to be active during the survey evening. Reference sites for *Pseudophryne australis* and *Litoria brevipalmata* are not known locally, but *Pseudophryne australis'* closely

related species, *Pseudophryne coriacea*, was actively calling throughout the survey period at a number of sites within the study area. *Litoria brevipalmata* is an infrequent calling species that only calls during one or two of the heaviest rainfall events during the breeding period (spring to autumn).

2.5 Field survey

2.5.1 *Cryptostylis hunteriana*

Targeted surveys were conducted for *Cryptostylis hunteriana* throughout the proposal and extended proposal area (refer Figure 2.1) within vegetation communities with greatest potential for onsite occurrences and seasonal suitability was confirmed by flowering individuals of closely related species, particularly *Cryptostylis subulata*, but also the more sparsely occurring *Cryptostylis erecta*.

Targeted *Cryptostylis hunteriana* surveys were undertaken on three dates, November 19, December 1 and December 4 2015. The methodology followed stratification of the study area's vegetation communities into those suited to *Cryptostylis hunteriana*. Suitable habitat for *Cryptostylis hunteriana* was determined to be those vegetation associations dominated by *Angophora costata* (Smooth-barked Apple) and/or *Eucalyptus piperita* (Sydney Peppermint) in the canopy strata. Those communities identified during the Parsons Brinckerhoff (Parsons Brinckerhoff 2014) survey containing suitable habit for *Cryptostylis hunteriana* include, HU 621 Smooth-barked Apple – Red Bloodwood open forest and HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest (refer Table 3.2).

Survey methodology was conducted as random meander surveys throughout suitable vegetation communities. Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random manner throughout the site recording all species observed, boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

Where *Cryptostylis subulata* or *Cryptostylis erecta* were recorded the surrounding area was searched in a more detailed manner thoroughly in the vicinity of these two orchids. Targeted flora surveys were undertaken within the Proposal area and extended proposal area by two ecologists on November 19 and December 1 and one ecologist on December 4, 2015. More thorough survey effort was conducted in those areas where other *Cryptostylis* species were present as *Cryptostylis hunteriana* is usually present in habitats containing closely related species. Vegetation communities in which *Cryptostylis subulata* and *Cryptostylis erecta* were observed within the study area included, HU 621 Smooth-barked Apple – Red Bloodwood open forest and HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest. The understorey of these communities were often predominantly grassy dominated by *Themeda australis* (Kangaroo Grass) and, or *Rytidosperma pallidum* (Silvertop Wallaby Grass).

2.5.1.1 Survey guidelines

There are no specific survey guidelines for *Cryptostylis hunteriana*, apart from the timing of surveys. Survey timing must correlate with the flowering period for *Cryptostylis hunteriana* since the lack of leaves prevents its detection outside of the flowering season. *Cryptostylis hunteriana* is however listed within the '*Survey Guidelines for Surveying Australia's Threatened Orchids listed under the EPBC Act*' (Commonwealth of Australia 2013). Surveys for this species were undertaken in accordance with these guidelines including:

- Determining the optimum flowering period for the species using Table 1 within the guidelines document – optimum flowering period for *Cryptostylis hunteriana* in NSW is between December and January. Further effort was undertaken to survey a known reference site in order to identify whether the species was flowering in a known population.

- Determining optimum locations of surveys - undertaken across the study area using the existing vegetation mapping and knowledge of the study area to identify areas of 'potential' and 'known' habitat to target survey efforts.

Minimal survey requirements – surveys involved random meander transects (Cropper 1993) were undertaken during the known flowering period for the species. Records of the survey effort were recorded using a hand-held GPS. No *Cryptostylis hunteriana* individuals were recorded and therefore no thorough searches were required in the vicinity of detected plants, although more intense survey effort was undertaken where other *Cryptostylis* spp. were observed.

2.5.2 Threatened frog species

Threatened frog survey methodology targeted potential habitat, being major and tributary drainage lines within the study area (refer to Figure 2.1). Site survey selection was determined by the presence of potential frog habitat. Drainage lines in the northeast of the study area were found to be highly ephemeral and dry despite recent rains, whereas drainage lines in the south of the study area and associated with George McGregor Park were holding water although the drainage line in the centre of the study area was reduced to stagnant ponds. Only the drainage lines, their immediate shorelines (within 2m) and associated vegetation were surveyed. Surveys were undertaken during nocturnal hours and encompassed streamside shorelines and vegetation searches, frog call detection and frog call playback. All species were identified to species level by direct observation or call identification.

2.5.3 Survey effort

The survey area where the random meander flora surveys and targeted threatened frog searches were undertaken is shown in Figure 2.1 and Figure 2.2, with a summary of the survey effort outlined in Table 2.4. A general list of native flora species that were in flower during the field surveys is provided in Enclosure A.

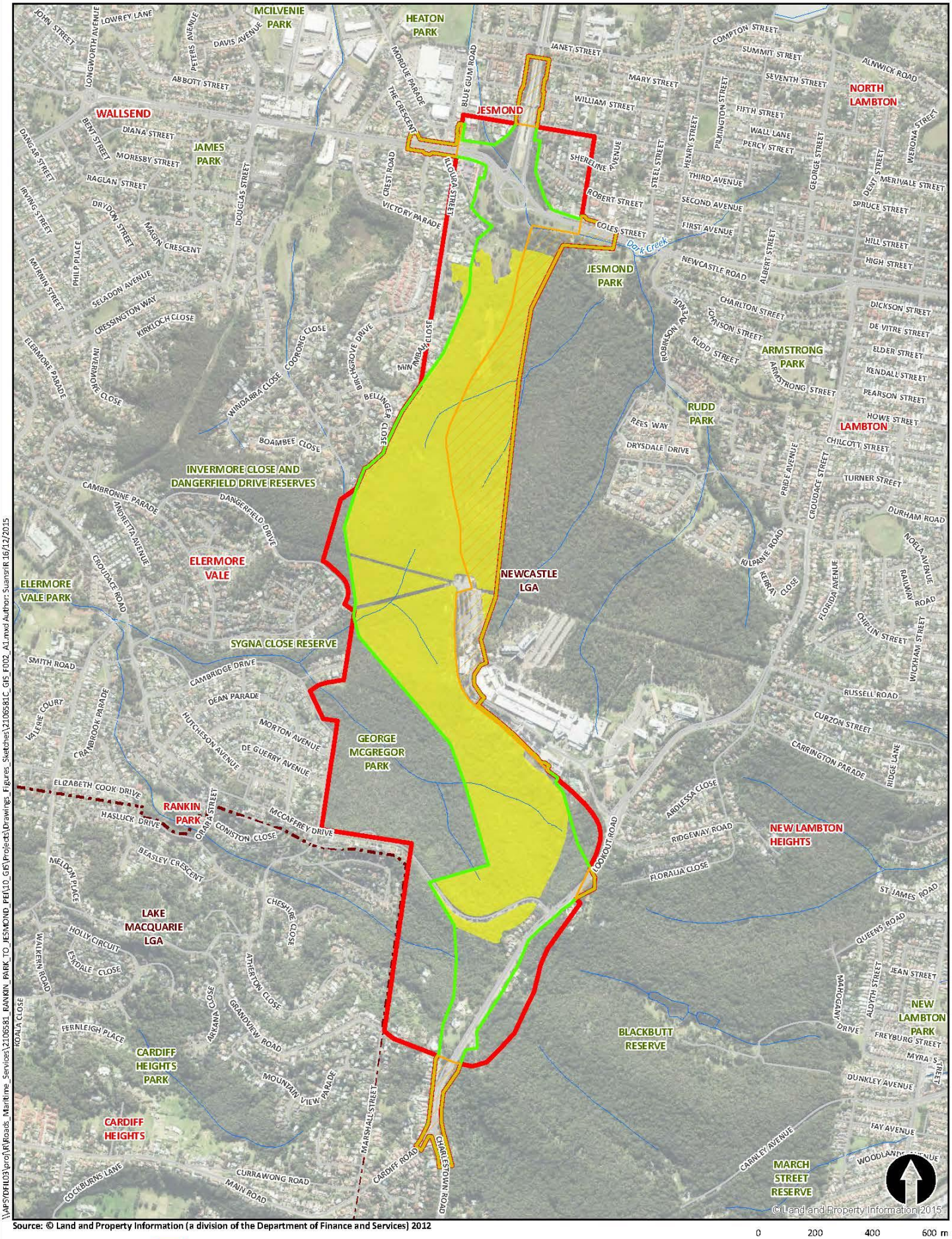
Table 2.4 Targeted flora and fauna survey effort

Species	Date of survey	Survey effort (person hours)
Cryptostylis hunteriana	19 November 2015	10.0
Cryptostylis hunteriana	1 December 2015	14.0
Cryptostylis hunteriana	4 December 2015	2.0
Total survey effort – *Cryptostylis hunteriana*		**26.0**
Threatened frog surveys	19 November 2015	2.0
Threatened frog surveys	26 November 2015	5.0
Threatened frog surveys	1 December 2015	4.0
Threatened frog surveys	3 December 2015	1.5
Total survey effort – *Threatened frogs*		**12.5**

2.6 Limitations

Limited surveys were completed south of Jesmond Park and north of the study area due to access issues (high volumes of traffic and thickets of *Lantana camara**) and lack of suitable habitat for the target species.

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. *Cryptostylis hunteriana*, in particular, is very difficult to detect due to its lack of leaves and its probable variable flowering habits, in response to soil moisture (Department of the Environment 2015), may limit the time period it is detectable annually and when flowering. The conclusions in this report are based upon data acquired for the site and the environmental field surveys are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.

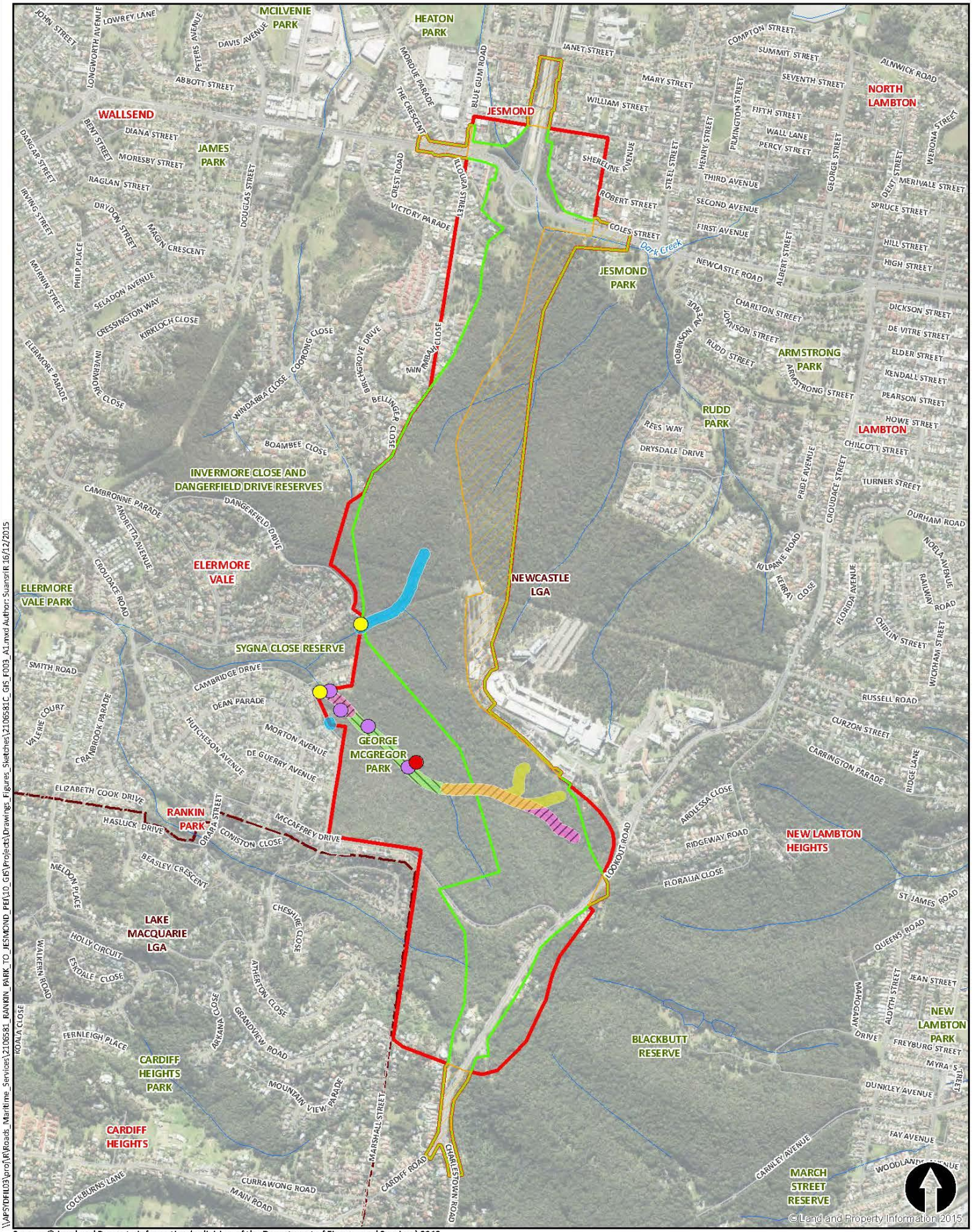


Source: © Land and Property Information (a division of the Department of Finance and Services) 2012

0 200 400 600 m

- Local roads
- Creek lines
- Proposal area
- Extended proposal area
- Study area
- Local government area
- *Cryptostylis hunteriana* survey areas

Figure 2.1
Cryptostylis hunteriana survey areas



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Source: © Land and Property Information (a division of the Department of Finance and Services) 2012

0 200 400 600 m

Local roads
Creek lines
Proposal area
Extended proposal area
Study area
Local government area

Frog survey areas
Survey date - 7/10/2015
Survey date - 26/11/2015
Survey date - 1/12/2015
Survey date- 3/12/2015

Frog species located during survey
Common Eastern Froglet
Red-backed Toadlet
Striped Marsh Frog

Figure 2.2
Frog survey areas

3. Results

3.1 Vegetation communities

Desktop analysis of the vegetation mapping and ground-truthing during the 2014 surveys (Parsons Brinckerhoff) found nine vegetation communities present within the study area (Table 3.1).

Table 3.1 Vegetation communities identified in the study area

Plant Community Type[1]	LHCCREMS Broad Scale Vegetation Mapping[2]	Threatened Ecological Community on the TSC Act
HU 629 Spotted Gum – Broad-leaved Ironbark grassy open forest	Lower Hunter Spotted Gum Ironbark Forest	Yes – Lower Hunter Spotted Gum Ironbark Forest[3]
HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant	Coastal Foothills Spotted Gum – Ironbark Forest	No
HU 631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	Hunter Valley Moist Forest	No
HU 621 Smooth-barked Apple – Red Bloodwood open forest	Coastal Plains Smooth-barked Apple Woodland	No
HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Coastal Sheltered Apple – Peppermint Forest	No
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant[1]	Alluvial Tall Moist Forest	No
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	Alluvial Tall Moist Forest	No
Planted and parkland vegetation	–	No
Exotic Vegetation	–	No
Dam	–	No

(1) Office of Environment and Heritage vegetation types database (Office of Environment and Heritage 2012) as used in BioMetric 2.0 (Office of Environment and Heritage 2015a).

(2) Lower Hunter and Central Coast Regional Environmental Management Strategy (2003).

(3) Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion listed as endangered under the NSW *Threatened Species Conservation Act 1995*.

3.2 Targeted threatened flora species

3.2.1 Habitat

The vegetation communities that contained suitable habitat for *Cryptostylis hunteriana* were targeted during the surveys. Vegetation communities identified as having habitat for these species is detailed in Table 3.2 and Figure 2.1.

Table 3.2 Vegetation communities with habitat for targeted species

Vegetation Community	*Cryptostylis hunteriana*	*Threatened frogs*
HU 629 Spotted Gum – Broad-leaved Ironbark grassy open forest	-	-
HU 631 Spotted Gum – Grey Ironbark open forest – atypical variant	-	-
HU 631 Spotted Gum – Grey Ironbark open forest – *Eucalyptus fergusonii* variant	-	-
HU 621 Smooth-barked Apple – Red Bloodwood open forest	Y	-
HU 622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest	Y	-
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – *Syncarpia glomulifera* variant[1]	-	Y
HU 637 Sydney Blue Gum – White Mahogany shrubby tall open forest – atypical variant	-	Y
Planted and parkland vegetation	-	-
Exotic Vegetation	-	-
Dam	-	Y

(1) Office of Environment and Heritage vegetation types database (Office of Environment and Heritage 2012) as used in BioMetric 2.0 (Office of Environment and Heritage 2015a).

3.2.2 Threatened flora species - *Cryptostylis hunteriana* (Leafless Tongue-orchid)

Cryptostylis hunteriana is listed as Vulnerable under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Cryptostylis hunteriana is a perennial terrestrial orchid with no leaves that derives it nutrients from dead organic matter in partnership with mycorrhizal fungi. The species produces moderately sized flowers at the top of a yellow-green stem. The flowers have a large maroon coloured labellum with a black centre breaking up into lines or dots above the orchid's pale throat. The species flowers in summer, with peak flowering in NSW from December to January (Department of the Environment 2015).

Its distribution occurs in eastern Australia within the coastal strip from for Orbost in Victoria, through NSW to the Tin Can Bay area of southern Queensland (Department of the Environment 2015).

Habitat for *Cryptostylis hunteriana* is reported as varied, extending across dry and wet woodlands, wet heaths, grasslands, rainforests and wetland margins (Department of the Environment 2015). Although its substrate preferences are thought to be predominantly moist and sandy, it has also been observed in dry and peaty soil types (Department of the Environment 2015).

Local population have been recorded locally on the Wallarah Peninsula, Charmhaven, Wyee, Chain Valley Bay, Freemans Waterhole and Vales Point-Wyee, NSW (Department of the Environment 2015).

3.2.2.1 Occurrence within proposal area and extended proposal area

No *Cryptostylis hunteriana* was recorded within the both the extended proposal area and the proposal area. Habitats surveyed contained other *Cryptostylis* spp. including both *Cryptostylis subulata* and *Cryptostylis*

erecta, although neither species were in high densities and *Cryptostylis erecta* was only encountered sparsely.

3.2.3 Other threatened flora species recorded

Although the *Cryptostylis hunteriana* was not recorded during the field surveys, one other threatened species was recorded that has previously been recorded as part of the initial biodiversity survey (Parsons Brinckerhoff 2014). The threatened flora species recorded is outlined in Table 3.3.

Table 3.3 Threatened flora recorded during the field surveys

Scientific name	Common name	EPBC Act[1]	TSC Act[2]	Flowering status
Tetratheca juncea	Black-eyed Susan	Vulnerable	Vulnerable	Strong flowering observed on patches of individuals

(1) Listed as Vulnerable (V) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
(2) Listed as Vulnerable (V) or Endangered (E) under the *Threatened Species Conservation Act 1995* (TSC Act).

For details regarding the abundance and distribution of these species refer to Section 4.3, Figure 4.1 and Figure 4.2 of the biodiversity survey report (Parsons Brinckerhoff, 2014a).

3.2.4 Flowering species of plant recorded

A total of 34 native plant species where recorded flowering within the Proposal area during the targeted survey undertaken (Enclosure A). One of these species, *Cryptostylis erecta*, had not been previously recorded within the Proposal area during other surveys undertaken in 2015. The most diverse family recorded was Fabaceae with 10 species, followed by Orchidaceae with five species. Exotic species were not recorded as part of this field survey, however numerous exotic species were observed and occurred adjoining the existing road corridors, including several noxious weeds.

3.3 Threatened frog species

Targeted threatened frog species were conducted in late November and early December 2015 (refer Figure 2.2). Three regionally occurring threatened frog species were targeted due to their presence in database searches conducted for the Project, being *Litoria aurea* (Green and Golden Bell Frog), *Litoria brevipalmata* (Green-thighed Frog) and *Pseudophryne australis* (Red-crowned Toadlet). During frog surveys, drainage line surveys were also assessed for their potential to support a range of local frog species, including other threatened frog species occurring in the region.

A small number of common frog species were heard calling in drainage lines across the surveyed habitats, including *Crinia signifera* (Common eastern Froglet), *Limnodynastes peronii* (Striped Marsh Frog) and *Pseudophryne coriacea* (Red-backed Toadlet). The main drainage line associated with the southern section of the proposal area was running slowly and had many pools and reaches holding water. Water quality was very good, from a visual assessment, and both Freshwater Shrimp (*Paratya australiensis*) and Long-finned Eel (*Anguilla reinhardtii*) were abundant during the surveys.

The drainage line surveyed in the central section of the study area was holding water in moderately sized rocky pools. Although the water was stagnant, *Limnodynastes peronii* (Striped Marsh Frog) was heard calling at this site and *Pseudophryne coriacea* (Red-backed Toadlet) were relatively abundant along the course of the drainage line.

Despite the apparent quality of this habitat, frog species were generally low. Other relatively common stream-side frogs such as *Litoria phyllochroa* (Leaf-green Tree Frog) and *Litoria fallax* (Eastern Dwarf Tree Frog) were not present, whilst there was relatively good frog activity at other sites checked for reference during the same nights as the survey.

Moderately high rainfall inputs were experienced prior to the commencement of surveys over November 14, 15 and 16. Conditions were not strongly conducive for very high frog activity, although Tuesday December 1 was very warm (38°C) during the day with local storm cloud generation associated with a falling barometer as evening fell. Such conditions usually induce a response from common frogs, although this was not the case within study area frog habitats. A reference site checked elsewhere in the region recorded good frog activity on the same night and *Litoria aurea* was found to be active at a reference site on Kooragang Island.

3.3.1 *Litoria aurea* (Green and Golden Bell Frog)

Litoria aurea is listed as endangered under the TSC Act and vulnerable under the EPBC Act.

A moderately large frog from around 25 mm in length, after metamorphosis, to some 85 mm once adult size is attained (Department of the Environment and Water Resources 2007). Their front feet are not webbed but the rear feet almost completely (Department of the Environment and Water Resources 2007). In daylight the colouration of individual frogs varies considerably with some individuals entirely bronze in colouration, others emerald green and many other individuals a combination of both colours in a distinctive spotted or blotchy pattern on the dorsum. In torpor, away from light their colouration can darken considerably. They have a relatively pointed snout in comparison to the tree frogs and have a distinctive cream coloured dorso-lateral line extending from the eye to the groin, which is often edged in bronze along the top and black underneath. The dorso-ventral black line extends through the eye to the snout in many individuals. The flanks have a lumpy texture, coloured green, bronze and/or cream. The tympanum is prominent and bronze, and the groin is bright blue.

Once common in freshwater wetland habitats throughout eastern Australia, populations are now largely limited to coastal habitats. In the Lower Hunter region *Litoria aurea* populations have protracted to freshwater habitats within saline influenced contexts such as Kooragang and Ash Islands in the Hunter estuary and the coastal fringes of Broughton Island north of Port Stephens (Department of Environment and Conservation 2005).

3.3.1.1 Occurrence within proposal area and the extended proposal area

No *Litoria aurea* (Green and Golden Bell Frog) individuals were recorded within during the field surveys. During the same period active individuals were observed at a reference site on Kooragang Island.

The study area is characterised by drainage lines in tall forest habitats, which are semi-permanent in nature due to the limited catchment area feeding them. Such habitats provide no suitable areas for *Litoria aurea* to persist, due to the lack of open basking areas, and the lack of saline influences to control water borne fungal pathogens like *Batrachochytrium dendrobatidis* (frog Chytrid Fungus), which is responsible for the disease Chytridiomycosis (NSW National Parks and Wildlife Service 2008). Chytridiomycosis is implicated in the decline of a number of frog species in Australia, including *Litoria aurea* (NSW National Parks and Wildlife Service 2008). Drainage lines within the study area offer the only frog habitat, which are semi-permanent and under favourable rainfall conditions would represent fast-flowing streams. Such habitats are not suited to the breeding biology of *Litoria aurea*, which breeds in ephemeral and semi-permanent still ponds (Department of Environment and Conservation 2005).

3.3.2 *Litoria brevipalmata* (Green-thighed Frog)

Litoria brevipalmata is listed as vulnerable under the TSC Act.

A medium sized frog, to around 40 mm in length, with very limited webbing to the rear feet and no webbing on the front (Office of Environment and Heritage 2014). They are brown dorsally, varying from relatively light to a deep rich chocolate. They have a broad dark band extending from the snout, through the eye and ending behind the fore legs as a series of splotches (Office of Environment and Heritage 2014). They are speckled black in the groin and marbled black on the rear of the thighs, with an over-wash of bright green to yellow, which gives the species its name. *Litoria brevipalmata* breeds throughout a fairly broad period from spring to autumn when conditions are favourable (Lemckert *et al.* 2006).

Studies of *Litoria brevipalmata* habitat have shown that they have a clear preference for wet forest types and can withstand small amounts of disturbance (Lemckert *et al.* 2006). They breed in ephemeral ponds with leaf litter or shrubs in preference to grassy substrates and calling is limited to rainfall events that are sufficient to flood breeding habitats (Lemckert *et al.* 2006).

3.3.2.1 Occurrence within proposal area and extended proposal area

No *Litoria brevipalmata* individuals (Green-thighed Frog) were recorded during the field surveys. It is considered unlikely that weather conditions within the site during the time of surveys were sufficient to induce males to call. Although *Litoria brevipalmata* is not averse to calling in cooler conditions (Lemckert *et al.* 2006) and other areas away from the site were checked to confirm suitable conditions for frog species breeding call activities, and, it is known to call only during significant pond replenishing rainfall events (Lemckert *et al.* 2006).

Nevertheless, under very significant rainfall events, drainage lines within the study area would be characterised by very high flow rates, which is not consistent with the ephemeral pond habitats preferred by *Litoria brevipalmata*. *Litoria brevipalmata* have floating egg masses which require still pond habitats (Lemckert *et al.* 2006). There are no potential areas within the study area that provided ephemeral pond habitats suited to the breeding habitats of this species. Therefore it is considered unlikely that this is present within the project area based on habitat requirements alone.

3.3.3 *Pseudophryne australis* (Red-crowned Toadlet)

Pseudophryne australis is listed as vulnerable under the TSC Act.

A small frog less than 30 mm in length, with a white and grey marbled belly, more or less reddish washed dorsum with tubercles, often red-topped, and a distinctive bright orange-red Tt-shaped mark between the eyes and extending forward to the snout (Office of Environment and Heritage 2015b).

This species has a strong association with the Sydney Sandstone formations to the west of the site in the Watagan Mountains and beyond to Wollemi NP and further south to the Blue Mountains and beyond (Office of Environment and Heritage 2015b). It occurs in damp areas along small drainage lines and soaks where males build nests to attract females (Office of Environment and Heritage 2015b).

3.3.3.1 Occurrence within the proposal area and extended proposal area

No *Pseudophryne australis* (Red-crowned Toadlet) individuals were recorded during the field surveys. During the survey period suitable habitat types, such as damp drainage lines with accumulated leaf litter were surveyed without success. A closely related and more common species, the Red-backed Toadlet (*Pseudophryne coriacea*), was encountered regularly throughout the study area's drainage lines, suggesting strongly that breeding conditions were suitable for *Pseudophryne australis*, as they are known to call all year round (Office of Environment and Heritage 2015b).

4. Discussions and conclusions

Seasonal targeted flora surveys for *Cryptostylis hunteriana* were completed in the proposal area and extended proposal area over three days in late November and early December 2015. Both the proposal area and the extend proposal area included a 20 metre boundary from the proposed design alignment of the project footprint between Jesmond and Rankin Park. Surveys targeted *Angophora costata* and *Eucalyptus piperita* dominated vegetation communities, which represented the most likely habitat types for *Cryptostylis hunteriana* within the study area.

Cryptostylis hunteriana

During the survey dates other orchid species were noted as flowering, including *Dipodium variegatum*, *Dipodium punctatum*, and importantly both *Cryptostylis subulata* and *Cryptostylis erecta*, which are closely related to *Cryptostylis hunteriana* and flower during the same period.

No *Cryptostylis hunteriana* were recorded within either the proposal area or the extended proposal area during the 2015 targeted surveys.

It is considered unlikely that *Cryptostylis hunteriana* occurs within the both the proposal area and the extended proposal area due to the extensive survey effort undertaken, and the fact that the species was not observed despite surveys conducted while other *Cryptostylis* spp. were noted as flowering throughout the study area. One other threatened plant species, *Tetratheca juncea* (Black-eyed Susan) was noted as flowering well in some areas of the study area during surveys.

Further threatened plant species were previously recorded during the 2014 biodiversity assessment, the resulting report outlined their abundance and distribution throughout the proposal area (Parsons Brinckerhoff 2014).

Threatened frogs

Seasonal targeted surveys were also conducted over four nights in late November and early December for three regionally occurring threatened frog species, being *Litoria aurea* (Green and Golden Bell Frog), *Litoria brevipalmata* (Green-thighed Frog) and *Pseudophryne australis* (Red-crowned Toadlet). Drainage lines within the study area were assessed for their potential to represent frog habitat, a number of which, including those traversing the extended proposal area in the north of the study area, were found to be highly ephemeral, very dry and dominated by terrestrial vegetation and as such offering no habitat for frogs.

The main drainage line in the south of the study area and associated with the proposal area appeared to have good water quality, evidenced by animal life, but no frog larvae were recorded in still or slowly flowing ponds. Although conditions during the survey period were not generally very warm in the evenings, one evening survey followed a very warm day and was associated with storm producing conditions, which normally results in an increase in frog activity. Very few frog species were noted as calling during the surveys despite frog activity on the same night at reference sites visited.

None of the three surveyed threatened frogs were recorded during the surveys. Although survey conditions were not at their peak, assessment of habitat within the study area found it very unlikely that any of the three target species would occur within the study area for the following reasons:

- *Litoria aurea* (Green and Golden Bell Frog) locally occurs in areas such as the Hunter estuary islands and Broughton Island, near Port Stephens, where habitats are subject to saline inputs that suppress frog contraction of the disease Chytridiomycosis. Such habitat conditions do not occur within the study area.

- Both *Litoria aurea* and *Litoria brevipalmata* (Green-thighed Frog) are pond breeders, *Litoria brevipalmata* in ephemeral ponds after sufficient rainfall to fill dry breeding habitats. Such breeding habitat conditions are not present within the study area. Potential breeding habitats within the site are represented by creekline ponds that would be fast flowing streams under high rainfall conditions, which is unlikely to suit the breeding biology of *Litoria aurea* or *Litoria brevipalmata*.
- *Pseudophryne australis* (Red-crowned Toadlet) distribution is closely aligned with Sydney sandstone geologic formations as occurs west of the study area and to the south of the Hunter region and is not present within the study area. *Pseudophryne australis* calls all year round and suitable patches of creekline debris for nest establishment occurred frequently within the study area, as evidenced by the presence *Pseudophryne coriacea* (Red-backed Toadlet) a closely related more widely distributed species utilising similar micro-habitat features. It is considered very likely that if present, *Pseudophryne australis* would have been detected within the study area, but habitat constraints and survey results suggest it very unlikely to occur.

Yours sincerely

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Team Manager, Environment

Enclosure A – Flowering Species of Plant Recorded

Table 1 Flowering species recorded

Family Name	*Scientific Name*	Common Name	EPBC Act[1]	TSC Act[2]	Native
Acanthaceae	*Brunoniella australis*	Blue Trumpet			True
Anthericaceae	*Thysanotus tuberosus*	Common Fringe-lily			True
Asteraceae	*Bidens pilosa*	Cobblers Pegs			False
Asteraceae	*Lagenifera stipitata*	Blue Bottle-daisy			True
Asteraceae	*Sonchus oleraceus*	Common Sowthistle			False
Asteraceae	*Vernonia cinerea*				True
Celastraceae	*Maytenus silvestris*	Narrow-leaved Orangebark			True
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V	V	True
Fabaceae (Faboideae)	*Glycine clandestina*	Twining Glycine			True
Fabaceae (Faboideae)	*Mirbelia rubiifolia*	Heathy Mirbelia			True
Fabaceae (Faboideae)	*Pultenaea daphnoides*	Large-leaf Bush-pea			True
Fabaceae (Faboideae)	*Trifolium repens*	White Clover			False
Fabaceae (Faboideae)	*Vicia sativa*	Common Vetch			False
Goodeniaceae	*Goodenia heterophylla*				True
Lobeliaceae	*Lobelia gibbosa*	Tall Lobelia			True
Lobeliaceae	*Pratia purpurascens*	Whiteroot			True
Orchidaceae	*Calochilus robertsonii*	Purplish Beard Orchid			True
Orchidaceae	*Cryptostylis erecta*	Tartan Tongue Orchid			True
Orchidaceae	*Cryptostylis subulata*	Large Tongue Orchid			True
Phormiaceae	*Dianella caerulea*				True
Poaceae	*Echinopogon caespitosus*				True
Poaceae	*Joycea pallida*	Silvertop Wallaby Grass			True
Poaceae	*Themeda australis*	Kangaroo Grass			True
Polygalaceae	*Comesperma ericinum*	Heath Milkwort			True
Proteaceae	*Lambertia formosa*	Mountain Devil			True
Proteaceae	*Persoonia levis*	Broad-leaved Geebung			True
Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush			True
Thymelaeaceae	*Pimelea linifolia*	Slender Rice-flower			True
Violaceae	*Viola hederacea*	Ivy-leaved Violet			True

(1) Listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*

(2) Listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*

Appendix K – Eastcoast Flora Survey 2015, *Lower Hunter Spotted Gum-Ironbark Forest: Verification Survey, Proposed Newcastle Inner City Bypass (Rankin Park to Jesmond), Newcastle LGA*

2015

Lower Hunter Spotted Gum-Ironbark Forest: Verification Survey, Proposed Newcastle Inner City Bypass (Rankin Park to Jesmond), Newcastle LGA

18 March 2015

Report to

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Cover image: Example of Lower Hunter Spotted Gum – Ironbark Forest from the study area.

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Executive Summary

An assessment has been made of vegetation previously reported as Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) within the proposed Newcastle Inner City Bypass, between the suburbs of Jesmond and Rankin Park in the Newcastle LGA. LHSGIF is a threatened ecological community (TEC) listed under the NSW *Threatened Species Conservation Act 1995*.

Following field reconnaissance, data collection and numerical data analysis, the presence of this TEC has been confirmed for the northern parts of the Bypass area, where it occurs principally on the exposed northerly to westerly slopes. Vegetation in this area provides a very good match for that described as Hinterland Spotted Gum – Ironbark Forest in a recent revision of this TEC, one of eleven definable forms of the community across the Sydney Basin. In support, an assessment of species presence within two sample plots against diagnostic lists showed there to be 64% and 72% 'hit' for Hinterland Spotted Gum – Ironbark Forest, and the floristic dichotomous key developed as part of that revision also leads directly to this form.

Further support for the identity of the Bypass vegetation was obtained through numerical classification of the two plot samples within two regional datasets (n=570 & n=244). Both analyses suggested that the two new sample plots are more closely related to LHSGIF elsewhere in the region than they are to other more general Spotted Gum-Ironbark vegetation, including Coastal Foothills Spotted Gum-Ironbark Forest. Again, this analysis showed that the site supports Hinterland Spotted Gum – Ironbark Forest, a definable form of LHSGIF.

In terms of the distribution of LHSGIF across the Bypass project area, the use of over 110 Rapid Data Points, collecting information on dominant plant species within canopy, shrub and ground layers, has provided a revised map of the TEC. An area of approximately 16.4 hectares within the investigation area has been shown to support LHSGIF, all in moderate to good condition. Although some minor differences are evident, this map differs little from that provided by Parsons Brinckerhoff (2014).

The significance of LHSGIF within the Investigation Area is such that it occurs at the eastern limit of distribution of this community within the region. As such, these eastern patches of the community tend to support additional species more typical of wetter environments (while still retaining their core diagnostic species), which is not a feature of the more inland stands. In the light of potential climate change scenarios, examples of communities and individual species at distributional limits may become important refugia for such vegetation, and hence their significance is heightened. This significance is moderated by the isolated nature of the Bypass stands, which are continually subject to higher fire frequency, weed invasion, exotic animals and increasing human traffic.

Retention of the best examples of LHSGIF within the greater Jesmond Bushland area would be desirable to maintain a sizeable example of the most easterly forms of the community. Fortunately, some stands mapped as part of this study do occur outside of the Investigation Area, and this seems to be a possible scenario. To minimize potential impacts on LHSGIF, alignment of the proposed Bypass would ideally take in the previously cleared strip just south of the existing Jesmond round-a-bout, and avoid the main south-western stand adjoining the existing urban areas of Jesmond. This option for the Bypass (Route 2) would require the removal of approximately 2.8 hectares of LHSGIF, and allows for the retention of the larger south-western portion.

Table of Contents

1. Background

Roads and Maritime Services (RMS) are proposing to construct a 3km section of the Newcastle Inner City Bypass ('Bypass') through bushland areas between the suburbs of Rankin Park and Jesmond, in the Newcastle local government area. This proposal involves connection of the existing Jesmond to Sandgate section of the Bypass to Lookout Road at New Lambton Heights, near its intersection with McCaffrey Drive. Major ecological studies have been undertaken by Parsons Brinckerhoff on behalf of the RMS, which have identified stands of the Lower Hunter Spotted Gum – Ironbark Forest endangered ecological community in the north of the study area (Parsons Brinckerhoff 2014).

Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) was listed as a Threatened Ecological Community (TEC) under the New South Wales *Threatened Species Conservation Act 1995* in 2005. Since that time, there have been numerous survey and mapping projects throughout the lower Hunter Valley and Central Coast that have further refined understanding of this community. This additional work culminated in a major revision which resulted in eleven definable sub-groups of the TEC (Bell 2013). As this revision is yet to be reviewed and adopted by the NSW Scientific Committee, the definition provided by them (from 2010) remains the legal description of the TEC.

RMS have requested verification of the identity, distribution and significance of LHSGIF within the proposed Bypass project area. This report presents the findings of a 5 hour survey of the northern half of the proposal, within the context of over 10 years study of this TEC. For the purposes of this work, a broad framework for LHSGIF TEC was adopted (referred to as "*Candidate-LHSGIF*"), based on the most recent Final Determination of the NSW Scientific Committee (2010). This Determination explicitly considers LHSGIF TEC to occur if:

- vegetation is dominated by *Corymbia maculata* and/or *Eucalyptus fibrosa* in the canopy;
- the site occurs within the Sydney Basin bioregion; and
- the site occurs on Permian or Triassic Narrabeen sediments.

2. Study Area

Figure 1 shows the location of the proposed Bypass project within the Newcastle LGA, and the investigation area for this study. The site lies within the Sydney Basin bioregion of Thackway & Cresswell (1995), and occurs on Permian Newcastle Coal Measures geology (Department of Mineral Resources 1999).

Given that Parsons Brinckerhoff (2014) have identified LHSGIF only in the northern half of the project area, only that section of the entire proposal has been inspected (the *Investigation Area*: ~47 hectares).

3. Survey Methods

3.1 Map Verification

The project area was inspected on foot over a 5 hour period on 18 February 2015. Numerous existing trails, bike tracks and foot tracks exist within the bushland area, which facilitated rapid movement across the site. For the purposes of map verification, rapid data points (RDP) were collected at regular intervals (~50-100m apart) with a hand-held Garmin GPS 60Csx, or where vegetation patterns were observed to change. Each data point recorded dominant plant species within the canopy, shrub and ground layers, and were geo-referenced to a specific location in geographical space via the GPS unit (+/- 3-6m accuracy). New RDP were added to an existing database of similar information from previous studies in the locale.

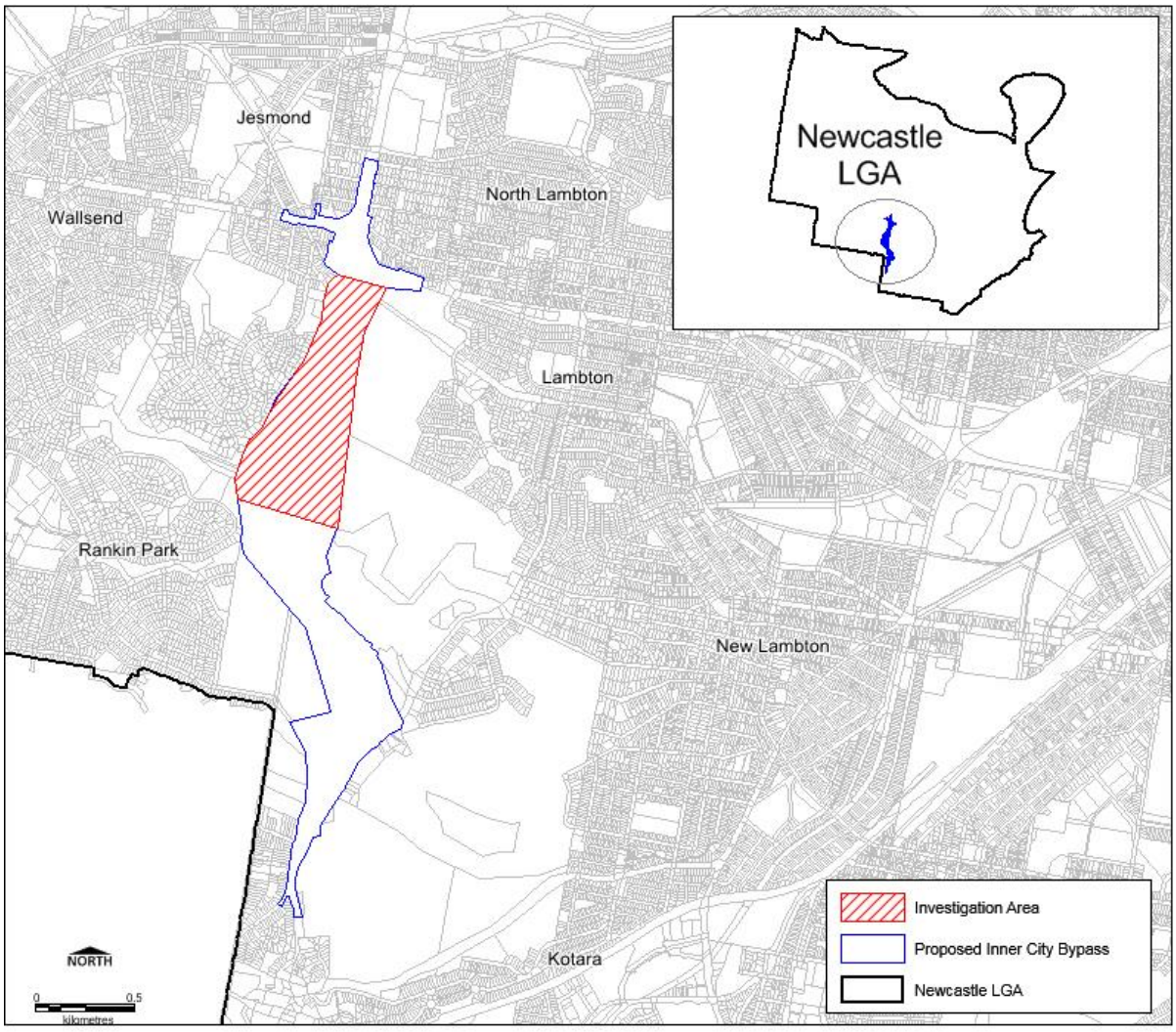

Figure 1 Proposed Newcastle Inner City Bypass, and area of investigation for the current study.

RDP were then transferred to GIS to create a new map of native vegetation communities, and in particular Candidate-LHSGIF. Used as a guide, floristic information contained within RDP drive the creation of polygon boundaries to create a spatially accurate vegetation map. Reference to

topographical features is also used in this process, which surrogates for the natural distribution of local soil types within geological strata, and hence vegetation.

Further details on this method of vegetation mapping can be found in Bell (2009) or Bell (2013).

3.2 Floristic Survey

Given the importance of confirming the presence or otherwise of the LHSGIF TEC, full floristic sampling plots were established within selective areas of Candidate-LHSGIF. Sample sites were selected preferentially (Kent & Coker 2001) so that floristic composition within these stands could be compared directly against existing lists of diagnostic species (eg: NSWNPWS 2000; NSW Scientific Committee 2010). Standard 0.04 ha sampling plots (20 x 20m) were censused for all vascular plant species (following Siverstsen 2010), and cover abundance of each estimated using the modified 1-6 scale of Braun-Blanquet (1 = few individuals & <5% cover; 2 = many individuals & <5% cover; 3 = 6-25% cover; 4 = 26-50% cover; 5 = 51-75% cover; 6 = 76-100% cover). Sampling opportunities were restricted in some parts due to weed invasion and previous disturbances. However, attempts were made to sample the observed variation in this community within these constraints.

3.3 Data Analysis

3.3.1 Numerical Classification

Full floristic data were subjected to numerical analysis using the Primer software program (version 6, Clarke & Gorley 2006), to validate the position of Candidate-LHSGIF within the regional classification. For analysis, new sampling plots were included within two existing regional datasets maintained by the author, both of which are characterised by a canopy of Spotted Gum (*Corymbia maculata*) and/or various species of Ironbark:

1. **All Spotted Gum-Ironbark**. Dataset of 570 sample plots from the Hunter region dominated by *Corymbia maculata* and any of the regional ironbark species (*Eucalyptus fibrosa, E. crebra, E. paniculata, E. siderophloia, E. fergusonii, E. caleyi, E. sideroxylon, E. beyeriana, E. placita, E. fracta*).

2. **Candidate-LHSGIF**. Dataset of >240 sample plots from the Hunter region dominated by *Corymbia maculata* and/ *Eucalyptus fibrosa* only, and which form the basis of a revised understanding of the LHSGIF TEC (Bell 2013). This is effectively a sub-set of the data contained in dataset 1.

Cluster analysis and non-metric multidimensional scaling (nMDS) were performed on each dataset using the group averaging strategy, the Bray-Curtis association measure and a Beta value of – 0.1. Ordinations were performed in two and three dimensions with 25 random starts and a minimum stress of 0.01. Primer v6 by default employs Kruskal's stress in nMDS ordinations for depicting the effort required to configure the distribution of sample data into 2 or 3 dimensions. For presentation purposes, only nMDS ordination graphs are included in this report.

3.3.2 Comparison against Diagnostic Species Lists

Floristic data collected within sample plots was also compared to publically available lists of diagnostic species for the LHSGIF EEC and related communities. Principally, these lists include those in the Final Determination for LHSGIF EEC (NSW Scientific Committee 2010) and the regional classification study upon which it is based (NSWNPWS 2000). Similar lists created in the revised classification of LHSGIF from throughout the Sydney Basin have also been examined (Bell 2013).

4. Results

4.1 Mapping

Over 110 RDPs were collated across the study area from existing and new data (Figure 2). The general trends observed from this data are that the more exposed (northerly to north-westerly) spurs and ridgelines support vegetation characterized by *Eucalyptus fibrosa, Corymbia maculata* and *Eucalyptus umbra*, while sheltered slopes and gullies are dominated by *Eucalyptus fergusonii* subsp. *fergusonii, Eucalyptus acmenioides, Eucalyptus propinqua* and *Corymbia maculata*. Southern and eastern parts also support forest of *Angophora costata, Corymbia gummifera, Eucalyptus capitellata* and *Eucalyptus piperita*. In urban bushland areas, locating precise boundaries on the ground is often difficult due to the impacts of frequent low-intensity fire over many years, and the consequent profusion of short-lived, resprouting species (eg: grasses).

A map showing the distribution of Candidate-LHSGIF based on these RDP is also shown in Figure 2. All mapped areas are of moderate to good condition, with few weeds and good native species diversity and structure. Small areas currently dominated by exotic grasses have been excluded from TEC mapping; these are representative of previous clearing events, and little to no canopy regrowth is apparent. Mapping has extended outside of the immediate Investigation Area to more fully understand relationships within the wider area. Within the Investigation Area, approximately 16.4 hectares of Candidate-LHSGIF are present. Relative to the mapping completed by Parsons Brinckerhoff (2014), only minor differences are apparent (but note that Investigation Areas differ between the two studies).

4.2 Numerical Analysis

Two full floristic sample plots were censused within the study area, one in an upper slope position sampling the dryer form of LHSGIF, and the other in a lower slope position sampling the moister form. Figure 2 shows the location of these sites.

4.2.1 All Spotted Gum-Ironbark

Figure 3 shows the 2-dimensional ordination (stress = 0.21) of 570 regional sample plots where *Corymbia maculata* co-dominates with one or more ironbark species. Both of the newly collected plots from the Bypass fall within the pre-defined group of candidate-LHSGIF samples, but towards the edge of this distribution. This position reflects the higher rainfall received at the eastern distributional limit of LHSGIF (reflected in the presence of 'moister' plant species), but that it shares many of the species indicative of LHSGIF elsewhere in the region. The 3-dimensional solution for this

ordination returned a better stress value of 0.16, but is difficult to present in report format and is not shown.

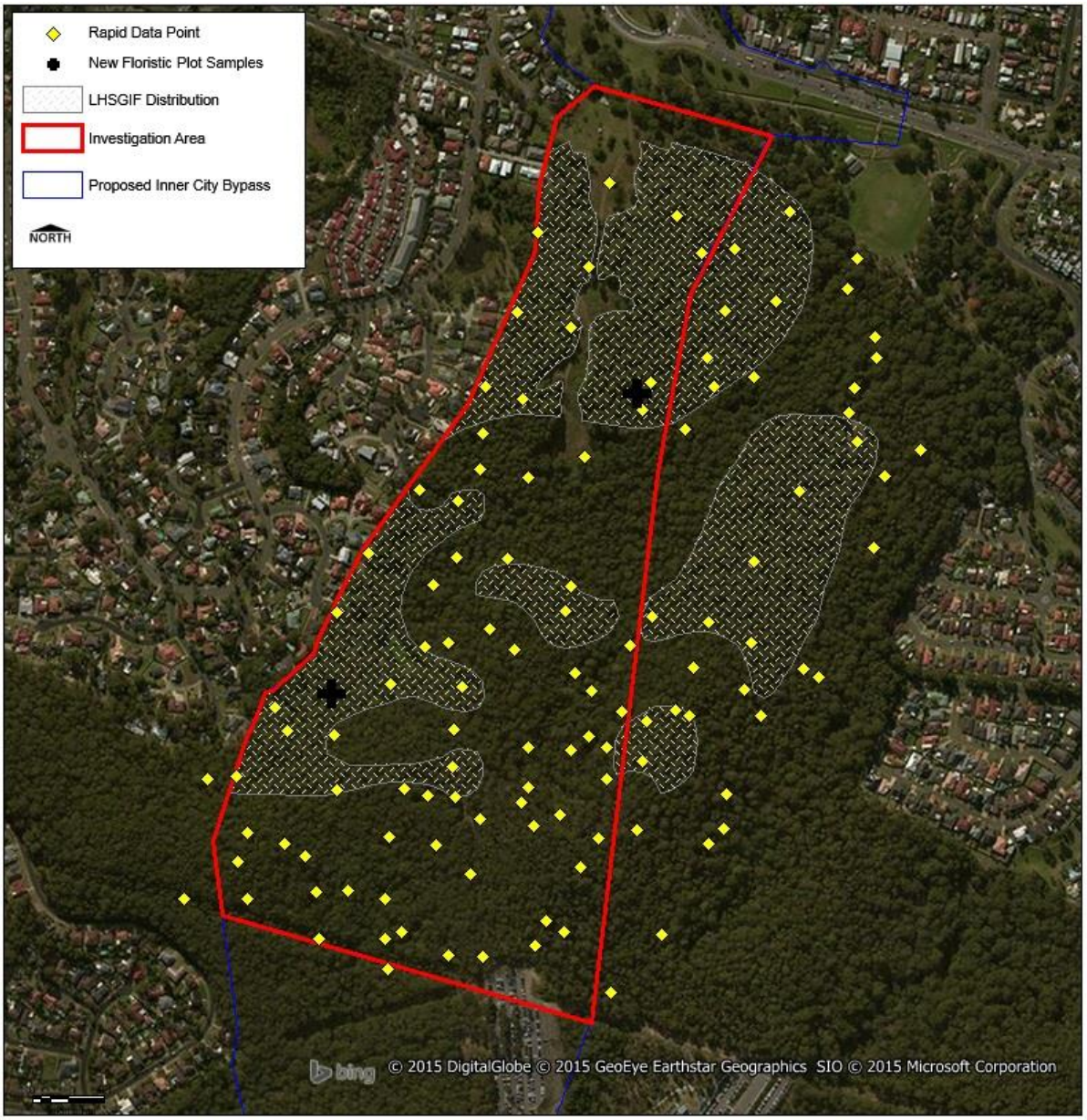

Figure 2 Distribution of Rapid Data Points and new Floristic Plot Samples within the study area, together with Candidate-LHSGIF as mapped in the current study.

4.2.2 Candidate-LHSGIF

In the analysis examining only vegetation dominated by *Corymbia maculata* and/or *Eucalyptus fibrosa* (Candidate-LHSGIF), data from the two newly sampled full floristic plots grouped well within the existing cluster of data demarcating the Hinterland Spotted Gum Ironbark form of LHSGIF (Bell 2013). Figure 4 shows the relationship between all sites for the 2-dimensional ordination (stress = 0.24): the 3-dimensional solution (not shown) returned a lower stress value of 0.17 and hence was a better 'fit'.

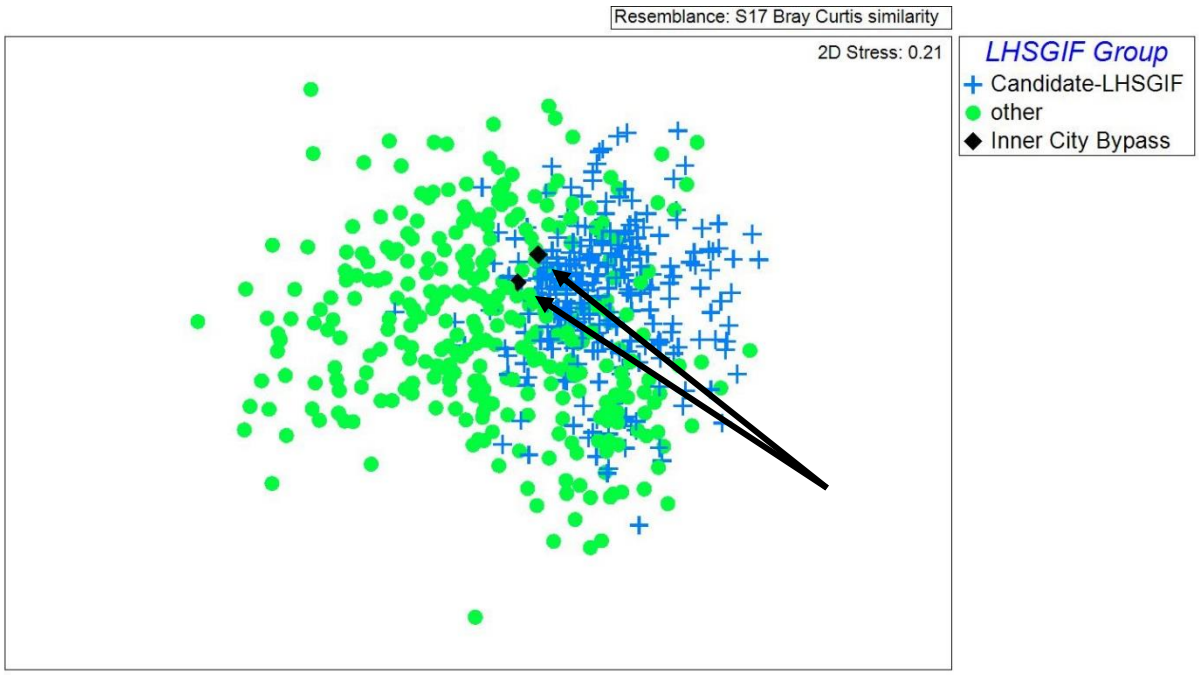

Figure 3 **Position of new sample plots (solid diamond, arrowed) within 570 full floristic plots dominated by *Corymbia maculata* and various ironbarks (Analysis 1).**

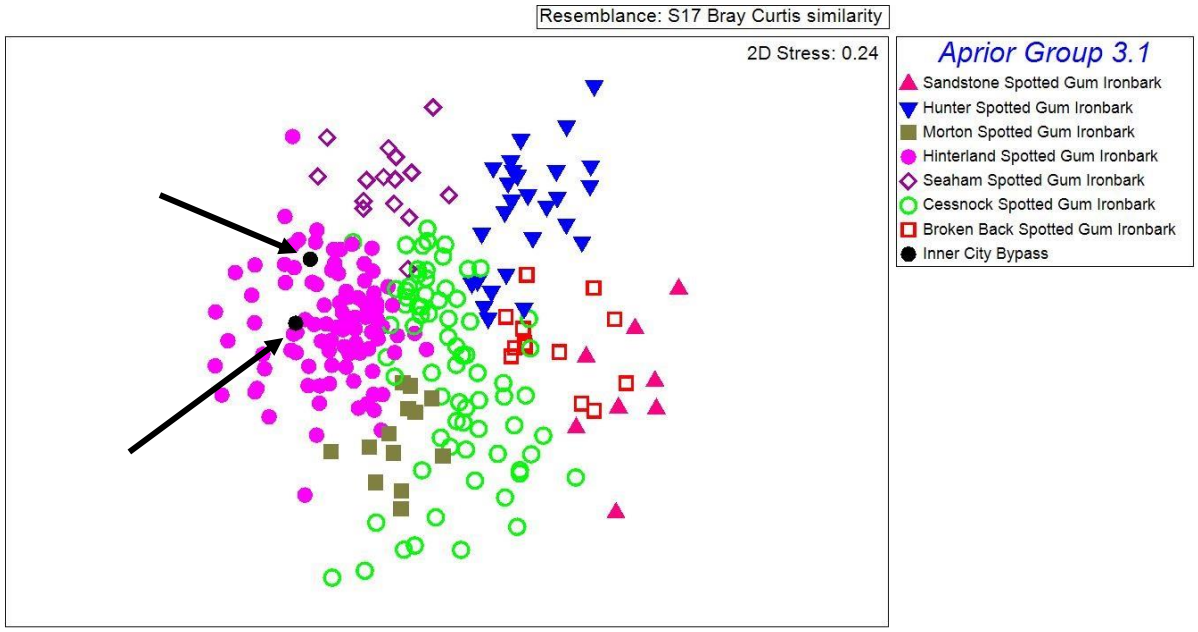

Figure 4 **Position of new sample plots (solid dots, arrowed) within 244 full floristic plots dominated by *Corymbia maculata* and/ or *Eucalyptus fibrosa* (Analysis 2)**

4.3 Comparative Species Analysis

Full species lists (excluding weeds) for each of the two full floristic plot samples were examined against the Final Determination for LHSGIF TEC and two of its non-threatened relatives from the coastal zone of the Hunter Valley (Coastal Foothills Spotted Gum – Ironbark Forest & Seaham Spotted Gum – Ironbark Forest). For completeness, they were also compared against the Coastal Plains Smooth-barked Apple Woodland, with which the Candidate-LHSGIF adjoins in the south of the site. All diagnostic species lists used for comparisons (including that for LHSGIF TEC) originate from the regional classification (NSWNPWS 2000). In addition, comparisons were also made against the diagnostic species list for the Hinterland Spotted Gum Forest of Bell (2013), the form of Candidate-LHSGIF TEC predicted to be present within the Bypass area. Appendix 1 lists the data for each Spotted Gum-Ironbark comparative analysis undertaken.

Table 1 summarises the results of the comparative analysis. As Final Determinations do not specify which of the species listed occur more frequently than others (see Preston & Adam 2004a, 2004b; Larkin 2009), it has been assumed that all are of equal weighting. Both sample plots were shown to support 20-22 of the 55 species listed for LHSGIF, representing 36-40% of the total. When compared against Coastal Foothills Spotted Gum – Ironbark Forest and Seaham Spotted Gum – Ironbark Forest, all calculations returned values of between 35% and 53%. Comparisons with Coastal Plains Smooth-barked Apple Woodland returned scores of 32% for both plots.

However, the best results (64-72%) were obtained when the two sample plots were compared against the diagnostic species list for Hinterland Spotted Gum Forest, a designated form of Candidate-LHSGIF in the recent revision of the TEC. This suggests that, as predicted, the Candidate-LHSGIF within the Bypass area equates well with this form, and fits its geographical pattern in the lower Hunter.

Table 1 Comparative analysis of presence-absence for two sample plots from the Bypass area against diagnostic species lists from NSWNPWS (2000) and Bell (2013).

	NSWNPWS (2000)				Bell (2013)
	in LHSGIF	in CFSGIF	in SSGIF	in CPSBAW	in HSGF
Total diagnostic species	55	36	54	37	36
Species from Plot 1	22 (40%)	19 (53%)	19 (35%)	12 (32%)	26 (72%)
Species from Plot 2	20 (36%)	18 (50%)	20 (37%)	12 (32%)	23 (64%)

NB: LHSGIF = Lower Hunter Spotted Gum-Ironbark Forest, CFSGIF = Coastal Foothills Spotted Gum-Ironbark Forest, SSGIF = Seaham Spotted Gum-Ironbark Forest, and CPSBAW = Coastal Plains Smooth-barked Apple Woodland (all from NSWNPWS 2000); HSGF = Hinterland Spotted Gum Forest (from Bell 2013).

5. Discussion

5.1 Diagnosis of LHSGIF

Vegetation classification is a dynamic process (de Cáceres & Wiser 2011), and improvements and revisions are common place as new data becomes available, particularly for endangered communities (eg: Kendall & Snelson 2009; Payne et al. 2010; Bell & Stables 2012). The endangered Lower Hunter Spotted Gum-Ironbark Forest has recently undergone a revision (Bell 2013), which

significantly increases understanding of the distribution and composition of this community. In more recent regional analysis, Somerville (2010) has also defined finer resolution communities within his Spotted Gum-Ironbark group, expanding LHSGIF and its relatives. The Hinterland group of Spotted Gum-Ironbark communities, extending along the western side of Lake Macquarie, is one of the more strongly defined units evident in these revisions.

The Bypass study area lies within the Sydney Basin and on Permian-aged geology, satisfying two of the three principal determining features of Lower Hunter Spotted Gum – Ironbark Forest TEC (NSW Scientific Committee 2010). In the areas inspected as part of this study, it is also dominated by *Corymbia maculata* and *Eucalyptus fibrosa* (satisfying the third determiner), with *Eucalyptus umbra* also commonly present. In moister areas, other canopy species present include *Eucalyptus propinqua* and *Eucalyptus acmenioides*, with *Eucalyptus fergusonii* also occasionally evident from adjacent sheltered slopes. On these characteristics alone, LHSGIF (as defined in the current Final Determination) can be deemed to be present within the study area.

Traditionally, inspection of an area to determine whether or not it supports vegetation equating to a listed endangered community involves, among other tests, assessing the plant species present (Adam 2004; Preston & Adam 2004a, 2004b; Larkin 2009). While simple in theory, in practical application such a process is fraught with difficulties, since it is heavily dependent on how the diagnostic species list was constructed, the scale at which such data was created and intended to be used, the condition of the sites where data was collected, and how samples were selected in the landscape. Other characteristics of a TEC must then come into play, such as physical characteristics of the environment. The use of numerical analysis techniques can often also be used to elucidate floristic relationships in problematic communities.

In the current situation, calculating the total number or proportion of species present within a sample to compare against the LHSGIF Final Determination or regional (NSWNPWS 2000) diagnostic species lists is unproductive: the regional classification from which this TEC is drawn is based on an environmentally stratified random sampling regime which is ineffective at defining rare communities (Bell 2013). In the current study, this is demonstrated by the fact that both sampling plots placed within Candidate-LHSGIF TEC recorded between only 35% and 53% of the diagnostic species contained in NSWNPWS (2000) for Lower Hunter Spotted Gum – Ironbark Forest, Coastal Foothills Spotted Gum – Ironbark Forest and Seaham Spotted Gum – Ironbark Forest, and 32% for Coastal Plains Smooth-barked Apple Woodland. All four of these communities occur within the Sydney Basin on Permian-aged sediments, but only one (Lower Hunter Spotted Gum – Ironbark Forest) is dominated by *Corymbia maculata* and *Eucalyptus fibrosa* in the canopy.

Diagnostic species lists were also generated by Bell (2013) for the revision of the Lower Hunter Spotted Gum – Ironbark Forest, following extensive numerical analysis where eleven forms of Candidate-LHSGIF were defined. The two plots sampled during the current study, when compared against this 2013 revision, returned comparative values of 64% and 74% species presence. Numerical analysis of this data within regional datasets also supported a determination of LHSGIF, with the Hinterland Spotted Gum – Ironbark Forest being the most likely form. The Hinterland Spotted Gum – Ironbark Forest comprises 92% of the key characteristic species listed in Paragraph 1 of the Final Determination for LHSGIF TEC, and 78% of the total species listed (discussed further in Bell 2013).

A floristic dichotomous key for the field recognition of the eleven Candidate-LHSGIF forms was presented in Bell (2013, reproduced here in Appendix 2), and it is useful to put this to the test in the current study. Using this key, the Hinterland Spotted Gum – Ironbark Forest is arrived at following lead 8, through the combination of a canopy dominated by *Eucalyptus fibrosa* and *Corymbia maculata*, a mid-storey without paperbark species (*Melaleuca*), a shrub layer with 'sandstone' species uncommon but dominated by prickly-leaved species such as *Daviesia ulicifolia* and *Bursaria spinosa*, and a ground layer dominated by *Themeda australis, Joycea pallida* and *Entolasia stricta*. This further supports the notion that Hinterland Spotted Gum - Ironbark Forest (a form of LHSGIF) is present within the Bypass area.

5.2 Distribution and Significance of LHSGIF

In terms of the distribution of LHSGIF within the Bypass area, additional field survey and analysis has allowed preparation of an alternative map showing TEC boundaries with a higher level of confidence. It is not specified in the Parsons Brinckerhoff (2014) ecology report how the original vegetation map was prepared, but evidently there is only limited change in the distribution of LHSGIF within the Bypass investigation area. GIS layers will be provided to RMS to assist further planning.

On current understanding, the core distribution of LHSGIF lies in the Cessnock district of the lower Hunter Valley. In this area, the community dominates most hills and slopes on clay soils. Further east towards the coast, as annual rainfall increases, LHSGIF becomes less prominent in the landscape to the point that at the extremities of its natural distribution it often occurs only as small isolated stands amidst other moister vegetation types. Such is the case in the Newcastle LGA, and within the current Investigation Area. A similar pattern has also been observed heading west from Cessnock, and to the south into Lake Macquarie and Wyong LGAs (Bell 2010, 2013).

The significance of LHSGIF within the Investigation Area is such that is occurs at the eastern limit of distribution of this community within the region. As such, these eastern patches of the community tend to support additional species more typical of wetter environments (while still retaining their core diagnostic species), which is not a feature of the more inland stands. In the light of potential climate change scenarios, examples of communities and individual species at distributional limits may become important refugia for such vegetation, and hence their significance is heightened. Smaller remnants of LHSGIF are also present around the University of Newcastle (~2km to the north), but no further stands are known further east. This significance is moderated by the isolated nature of the Bypass stands, which are continually subject to higher fire frequency, weed invasion, exotic animals and increasing human traffic. Several stands occur along the Newcastle Link Road near Wallsend, ~3km to the west, and together with the Newcastle University remnants represent the closest extant examples of LHSGIF.

5.3 Recommendations

Retention of the largest intact examples of LHSGIF within the greater Jesmond Bushland area, preferably buffered by surrounding vegetation, would be desirable to maintain a sizeable example of the most easterly forms of the community. Fortunately, some stands mapped as part of this study do occur outside of the Investigation Area (see Figure 2), and this seems to be a plausible scenario.

Minimizing the potential impacts on LHSGIF would involve alignment of the proposed Bypass through the previously cleared strip just south of the existing Jesmond round-a-bout, and then avoiding the main south-western stand adjoining the existing urban areas of Jesmond. To this end, two potential Bypass routes are currently being investigated by RMS (Figure 5). For Route 1, a total of approximately 6.3 hectares of LHSGIF would be removed, while for Route 2 approximately 2.8 hectares would require removal. From the point of view of the protection of LHSGIF, it is recommended that Route 2 be adopted, as it would require the least amount of TEC to be removed and it allows for the retention of the larger south-western portion.

Figure 5 Alternate routes of the Bypass through bushland supporting Lower Hunter Spotted Gum-Ironbark Forest: Route 1 at left, Route 2 at right.

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Appendix 1 Comparative Analysis Data

Floristic data used in comparative analysis. LHSGIF = Lower Hunter Spotted Gum-Ironbark Forest, CFSGIF = Coastal Foothills Spotted Gum-Ironbark Forest, SSGIF = Seaham Spotted Gum-Ironbark Forest, CPSBAW = Coastal Plains Smooth-barked Apple Woodland, HSGRIF = Hinterland Spotted Gum-Ironbark Forest. 'y' = species presence in specific list. Note that species present within the two new plots (WLSP4 & WLSP5) but not present in comparative lists are placed in [ ].

	NPWS 2000				Bell 2013	New plots	
Species	**LHSGIF**	**CFSGIF**	**SSGIF**	**CPSBAW**	**HSGIF**	**WLSP4**	**WLSP5**
Acacia falcata			y			y	
Acacia implexa			y				
[Acacia longifolia]						y	
Acacia parvipinnula	y						
Acacia ulicifolia					y	y	y
Allocasuarina torulosa		y				y	
Angophora costata	y	y					
Aristida vagans	y		y	y	y		y
Arthropodium milleflorum			y				
[Arthropodium sp. B]							y
Billardiera scandens	y	y			y	y	y
Brachycome graminea		y					
Breynia oblongifolia	y	y	y				
Brunoniella australis					y		
Bursaria spinosa	y				y	y	y
[Cassytha glabella]							y
Cheilanthes sieberi	y		y				
Corymbia eximia	y						
Corymbia gummifera	y						
Corymbia maculata	y	y	y	y	y	y	y
Cymbopogon refractus	y		y				
Daviesia leptophylla	y						
Daviesia ulicifolia	y	y			y	y	y
Desmodium rhytidophyllum		y	y				
Desmodium varians			y				
Dianella caerulea	y	y	y		y	y	y
Dianella revoluta	y				y	y	
Dianella tasmanica			y				
Dichelachne micrantha			y			y	y
Dichondra repens			y				
Digitaria parviflora	y						
Digitaria ramularis			y				
Dillwynia retorta							
[Dipodium punctatum]						y	
Echinopogon caespitosus			y				
Echinopogon ovatus			y				

	NPWS 2000				Bell 2013	New plots	
Species	**LHSGIF**	**CFSGIF**	**SSGIF**	**CPSBAW**	**HSGIF**	**WLSP4**	**WLSP5**
Entolasia marginata			y				
Entolasia stricta	y	y	y	y	y	y	y
Epacris pulchella				y			y
Eragrostis brownii			y				
Eucalyptus acmenoides	y	y	y				y
Eucalyptus agglomerata	y						
Eucalyptus canaliculata intergrades	y						
Eucalyptus crebra	y		y				
Eucalyptus fergusonii	y						y
Eucalyptus fibrosa	y	y	y		y	y	y
Eucalyptus globoidea	y	y			y	y	
Eucalyptus microcorys		y					
Eucalyptus moluccana	y		y				
Eucalyptus nubila	y						
Eucalyptus paniculata	y	y					
Eucalyptus propinqua		y					y
Eucalyptus punctata	y	y	y	y		y	
Eucalyptus siderophloia	y	y	y				
Eucalyptus sparsifolia	y						
Eucalyptus tereticornis	y		y				
Eucalyptus umbra	y	y		y	y	y	
Eustrephus latifolius		y	y				y
Gahnia aspera			y				
Galium gaudichaudii			y				
Glycine clandestina	y	y	y		y	y	y
Gonocarpus tetragynus				y	y	y	y
Goodenia hederacea subsp. hederacea	y						
Goodenia heterophylla subsp. heterophylla					y	y	y
Grevillea montana	y						
Hardenbergia violacea	y	y	y		y	y	y
[Hibbertia empetrifolia]						y	y
Imperata cylndrica		y	y	y	y	y	y
Joycea pallida					y	y	
Lagenifera stipitata			y				
Laxmannia gracilis	y						
Lepidosperma laterale	y		y		y		
Leucopogon juniperinus			y				
Lissanthe strigosa	y						
Lomandra confertifolia					y		
Lomandra filiformis subsp. coriacea	y		y		y	y	y
Lomandra filiformis subsp. filiformis					y		
Lomandra longifolia	y	y	y				

	NPWS 2000				Bell 2013	New plots	
Species	**LHSGIF**	**CFSGIF**	**SSGIF**	**CPSBAW**	**HSGIF**	**WLSP4**	**WLSP5**
Lomandra multiflora	y		y		y	y	y
Lomandra obliqua				y	y	y	
Macrozamia flexuosa	y						
[Macrozamia reducta]						y	
Maytenus silvestris	y	y				y	y
Melaleuca decora							
Melaleuca nodosa	y	y			y		
Microlaena stipoides	y	y	y		y		y
Notelaea longifolia							y
[Notodanthonia longifolia]			y				
Opercularia diphylla					y	y	y
Oplismenus imbecillis			y				
Oxalis perennans			y				y
Ozothamnus diosmifolius	y						
Pandorea pandorana			y			y	y
Panicum effusum			y				
Panicum simile	y		y	y	y	y	
Paspalidium distans			y		y		y
Persoonia linearis	y	y	y			y	
Phyllanthus hirtellus	y			y	y	y	y
Plectranthus parvifolius			y				
[Poa affinis]							y
Polyscias sambuccifolia		y					
Pomax umbellata	y						
Pratia purpurascens	y	y	y	y	y	y	y
Pseuderanthemum variabile		y	y	y		y	y
Pteridium esculentum				y			y
Pterostylis baptistii		y					
Pterostylis furcillata		y					
Ptilothrix deusta					y		
[Pultenaea euchila]						y	
Pultenaea villosa					y		y
Sigesbeckia australis			y				
Syncarpia glomulifera	y	y		y			y
Themeda australis	y	y	y	y	y	y	y
Vernonia cinerea	y	y	y		y	y	
Total Species	55	36	54	37	36	39	40

Appendix 2 Dichotomous Key for Recognition of Candidate-LHSGIF Groups (from Bell 2013)

Table 4.10. Dichotomous key for field recognition of Candidate-LHSGIF groups defined in this study for the Sydney Basin.

1. Canopy strongly dominated by *Eucalyptus fibrosa;* with *Melaleuca decora* & *M. nodosa* as a mid-layer 2

2. Low grass diversity, characterised by *Entolasia stricta, Aristida vagans* and *Panicum simile* ..... . ***Cessnock Ironbark Forest***

2* Higher grass diversity, characterised by above 3 spp and *Microlaena stipoides, Paspalidium distans, Themeda australis, Joycea pallida*..... ***Hinterland Ironbark Forest***

1* Canopy dominated by *Eucalyptus fibrosa* with *Corymbia maculata* 3*

3. Mid-storey characterised by paperbarks, particularly *Melaleuca nodosa,* with *Bursaria spinosa* ..... ***Cessnock SGIF (pb)***

3* Mid-storey with paperbarks (*Melaleuca* spp.) sparse or completely absent 4

4. Shrub layer with 'sandstone' species common, though not dominant, such as *Persoonia linearis, Dillwynia sieberi, Hakea sericea* 5

5. Shrub layer including *Grevillea arenaria, Persoonia mollis* subsp *leptophylla* and *Macrozamia communis* ..... ***Morton SGIF***

5* Shrub layer including *Grevillea parviflora* subsp *parviflora, Grevillea montana* and *Dillwynia retorta* ..... ***Cessnock SGIF (t)***

4* Shrub layer with 'sandstone' species uncommon 6

6. Shrubs dominated by *Acacia amblygona, Dodonaea viscosa* var. *cuneata, Leucopogon muticus* or *Lissanthe strigosa* 7

7. Ground layer dominated by *Lepidosperma gunnii, Lomandra* spp*., Dianella revoluta* ..... ***Broken Back SGIF***

7* Ground layer dominated by *Cleistochloa rigida*..... ***Sandstone SGIF***

6* Shrubs dominated by prickly-leaved shrubs, including *Daviesia ulicifolia, Bursaria spinosa, Podolobium ilicifolium, P. aciculiferum* 8

8. Ground layer dominated by the grasses *Themeda australis, Joycea pallida* & *Entolasia stricta* ..... ***Hinterland SGIF***

8* Ground layer with the grasses *Themeda australis* and *Joycea pallida* not dominant, often sparse or absent 9

9. Ground layer dominated by the grasses *Aristida vagans, Aristida ramosa* & *Cymbopogon refractus* ..... ***Hunter SGIF***

9* Ground layer dominated by the grasses *Entolasia stricta, Aristida vagans, Panicum simile, Themeda australis*..... 10

10. Ground layer with common herbs & forbs *Pratia purpurascens, Vernonia cinerea*, Dichondra repens*, Pseuderanthemum variabile* ..... ***Seaham SGIF***

10*. Ground layer with common herbs & forbs *Phyllanthus hirtellus, Pomax umbellata, Goodenia rotundifolia* ..... ***Cessnock SGIF (npb)***

Appendix L – Proponent details and environmental record

Proponent information

Title of the action	Proposed Newcastle Inner City Bypass – Rankin Park to Jesmond
EPBC Referral Number	2015/7550
Designated proponent	NSW Roads and Maritime Services
Postal address	59 Darby Street, Newcastle, NSW 2300

Environmental record of responsible party

		Yes	No
1	**Does the party taking the action have a satisfactory record of responsible environmental management?** Roads and Maritime is the proponent and has a strong history of working to ensure that road projects first avoid impacts as the highest priority, and where impacts are likely, of taking steps to minimise, mitigate and offset such impacts. Roads and Maritime has engaged appropriately qualified and experienced ecologists to carry out environmental assessments for the project to ensure impacts to the environment are comprehensively considered and impacts avoided or minimised wherever possible.	**Yes**	
2	**Has either (a) the party proposing to take the action, or (b) if a permit has been applied for in relation to the action, the person making the application - ever been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources?** Roads and Maritime works closely with key NSW regulatory agencies including the EPA and OEH to ensure compliance with statutory requirements but has occasionally been subject to legal proceedings with respect to environmental matters. Where incidents have occurred most have been minor and as a consequence resulted in penalty infringement notices.	**Yes**	
3	**If the party taking the action is a corporation, will the action be taken in accordance with the corporation's environmental policy and planning framework?** Roads and Maritime has set the environmental direction for the organisation in its Corporate Framework which seeks to minimise impacts on the natural, cultural and built environment from road use and Roads and Maritime activities. Roads and Maritime commitment to meeting this priority is demonstrated in its environmental policy and the environmental considerations incorporated into its activities. Roads and Maritime has detailed procedures and guidelines for carrying out environmental assessment of its activities, including specific requirements for biodiversity assessment, mapping biodiversity impacts during construction and offsetting unavoidable impacts.	**Yes**	

		Yes	No
4	**Has the party taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?** Examples of proposal and the corresponding EPBC Referral number: • Pacific Highway upgrade, Oxley Highway to Kempsey 2012/6518. • Pacific Highway upgrade, Woolgoolga to Ballina 2012 6394. • Olympic Highway realignment, Kapooka 2013/6596. • Forty Bends, Lithgow 2013/6804. • Bells Line of Road 2014/7346	**Yes**	

Appendix M – EPBC Act assessments of significance

Assessments of Significance

Introduction

This document contains assessments of significance pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) significant impact guidelines (DotE 2013) for potential impacts of the Project on known local population(s) of Black-eyed Susan (*Tetratheca juncea*) and the Grey-headed Flying-fox (*Pteropus poliocephalus*). Assessments of significance have also been prepared for an additional ten threatened species (five flora and five fauna) recorded or considered as having moderate potential to occur within the Project construction footprint.

These species include the:

- Koala (*Phascolarctos cinereus)*
- Large-eared Pied-bat (*Chalinolobus dwyeri*)
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)
- Swift Parrot (*Lathamus discolor)*
- Regent Honey Eater (*Anthochaera phrygia*)
- Leafless Tongue-orchid (*Cryptostylis hunteriana*)
- Newcastle Double Tail (*Diuris praecox*)
- Small-flower Grevillea (*Grevillea parviflora subsp. parviflora*)
- Heath Wrinklewort (*Rutidosis heterogama*)
- Magenta Lilly Pilly (*Syzigium paniculatum*).

This document has been prepared to accompany the Biodiversity Assessment Report (BAR) for this Project and is not intended as a stand-alone document. Please refer to the main BAR document for a description of the Project.

Vulnerable Fauna Species

Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria however, only a small portion of this range is used at any one time, depending on the availability of food. The species is widespread throughout its range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland (DotE 2015c).

This species requires roosting sites and foraging resources comprising fruit and nectar producing canopy species in a variety of vegetation communities including rainforest, open forest, closed and open woodland, Paperbark (*Melaleuca*) swamps, Banksia woodlands and commercial fruit crops and introduced species in urban environments (DotE 2015c).

Grey-headed Flying-fox were observed flying over the Project construction footprint and suitable foraging habitat (in the form of blossom-producing trees) was identified within the Project construction footprint Project(Parsons Brinckerhoff 2015). A known breeding camp for this species occurs directly to the south-east of the Project construction footprint (about 230 metres from the southern extent of the Project construction footprint) in Blackbutt Reserve. It should be noted however that the Project camp is located about 100 metres to the east of Lookout Road. It is likely that individuals from this camp forage within the Project construction footprint on a regular basis when trees are in flower (Parsons Brinckerhoff 2015).

The Project would result in the removal of 39.2 hectares (ha) of native vegetation identified as providing a suitable foraging resource for the Grey-headed Flying-fox.

EPBC Act - Assessment of Significance
Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable)
According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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
Blackbutt Reserve, which is located directly to the south-east of the Project construction footprint , provides a camp-site for a large Grey-headed Flying-fox population. This camp is not identified as a Nationally important camp under the Draft EPBC Act Policy Statement Camp management guidelines for the Grey-headed and Spectacled flying-fox (DotE, 2014). However, it is considered to be regionally important as it is known to support breeding females, is the only known camp in the Newcastle Local Government Area (LGA) and provides a year-round foraging resource, being the only continuously occupied camp in the Lower Hunter region (Geolink 2013). An 'important population' under the Significant Impact Guidelines 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. For the purposes of this assessment, the Grey-headed Flying-fox population in the study area is considered to be an important population as it is a key source population for breeding and dispersal within the region.

EPBC Act - Assessment of Significance

Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable)

Flora species in the Project construction footprint provide a variety of foraging resources for the Grey-headed Flying-fox from a range of species that together would flower throughout much of the year (Parsons Brinckerhoff 2015). The Project construction footprint provides habitat for winter-flowering myrtaceous tree species such as the Spotted Gum (*Corymbia maculata*) and Ferguson's Ironbark (*Eucalyptus fergusonii*) which provide an important foraging resource for the Grey-headed Flying-fox during the winter months which normally presents a food resource bottleneck (Parsons Brinckerhoff 2015). Red Bloodwood (*Corymbia gummifera*), which is also present in the Project construction footprint, is a proliferic flowering species and is important for nectarivorous fauna during the autumn months (Parsons Brinckerhoff 2015).

The Draft National Recovery Plan for the Grey-headed Flying-fox (DECCW 2009) outlines the criteria for identifying foraging habitat considered critical to the survival of the species. In accordance with the plan, foraging habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat, for Grey-headed Flying-foxes:

1. Productive during winter and spring, when food bottlenecks have been identified;
2. Known to support populations of >30 000 individuals within an area of 50 km radius (the maximum foraging distance of an adult);
3. Productive during the final weeks of gestation and during the weeks of birth, lactation and conception (September to May);
4. Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions); and
5. Known to support a continuously occupied camp (DECCW 2009).

With consideration of the guidelines provided above, the foraging habitat present within the Project construction footprint is considered critical to the survival of the Grey-headed Flying-fox due to the presence of winter flowering species which are known to support a continuously occupied camp located at Blackbutt Reserve. However, given the relatively large tracts of native vegetation adjacent to the Project construction footprint, feeding resources contained within the Project construction footprint would provide a small proportion of that available to the species in the wider locality (Parsons Brinckerhoff 2015).

Although native vegetation within the Project construction footprint is consistent with the definition for foraging habitat critical to the survival of the Grey-headed Flying-fox, it is considered to provide only a small proportion of that available in the wider locality (about 0.012% based on estimates of total foraging habitat within the Lower Hunter region (Geolink (2013)). Consequently the removal of about 39.2 ha of native vegetation identified as providing a critical foraging habitat to an important population of Grey-headed Flying-fox is considered unlikely to lead to a long-term decrease in the size of the population, given the availability of similar habitat within the wider locality.

Indirect impact to the camp would also be minimal as the camp is located about 230 metres south-east of the Project construction footprint. Any indirect impacts from construction would be minimal due to its distance from active works. In addition, the camp is located about 100 metres to the east of Lookout Road and is already subjected to the indirect impacts associated with a major road and it is considered unlikely these impacts would change significantly after construction of the Project.

Reduce the area of occupancy of an important population

About 39.2 ha of native vegetation identified as providing a critical foraging resource for the Grey-headed Flying-fox would be removed as a result of the Project. This would vegetation is likely to be foraged as part of a larger home range and represents a small proportion (about 0.12%) of the foraging habitat available in the wider locality. The Project would not directly impact upon the existing identified Grey-headed Flying-fox camp located within Blackbutt Reserve and would not reduce the area of roosting occupancy of the identified important population at this location. As mentioned above, the camp is located about 230 metres from any anticipated construction works

EPBC Act - Assessment of Significance
Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable)
associated with the Project and is located about 100 metres from Lookout Road. As such, indirect impacts would be minimal and unlikely to reduce the area of occupancy for the population.
Fragment an existing important population into two or more populations
The removal of about 39.2 ha of native vegetation will fragment the existing available critical foraging habitat within the Project construction footprint and reduce connectivity in the wider area by increasing gaps in the existing vegetation cover. These gaps would be readily traversed by the Grey-headed Flying-fox which is a highly mobile aerial species and consequently any fragmentation of foraging habitat is considered to be overcome by this species. Furthermore, the Project would not directly impact the Grey-headed Flying-fox camp located within Blackbutt Reserve and consequently would not fragment this important population into two or more populations.
Adversely affect habitat critical to the survival of the species
As discussed above, vegetation within the Project construction footprint is identified as foraging habitat critical to the survival of an important population of the Grey-headed Flying-fox in accordance with the criteria outlined in the Draft National Recovery Plan (DECCW 2009). The removal of about 39.2 ha of native vegetation identified as providing foraging habitat critical to the survival of the Grey-headed Flying-fox would adversely affect habitat critical to the survival of an important population of the species. The Project will fragment the existing available critical foraging habitat within the Project construction footprint and reduce connectivity in the wider area by increasing gaps in the existing vegetation cover. As mentioned above, the camp would not be directly impacted by the Project, is located about 230 metres from any anticipated construction works associated with the Project and is located about 100 metres from Lookout Road..
Disrupt the breeding cycle of an important population
The Project would not remove any areas of suitable breeding or roosting habitat for the Grey-headed Flying-fox. The removal of about 39.2 ha of foraging habitat for this species would reduce connectivity by increasing gaps on the existing vegetation, however is not considered to create a barrier to the movements of this highly mobile aerial species between the camp site and foraging habitats. Consequently, the Project is not considered likely to disrupt the breeding cycle of an important population of this species. As mentioned above, the camp is located about 230 metres from any anticipated construction works associated with the Project and is located about 100 metres from Lookout Road. As such, indirect impacts would be minimal and unlikely to disrupt the breeding cycle of the Grey-headed Flying-fox.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The Lower Hunter region contains a number of species in the blossom diet of the Grey-headed Flying-fox that produce abundant nectar relatively frequently and therefore play a key role in supporting the seasonal pattern of camp occupation in the region, including important periods in the reproductive cycle (Geolink 2013). Forests and woodlands that provide plants in the nectar diet of the Grey-headed Flying-fox covers 56% (approx. 239,575 ha) of the Lower Hunter region, or about 91% of extant vegetation (Geolink 2013). Vegetation that provides plants in the fruit diet of the Grey-headed Flying-fox covers 4.4% (approx. 18,824 ha) of the region (Geolink 2013). A total of 39.2 ha of native vegetation, identified as providing a critical foraging resource for the Grey-headed Flying-fox would be removed as a result of the Project. The Project will fragment the existing available critical foraging habitat within the Project construction footprint and reduce

connectivity in the wider area by increasing gaps in the existing vegetation cover. This will result in increased edge effects and has the potential to decrease the quality of remnant foraging habitat critical to the survival of an important population of this species.

While the Project would result in a decrease in the availability of known foraging habitat critical to the survival of an important population, it is considered that the overall impacts are not to the extent that this highly mobile aerial species, as a whole, is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A number of mitigation measures will be adopted and outlined in the Environmental Impact Statement (EIS) and a Construction Environmental Management Plan (CEMP) for the Project to limit the potential for spread of invasive weed species to areas outside of the construction footprint which may adversely alter existing foraging habitat for the Grey-headed Flying-fox.

Traces of feral animals (Fox and Rabbit) were observed during surveys, and there is potential for cats and dogs to occur within the Project construction footprint and surrounds due to the close proximity to urban dwellings. The Project is not likely to increase the number of feral animals utilising the area.

Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the construction footprint.

Introduce disease that may cause the species to decline

Grey-headed Flying-foxes have been identified as natural reservoirs of three diseases, these being Australian bat lyssavirus (ABL), Hendra virus and Menangle virus (DECCW 2009). The risk of disease to the general bat population is somewhat unknown and an active area of research.

Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats.

In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) should be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the construction footprint.

These measures relate to the vegetation clearing and construction stages of the Project only and should accompany measures that ensure plant and machinery does not enter any areas of retained vegetation outside of the construction footprint. It is envisaged that once the bypass has been completed, these measures would no longer be required.

With the adoption of appropriate mitigation measures as outlined above, the Project is considered unlikely to introduce disease that may cause this species, as a whole, to decline.

Interfere substantially with the recovery of the species

The Draft National Recovery Plan for the Grey-headed Flying-fox (DECCW 2009) identifies a range of actions to promote the recovery of the species, including in particular identifying and protecting foraging and roosting habitat critical to the survival of the species. The Project is inconsistent with this recovery action as it will remove 39.2 ha of native vegetation that meets the criteria for foraging habitat critical to the survival of the Grey-headed Flying-fox (DECCW 2009). Whilst this area of vegetation contributes to the foraging resources for a local camp located in Blackbutt Reserve, it is

EPBC Act - Assessment of Significance
Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable)
a small component of a much larger area of potential foraging habitat in the locality and the Lower Hunter region. There will be no direct impacts on breeding habitat (the Blackbutt Reserve camp) and the Project is unlikely to form a barrier to movements of the Grey-headed Flying-fox between the camp and foraging grounds in the locality. As such the Project is unlikely to substantially interfere with the recovery of the species. The NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to . appropriately offset and to assist with the long-term conservation of foraging habitat critical for the survival of the local Grey-headed Flying-fox population.
Conclusion of Assessment of Significance:
Pursuant to the significant impact guidelines (DotE 2013) presented above, the Project is likely to have a significant impact on an important population of the Grey-headed Flying-fox given that it will adversely affect the quality and extent (removed 39.2ha) of foraging habitat critical to the survival of an important population of the species. A number of mitigation measures will be implemented and outlined in the EIS and CEMP for the Project to reduce potential for adverse indirect impacts on Grey-headed Flying-fox habitat in the Project construction footprint and surrounds. The NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 39.2 ha of native vegetation) that cannot be avoided or mitigated.

Koala (*Phascolarctos cinereus*)

The Koala is widely distributed in eastern Australia, occurring from north-eastern Queensland to the south-east corner of SA (ANZECC 1998). This distribution equates to about one million square kilometres. In NSW, the Koalas range occurs along the coast and extends west to the Darling Riverine Plains and Mulga Lands bioregions in the north of the state; to the Cobar Peneplain bioregion in the centre of the state; and to the Riverina and eastern most parts of the Murray-Darling Depression bioregions in the south. It is restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares (DotE 2015b).

The Koala was not recorded during surveys. The closest record is from two kilometres away in Blackbutt Reserve in 1986. Potential Koala habitat is present in the three Spotted Gum vegetation types which occur within the Project construction footprint all of which contain *Eucalyptus punctata* (Grey Gum), a secondary food tree species. *Eucalyptus robusta* (Swamp Mahogany) which is a preferred primary feed tree is also present in low densities within the Project construction footprint.

EPBC Act - Assessment of Significance

Koala (*Phascolarctos cinereus*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Does the Koala species within the Project construction footprint constitute an important population?

According to DotE (2013), 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.

According to State Environmental Planning Policy No 44 – Koala habitat protection (SEPP 44), core koala habitat constitutes an area of land with a resident population of Koalas, evidenced by attributes such as breeding females and recent sightings of and historical records of a population.

The Koala referral guidelines (DotE 2015c) include a modelled distribution map of Koalas across eastern Australia. Within the Project construction footprint, Koalas are modelled as known / likely to occur. Database searches undertaken identified three records within 10 kilometres of the Project construction footprint. The most recent record of a Koala in the locality was in 1986, two kilometres from the Project construction footprint at Blackbutt Reserve (GHD, 2015). Targeted searches were undertaken by Parsons Brinckerhoff (2014) at four locations across the Project construction footprint and surrounds in October 2014. The Spot Assessment Technique was applied to inspect *Eucalyptus punctata* trees for signs of Koala activity, including scratches and scats. Searches did not identify any Koalas, or evidence of Koalas within the Project construction footprint and surrounds. Therefore, there is no core habitat within the Project construction footprint and it is highly unlikely that a population of Koalas exists within the Project construction footprint and surrounds.

Potential Koala habitat includes areas of native vegetation where the trees of the types listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. *Eucalyptus punctata* was a dominant species in some vegetation types, resulting in parts of the study being considered as potential habitat. The forest surrounding the Project construction footprint is isolated from other areas of native vegetation due to roads and residential properties. Although Koalas have been observed to migrate through urbanised areas, this is considered unlikely, as there are no vegetated corridors through the urban areas that would allow for movement into this isolated patch of forest. In the unlikely event that an individual did

EPBC Act - Assessment of Significance
Koala (*Phascolarctos cinereus*) (Vulnerable)
migrate into this patch of forest, 298.1 ha of forest would remain which they could potentially utilise as habitat.
For the reasons stated above, the Project construction footprint and surrounds does not contain a key source population for breeding or dispersal or a population that is necessary for maintaining genetic diversity of the Koala. The Koala is widely distributed in eastern Australia, occurring from north-eastern Queensland to the south-east corner of SA (ANZECC 1998). This distribution equates to about one million square kilometres. In NSW, the Koalas range occurs along the coast and extends west to the Darling Riverine Plains and Mulga Lands bioregions in the north of the state; to the Cobar Peneplain bioregion in the centre of the state; and to the Riverina and eastern most parts of the Murray-Darling Depression bioregions in the south (DotE 2015b). In the unlikely event that Koalas exist within the Project construction footprint and surrounds, the location is not near the limit of the species range given its extensive distribution. Due to the isolated nature of the Project construction footprint and surrounds, the lack of evidence of Koalas in the Project construction footprint (despite targeted searches) and no records of Koalas in the locality area since 1986, it can be assumed that an important population of Koalas is highly unlikely to exist within the Project construction footprint.
Will the Project lead to a long-term decrease in the size of the important population? As discussed above, an important population of Koalas does not exist at the site. Considering the isolated nature of the site, the lack of evidence of Koalas in the Project construction footprint and no records of Koalas in the locality since 1986, the Project would not result in a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population
It is estimated that 32.8 ha of vegetation containing *Eucalyptus punctata* and *Eucalyptus robusta* (listed Koala feed trees) would be removed as a result of the Project. The Project would reduce the potential area of occupancy for Koalas. However, as discussed above, an important population of Koalas is unlikely to exist within the Project construction footprint and surrounds. There is no evidence of Koalas within the Project construction footprint and surrounds (despite targeted searches), and no records of Koalas in the locality since 1986. There is little opportunity for Koalas to migrate into the Project construction footprint and surrounds as there are no vegetated corridors through the surrounding urban areas that would allow for movement into this isolated patch of forest. In the unlikely event that they did migrate into the patch of forest, about 298.1 ha would remain that would be unaffected by the Project. Due to the absence of Koalas within the Project construction footprint and surrounds and its isolated nature, the Project would not result in a reduced area of occupancy for an important population.
Fragment an existing important population into two or more populations
The Project would remove about 32.8 ha of potential habitat for the Koala. The habitat to be removed would be in a linear construction footprint and would result in the fragmentation of one large area of forest into three smaller patches. This has the potential to fragment populations of species. However, as discussed above, the Project construction footprint and surrounds are highly unlikely to contain a population of Koalas. There is no evidence of Koalas in the Project construction footprint and surrounds (despite targeted searches), with the closest record being two kilometres from the site in 1986 near Blackbutt Reserve (which contains a further 298.1 ha that would be unaffected by the Project).

EPBC Act - Assessment of Significance
Koala (*Phascolarctos cinereus*) (Vulnerable)
Therefore the Project would not fragment an existing important population into two or more populations. Furthermore, the Project's Fauna Connectivity Strategy has provision for dedicated terrestrial and arboreal fauna crossings which would be suitable for use by the Koala.
Adversely affect habitat critical to the survival of the species
Parsons Brinckerhoff (2015) assessed the quality of Koala habitat within the Project construction footprint and surrounds using the Koala habitat assessment tool (DotE 2014). The following attributes were used to assess whether the habitat within the Project construction footprint and surrounds could be considered critical habitat: • There are no known Koala occurrences at the site • The Project construction footprint and surrounds contains two known Koala feed tree species • The Project construction footprint and surrounds is not part of an area of contiguous landscape greater than 300 ha. • The Project construction footprint and surrounds is within an area with dog and vehicle threats present and with no known Koala occurrences • The habitat is unlikely to be important for achieving the interim recovery objectives for the relevant context Based on these attributes, Parsons Brinckerhoff (2015) determined that the habitat to be removed as a result of the Project is not considered habitat that is critical to the survival of the Koala species. The removal of 32.8 ha of vegetation would therefore not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population
The road construction would result in the loss of about 32.8 ha of potential foraging and breeding habitat in a linear construction footprint. If in the unlikely event that Koalas were present at the site they could still forage and breed in other parts of the Project construction footprint and surrounds as large patches of vegetation would remain. However, as discussed above, an important Koala population is highly unlikely to exist at the site and opportunities for migration into the isolated patch of forest are limited. The Project would not result in a disruption of the breeding cycle of 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
The Project would decrease the availability of potential Koala habitat within the Project construction footprint and surrounds. *Eucalyptus punctata* was found in several vegetation communities across the site and is a feed tree for Koalas. It is estimated that 32.8 ha of vegetation containing *Eucalyptus punctata* would be removed as a result of the Project. The habitat to be removed would be in a linear construction footprint for the construction of a road and would result in the fragmentation of one large area of forest into three smaller patches. The Project would include a series of fauna crossing infrastructure which would provide opportunities for individuals to move between the remaining patches of forest. There is no evidence of Koalas in the Project construction footprint and surrounds (despite targeted searches), and no records of Koalas in the locality since 1986, which was near Blackbutt Reserve. 298.1 ha of forest would remain unaffected adjacent to the Project construction footprint. It is highly unlikely that Koalas exist within the Project construction footprint and surrounds, and there is little opportunity for migration. The forest surrounding the Project construction footprint is largely isolated from other areas of intact native vegetation due to surrounding roads and residential

properties. It is highly unlikely that Koalas would be able to migrate into the Project construction footprint and surrounds to feed on these trees as there are no vegetated corridors through the urban areas that would allow for movement into this isolated patch of forest.

As there were no signs or observations of Koalas in the Project construction footprint and surrounds, and the isolated nature, the removal and isolation of 32.8 ha of potential vegetation as a result of the Project is highly unlikely to lead to a decline in the species.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed activity would involve the permanent removal of a linear strip of vegetation which contains 32.8 of potential habitat for the Koala. It is likely that weed infestation within the Project construction footprint could increase due to edge effects during both construction and operation of the Project. Increases in weed incidences in the Project construction footprint are not likely to impact potential Koala habitat in the Project construction footprint and surrounds.

A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project to limit the potential for spread of invasive weed species to areas outside of the Project construction footprint which may adversely alter existing foraging habitat for the Koala.

Traces of feral animals (Fox and Rabbit) were observed during surveys, and there is potential for cats and dogs to occur within the Project construction footprint and surrounds due to the close proximity to urban dwellings. The Project is not likely to increase the number of feral animals utilising the area. However as there were no Koalas observed within the Project construction footprint and surrounds, and limited opportunities for individuals to migrate into the area, it is highly unlikely that this would impact on any Koalas.

Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the Project construction footprint.

Introduce disease that may cause the species to decline

Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats.

In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) should be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint.

These measures relate to the vegetation clearing and construction stages of the Project only and should accompany measures that ensure plant and machinery does not enter any areas of retained vegetation outside of the Project construction footprint. It is envisaged that once the bypass has been completed, these measures would no longer be required.

With the adoption of appropriate mitigation measures as outlined above, the Project is considered unlikely to introduce disease that may cause this species decline.

EPBC Act - Assessment of Significance
Koala (*Phascolarctos cinereus*) (Vulnerable)
Interfere substantially with the recovery of the species
The overall objective of the 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 would remove 32.8 ha of potential habitat along a linear construction footprint. The Project would have a minor impact on potential foraging and breeding habitat of the Koala. There is no evidence of Koalas in the Project construction footprint and surrounds (despite targeted searches), and no records of Koalas in the locality since 1986. It is therefore highly unlikely that Koalas exist within the Project construction footprint and surrounds. The potential for migration into the Project construction footprint and surrounds is very small. The forest surrounding the Project construction footprint is isolated from other areas of intact native vegetation due to surrounding roads and residential properties. There are no vegetated construction footprints through the surrounding urban areas that would allow for movement into this isolated patch of forest. As there is unlikely to be a Koala population within the Project construction footprint, and there is little opportunity for Koalas to migrate into Project construction footprint and surrounds, the Project is unlikely to interfere substantially with the recovery of Koalas.
Conclusion of Assessment of Significance:
The Project would remove 32.8 ha of vegetation that contains two listed feed trees. The Project is not likely to have a significant impact on the Koala as: • There are no important populations of Koalas within the Project construction footprint and surrounds (despite targeted survey efforts) and no records have been observed in the locality since 1986 near Blackbutt Reserve. • 298.1 ha of forest adjacent to the Project construction footprint would remain unaffected by the Project. • There is minimal potential for migration into the Project construction footprint and surrounds as it is isolated from other areas and there are no vegetated corridors through the surrounding urban areas that would allow for movement into this isolated patch of forest. • The Project would not result in the fragmentation of Koala habitat. Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 32.8 ha of native vegetation) that cannot be avoided or mitigated.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

The Large-eared Pied Bat is a medium-sized insectivorous bat with shiny, black fur on the body with a white stripe on the ventral side of the torso where it adjoins the wings and tail. The species' current distribution is also poorly known.

In NSW, the species is considered rare with a patchy distribution most likely due to the specific habitat requirements of the species. A maternity roost site for the species usually requires sandstone caves or cliff overhangs, although it has also been observed roosting in disused mine shafts and abandoned Fairy Martin nests (Pennay 2008). Sandstone cliffs and fertile woodland valley habitat within close proximity of each other is habitat of importance to the Large-eared Pied Bat (DECC 2007)

The Project construction footprint and surrounds does not contain habitat that would be used for breeding/maternity sites for this species. There are no potential roost sites for Large-eared Pied Bat within the Project construction footprint and surrounds however the species may forage within the Project construction footprint and surrounds on occasion.

EPBC Act - Assessment of Significance

Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Does the Large-eared Pied Bat species within the Project construction footprint constitute an important population?

According to DotE (2013), 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.

A PMST search identified that the species or species habitat has the potential to occur within 10 kilometres of the Project construction footprint and surrounds ((DotE 2015a)). No records of these species have been recorded within 10 kilometres of the Project construction footprint and surrounds using the OEH Wildlife Atlas search (OEH 2014b). Parsons Brinckerhoff (2015) determined that there is a moderate likelihood of this species occurring within the Project construction footprint and surrounds.

Anabat detectors were used at five locations across the Project construction footprint and surrounds. Harp traps were used to trap foraging microbats and were set up at four locations over two consecutive nights. These surveys did not detect any Large-eared Pied Bats within the Project construction footprint and surrounds.

In NSW, the species is considered rare with a patchy distribution most likely due to the specific habitat requirements of the species. A maternity roost site for the species usually requires sandstone caves or cliff overhangs, although it has also been observed roosting in disused mine shafts and abandoned Fairy Martin nests (Pennay 2008). The species also possibly roosts in the hollows of trees (Duncan et al. 1999). Maternity roost sites must be in close proximity to fertile wooded valley habitat for foraging. Almost all records of the species are within several kilometres of clifflines or rocky terrain (DERM 2011). Some of the Project construction footprint and surrounds is mapped as sandstone (Newcastle map series 1:100 000). However, appropriate sandstone caves and cliffs that could be used as maternity sites were not observed during surveys and are unlikely to be present within the Project construction footprint and surrounds.

EPBC Act - Assessment of Significance

Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable)

The Large-eared Pied Bat is dependent on diurnal roosts for shelter during the day and at night when not feeding. Diurnal roosts can include mine shafts, caves, overhangs and abandoned Fairy Martin Nests. It is unlikely that the Project construction footprint and surrounds contains suitable roost sites for this species.

The Large-eared Pied Bat forages in a range of vegetation types, including wet and dry sclerophyll forest. This species is known to be associated with several vegetation types recorded within the Project construction footprint and surrounds. These include:

- Smooth-barked Apple - Red Bloodwood open forest (HU621)
- Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest (HU622)
- Sydney Blue Gum - White Mahogany shrubby tall open forest (HU637, atypical variant and *Syncarpia glomulifera* variant)

There are no previous records of the species within 10 kilometres of the Project construction footprint and the species was not recorded at the site during surveys. The Project construction footprint and surrounds is an isolated patch of forest surrounded by roads and urban development. The species has very specific maternity roost habitat requirements which are unlikely to be present at the site.

Large-eared Pied Bats are known to occur from Shoalwater Bay, north of Rockhampton, Queensland through to Ulladulla, on the south coast of NSW. The Project construction footprint and surrounds is therefore not near the limit of the species range (DotE 2015b).

The Project construction footprint and surrounds does not contain habitat that would be used for breeding/maternity sites for this species. As such it is highly unlikely that there would be a key source population for either breeding or dispersal present within the Project construction footprint and surrounds or a population necessary for maintaining genetic diversity of the species.

There is a small possibility that the species may forage and utilise diurnal roosts at the site on occasion. It can be concluded that under the guidelines (DotE 2013), there is no population at the site that is necessary for the species' long-term survival and recovery.

Will the Project lead to a long-term decrease in the size of the important population?

As discussed above, it is highly unlikely that an important population of Large-eared Pied Bats occurs within the site. Furthermore there are no known roost camps or records of the species within 10 kilometres of the Project construction footprint and surrounds and it does not contain suitable breeding habitat or maternity sites for this species. The Large-eared Pied Bat may forage within the Project construction footprint and surrounds on occasion and about 39.2 ha of potential foraging habitat would be removed as a result of the Project. This species is highly mobile and there are extensive areas of similar potential foraging habitat for this species in the locality including large amounts reserved within the nearby Blackbutt reserve and Glenrock State Conservation Area.

The Project would not impact on any breeding or maternity sites for this species and it is considered highly unlikely that an important population exists at the site. The Project would not result in a long-term decrease in the size of an important population of the species.

Reduce the area of occupancy of an important population

The species is unlikely to occupy the Project construction footprint and surrounds due to the lack of appropriate habitat. There are no known roost camps or records of the species within 10 kilometres.

Habitat modelling based on surveys in the southern Sydney region (DECC 2007) suggest that the Large-eared Pied Bat is largely restricted to the interface of sandstone escarpment (for roost habitat) and relatively fertile valleys (for foraging habitat) (Pennay 2008).

EPBC Act - Assessment of Significance
Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable)
There are no potential roost sites for Large-eared Pied Bat within the Project construction footprint and surrounds however the species may forage within the area on occasion. About 39.2 ha of potential foraging habitat would be removed as a result of the Project. There would still be opportunities for the species to forage in patches of forest surrounding the Project construction footprint due to the high mobility of the species. As discussed above, it is highly unlikely that an important population of Large-eared Pied Bats occurs within the Project construction footprint and surrounds. If individuals were present, they would more than likely be visiting on a transient basis and would still be opportunities for them to forage in the surrounding forest. It is therefore considered highly unlikely that the Project would reduce the area of occupancy of an important population of the species.
Fragment an existing important population into two or more populations
The Project would remove about 39.2 ha of potential foraging habitat for the Large-eared Pied Bat in a linear strip for the construction of a road. Road construction footprints have the potential to fragment populations of species. However, the species is highly mobile and would still be able to move between patches of forest. As discussed above, it is highly unlikely that an important population of Large-eared Pied Bats occurs at the site. There were no records of the species during surveys, and there are no known roost camps within 10 kilometres of the Project construction footprint and surrounds. The Project construction footprint and surrounds does not contain suitable breeding or maternity habitat. The species may forage within the Project construction footprint on occasion. About 39.2 ha of potential foraging habitat would be removed as a result of the Project. However, about 298.1 ha of forest adjacent to the Project construction footprint would be unaffected and there would still be opportunities for the species to forage due to the high mobility of the species. The Project would not reduce the area of occupancy of an important population of the species.
Adversely affect habitat critical to the survival of the species
The National Recovery Plan for the Large-eared Pied Bat discusses criteria for identifying habitat considered critical to the survival of the species. In accordance with the plan, habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival for Large-eared Pied Bat: • Any known maternity roost site • Sandstone cliffs and fertile wooded valley habitat is close proximity of each other There are no known maternity roosts within the site, and there are no records of the species within 10 kilometres of the Project construction footprint and surrounds. Although there is some areas of sandstone outcropping within the Project area are no sandstone escarpments or cliffs that would be utilised as maternity roosts for this species. Based on lack of suitable roosting habitat within the site, it is considered highly unlikely that the Project would impact on habitat that is critical to the survival of the species.
Disrupt the breeding cycle of an important population
The Project would not remove any areas of suitable breeding or roosting habitat for the Large-eared Pied Bat. The removal of about 39.2 ha of potential foraging habitat for this species would reduce connectivity by increasing gaps in the existing vegetation. This is not considered to create a barrier to the movements of this highly mobile aerial species between foraging habitats. Consequently, the Project is not considered likely to disrupt the breeding cycle of an important population of this species. As discussed previously, it is highly unlikely that important population of Large-eared Pied Bats would occur at the site. If individuals were present within the Project construction footprint and

surrounds, there would still be opportunities for them to forage in the surrounding forest. Therefore, the Project would not reduce the area of occupancy of an important population of the species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project would decrease and fragment the availability of foraging habitat within the locality. It is estimated that 39.2 ha of potential foraging habitat would be removed as a result of the Project. The habitat to be removed would be in a linear construction footprint for the construction of a road, which would result in the fragmentation of one large area of forest into three smaller patches. This is unlikely to impact on the foraging behaviour of this highly mobile species that would be able to readily transverse any gaps in the canopy that would result from the construction of the Project.

There are no records of the species or known roost camps within 10 kilometres of the Project construction footprint and surrounds. The species is highly unlikely to roost at the site due to the lack of appropriate habitat. The species may forage within the Project construction footprint on occasion but it is unlikely. Although some of the potential foraging habitat would be removed, the construction of Project would not inhibit the species from accessing other patches of vegetation. It is therefore considered the Project would be highly unlikely to result in the modification, destruction or isolation of habitat to such an extent that it would cause the species to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed activity would involve the permanent removal of a linear strip of vegetation which contains 39.2 ha of potential foraging habitat for the Large-eared Pied Bat. It is possible that the Project could lead to the introduction or spread of invasive species to vegetation surrounding the Project construction footprint and surrounds due to edge effects created by the Project.

To mitigate potential for spread and introduction of invasive weeds into surrounding vegetation which could impact on potential foraging habitat for the Large-eared Pied Bat, a number of mitigation measures will be adopted as outlined in the EIS and CEMP for the Project. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the Project construction footprint.

Traces of feral animals (Fox and Rabbit) were observed during surveys, and there is potential for cats and dogs to occur within the Project construction footprint and surrounds due to the close proximity to urban dwellings. The Project is not likely to increase the number of feral animals utilising the area.

Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the Project construction footprint.

Introduce disease that may cause the species to decline

There are no known diseases which affect the Large-eared Pied Bat.

Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and therefore could damage potential foraging habitat for the Large-eared Pied Bat.

In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) should be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of

EPBC Act - Assessment of Significance
Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable)
personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint. These measures relate to the vegetation clearing and construction stages of the Project only and should accompany measures that ensure plant and machinery does not enter any areas of retained vegetation outside of the Project construction footprint. It is envisaged that once the bypass has been completed, these measures would no longer be required. With the adoption of appropriate mitigation measures as outlined above, the Project is considered unlikely to introduce disease that may cause this species, as a whole, to decline.
Interfere substantially with the recovery of the species
The National Recovery Plan for the Large-eared Pied Bat (DERM 2011) identifies a range of actions to promote the recovery of the species. These include: • Identify priority roost and maternity sites for protection. • Implement conservation and management strategies for priority sites • Educate the community and industry to understand and participate in the conservation of the Large-eared Pied Bat • Research to augment biological and ecological data to enable conservation management • Determine the meta-population dynamics throughout the distribution of the Large-eared Pied Bat. The Project is unlikely to interfere with the recovery of the species as it would not impact on roost or maternity sites for this species. None of the other actions identified in the recovery plan for this species is relevant to the Project.
Conclusion of Assessment of Significance:
Pursuant to the significant impact guidelines (DotE 2013) presented above, the Project would not have a significant impact on an important population of the Large-eared Pied Bat as: • There have been no records or are any known maternity roosts within 10 kilometres of the Project construction footprint and surrounds. • The Large-eared Pied Bat would only utilise the site as potential foraging habitat. • About 39.2 ha of potential foraging habitat would be removed which represents only as small proportion of the potential foraging habitat in the locality. • The Project would not result in the fragmentation of habitat as if present this highly mobile species would be able to continue foraging in vegetation surrounding the site and within other similar vegetation in the local area. A number of mitigation measures will be implemented and outlined in the EIS and CEMP for the Project to reduce potential for adverse indirect impacts on the Large-eared Pied Bat habitat in adjoining areas of the Project construction footprint and surrounds. Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 39.2 ha of native vegetation) that cannot be avoided or mitigated.

Endangered Fauna Species

Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)

The Spotted-tailed Quoll has been recorded across a range of habitats from rainforest through woodland, heath and inland riparian forest from the coast to the sub-alpine zone. The species is nocturnal and will shelter in hollow-bearing trees, fallen logs, caves, crevices and cliff faces during the day. Their home range is large, with females occupying home ranges of up to 750 ha and males up to 3500 ha which they often traverse along densely vegetated cliff lines. Quolls have a varied diet, ranging from arboreal and terrestrial mammals to insects, carrion and domestic chickens (OEH 2014b).

The Spotted-tailed Quoll was not recorded during surveys, but the Project construction footprint contains potential habitat and denning sites. Habitats at the site would represent only a small proportion of the habitats utilised by this species.

EPBC Act - Assessment of Significance

Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) (Endangered)

According to the DotE (2013) 'significant impact criteria' for endangered species, an action is likely to have a significant impact on an 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

Does the Spotted-tailed Quoll within the construction footprint constitute as a population of a species?

According to DotE (2013), a 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

The PMST search undertaken identified that Spotted-tailed Quoll habitat is present or likely to be present within 10 kilometres of the Project (DotE 2015a). The OEH Wildlife Atlas search did not identify any records of the species within 10 kilometres of the Project and the closest known record is about 12 kilometres to the south east of the sit (OEH 2015a). Parsons Brinckerhoff (2015) determined that there was a moderate likelihood of the species occurring within the Project construction footprint and surrounds due to the potential habitat present. Targeted searches were undertaken by Parsons Brinckerhoff (2014) across the Project construction footprint and surrounds in October 2014 using camera traps and spotlight surveys. No evidence of Spotted-tailed Quolls was observed. This species is known to be elusive, making them difficult to detect.

The Project construction footprint is within an isolated patch of forest surrounded by roads and urban development. Spotted-tailed Quolls would not easily be able to migrate into the Project construction footprint and surrounds as there are no vegetated construction footprints through the surrounding urban areas that would allow for movement into this isolated patch of forest.

Due to the isolated nature of the Project construction footprint, the lack of evidence of quolls within the Project construction footprint and surrounds and no records of the species within 10 kilometres of the Project site, it is considered unlikely that a population of quolls exist.

Will the Project lead to a long-term decrease in the size of a population?

The Project would remove about 39.2 ha of native vegetation which could constitute Spotted-tailed Quoll habitat. This would include 179 hollow bearing trees with medium sized hollows, which have the potential to provide den sites for Spotted-tailed Quolls.

As discussed above, a Spotted-tailed Quoll population is unlikely to occur within the Project construction footprint and surrounds. Considering the isolated nature of the site, the lack of evidence of Spotted-tailed Quolls in the Project construction footprint and surrounds and no

EPBC Act - Assessment of Significance
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) (Endangered)
records of Spotted-tailed Quoll s within 10 kilometres of the Project construction footprint, the Project is therefore unlikely to result in a long-term decrease in the size of a population of the species.
Reduce the area of occupancy of the species
The Project would remove about 39.2 ha of native vegetation which could constitute Spotted-tailed Quoll habitat. This would include 179 suitable hollow bearing trees, of which some hollows could be used for dens. As discussed above, a Spotted-tailed Quoll population is unlikely to occur within the Project construction footprint and surrounds as vegetation occurs as an isolated patch surrounded by roads and urban development. Further, there is a lack of evidence of Spotted-tailed Quolls in the Project construction footprint and surrounds including the absence of records within 10 kilometres of the Project. There is little opportunity for individuals to migrate into the forest surrounding the Project construction footprint as there are no vegetated corridors through the urban areas that would allow for movement into this isolated patch of forest. 298.1 ha of forest would remain unaffected adjacent to the Project construction footprint which could provide habitat for the species. The Project would remove about 39.2 ha of potential habitat for the species which could reduce the area of occupancy of the species. However, due to the lack of evidence and records of the species within the Project construction footprint and surrounds and the isolated nature of the site, the Project is unlikely to reduce the area of occupancy for a population of Spotted-tailed Quolls.
Fragment an existing population into two or more populations
The Project would remove about 39.2 ha of potential habitat for the Spotted-tailed Quoll in a linear construction footprint for the construction of a road. The habitat to be removed would be linear in nature and would result in the fragmentation of one large area of forest into three smaller patches. The Project would include fauna crossing infrastructure which would provide opportunities for individuals to migrate between remnant vegetation and through contiguous vegetation beneath the bridges. As discussed above, the Project construction footprint and surrounds is unlikely to contain a population of Spotted-tailed Quolls. There is no evidence or records of Spotted-tailed Quolls within the Project construction footprint and surrounds (despite targeted searches) and the Project construction footprint and surrounds is within an isolated patch of forest surrounded by urban development. In the unlikely event that Spotted-tailed Quolls do inhabit the site the Project would not result in the fragmentation of the population as connectivity of the vegetation would be maintained through installation of fauna crossing infrastructure as part of the Fauna Connectivity Strategy which would allow fauna to pass underneath the alignment. Therefore the Project is highly unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species
No area of critical habitat has been listed for this species. Habitat requirements of the Spotted-tailed Quoll include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves. Individuals also require an abundance of food, such as birds and small mammals, and large areas of relatively intact vegetation through which to forage. The Project would involve the loss of 39.2 ha of foraging habitat from along a linear construction footprint of forest which would include 179 suitable hollow-bearing trees. As there is no critical habitat listed for the species, and the species is unlikely to occur at the site, the Project is therefore unlikely to adversely affect habitat critical to the survival of the species.

EPBC Act - Assessment of Significance
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) (Endangered)
Disrupt the breeding cycle of a population
In the unlikely event that Spotted-tailed Quolls were present within the Project construction footprint and surrounds there is potential breeding habitat that could be impacted by the Project including fallen logs, tree hollows or rock outcrops which could be used as dens. About 179 suitable hollow bearing trees would be removed (within the 39.2 ha of potential foraging habitat to be removed) along the alignment as a result of the Project. These trees have hollows suitable for Spotted-tailed Quolls to use for dens. Hollow-bearing trees and logs would remain in large patches of vegetation on either side of the alignment. Individuals would be able move underneath the alignment to other potential den sites. As previously discussed, it is unlikely that a population of Spotted-tailed Quolls exist within the Project construction footprint and surrounds and opportunities for migration into the isolated patch of forest surrounding the Project construction footprint are limited. The Project would remove some potential foraging and den habitat for the species but would not prevent movement into other areas of forest surrounding the Project construction footprint. If Spotted-tailed Quolls did happen to inhabit the Project construction footprint and surrounds, the breeding cycle of a population would be marginally disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The Project would decrease and fragment the availability of habitat within the locality. It is estimated that 39.2 ha of potential habitat would be removed as a result of the Project. The habitat to be removed would be in a linear construction footprint for the construction of a road and would result in the fragmentation of one large area of forest into three smaller patches. The Project would include some bridges and other structures which would provide opportunities for individuals to move amongst the patches of forest. Surveys did not detect evidence of Spotted-tailed Quolls in the Project construction footprint and surrounds and there are no records within 10 kilometres of the Project construction footprint (OEH 2014a). The closest record for the Spotted-tailed Quoll is about 12 km to the south east of the site. There is little opportunity for Spotted-tailed Quolls to migrate into the Project construction footprint and surrounds in the future as the surrounding forest is already an isolated patch of vegetation. It is unlikely that Spotted-tailed Quolls exist within the Project construction footprint and surrounding forest. The Project would remove potential habitat and result in fragmentation of potential habitat into smaller patches. However, in the unlikely event that individuals do occur within the Project construction footprint they would still be able to move between these patches. Although there is no evidence of Spotted-tailed Quolls within the Project construction footprint and surrounds, in the unlikely event that they did occur, the removal of habitat is unlikely to lead to a decline in the species.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat
The proposed activity would involve the permanent removal of a linear strip of 39.2 ha of potential habitat. There is potential for weed infestation within the Project construction footprint and surrounds to increase due to edge effects during both construction and operation of the Project. Increases in weed incidences in the Project construction footprint and surrounds are not likely to impact potential quoll habitat. A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project. These measures will seek to limit the potential for spread of invasive weed species to areas outside

of the construction footprint which may adversely alter existing foraging habitat for the Spotted-tailed Quoll.

Traces of feral animals (Fox and Rabbit) were observed during surveys, and is potential for cats and dogs to occur within the Project construction footprint and surrounds due to the close proximity to urban dwellings. The Project is not likely to increase the number of feral animals utilising the area. However, as there were no Quolls observed, and limited opportunities for individuals to migrate into the area, it is highly unlikely that if invasive species did increase at the site this would impact on a population of Quolls.

Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of construction footprint.

Introduce disease that may cause the species to decline

Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats.

In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the construction footprint.

With the adoption of appropriate mitigation measures as outlined above, the Project is considered unlikely to introduce disease that may cause this species decline.

Interfere with the recovery of the species

A National Recovery Plan has been prepared for the Spotted-tailed Quoll (OEH 2016) which identifies a range of actions to promote the recovery of the species. These include:

- Investigate key aspects of biology and ecology of the Spotted-tailed Quoll to acquire targeted information to aid recovery
- Reduce the rate of habitat loss and fragmentation on private land
- Evaluate and manage the risk posed by silvicultural practices
- Determine and manage the threat posed by introduced predators (foxes, cats, wild dogs) and of predator control practices on Spotted-tailed Quoll populations
- Determine and manage the impact of fire regimes on populations.
- Reduce deliberate killings and frequency of road mortality
- Assess the threat of cane toads and implement threat abatement plans if necessary
- Determine likely impact of climate change on populations
- Increase community awareness and involvement in the Recovery Program

The Project will remove 39.2 ha of potential habitat and contribute to one of the recovery actions-fragmentation and reduction of potential habitat. Although the Project will incrementally add to the loss of potential habitat for the Spotted-tailed Quoll, it is unlikely to interfere with the recovery of this species. None of the other actions identified in the recovery plan for this species are likely to be impacted by the Project.

EPBC Act - Assessment of Significance

Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) (Endangered)

Conclusion of Assessment of Significance:

The Project would remove 39.2 ha of potential habitat for the Spotted-tailed Quoll. The Project is not likely to have a significant impact on the Spotted-tailed Quoll as:

- There are no known populations of Spotted-tailed Quoll within the Project construction footprint and surrounds (despite targeted survey efforts) and no records have been observed within 10 kilometres of the Project.
- 298.1 ha of forest would remain adjacent to the Project which would contain potential habitat for the species.
- There is minimal potential for migration into the Project construction footprint and surrounds as it is isolated patch of forest. There are no vegetated corridors through the surrounding urban areas that would allow for movement into the Project construction footprint and surrounds.
- In the unlikely event that Spotted-tailed Quolls do inhabit the site the Project would not result in the fragmentation of the population as connectivity of the vegetation would be maintained through installation of fauna crossing infrastructure which would allow fauna to pass underneath the alignment.
- The Project will not interfere with the recovery of the species.

Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 39.2 ha of native vegetation) that cannot be avoided or mitigated.

Swift Parrot (*Lathamus discolor*)

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes. Swift Parrots will return to some foraging sites on a cyclic basis depending on food availability. The Swift Parrot does not breed in NSW. This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales but can occur from South Australia to southern Queensland.

A key habitat for the species on the coast and coastal plains of New South Wales is Lower Hunter Spotted Gum - Ironbark Forest which is identified as an endangered ecological community within the Project construction footprint. Spotted Gum - Grey Ironbark open forest is another vegetation community present at the site. Within these two communities, Spotted Gum (*Eucalyptus maculata*) is a preferred feed tree. The Project construction footprint and surrounds also contains some Swamp Mahogany (*Eucalyptus robusta*) trees which are also listed as a preferred feed tree for the species. These tree species provide important foraging and roosting habitat for the species (OEH 2015b).The Swift Parrot inhabits dry sclerophyll eucalypt forests and woodlands. It occasionally occurs in wet sclerophyll forests (Swift Parrot Recovery Team 2001). Saunders and Heinsohn (2008) observed that the Swift Parrot predominantly forages within habitats that have been so significantly cleared that they are classified as endangered ecological communities.

Despite targeted surveys during key survey detection times (Winter) within the study area, the Swift Parrot was not recorded in the Project construction footprint and surrounds. The Swift Parrot is likely to forage in the Project construction footprint and surrounds on occasion.

EPBC Act - Assessment of Significance

Swift Parrot (*Lathamus discolor*) (Endangered)

According to the DotE (2013) 'significant impact criteria' for endangered species, an action is likely to have a significant impact on an 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

Does the Swift Parrot within the Project construction footprint constitute as a population of a species?

According to DotE (2013), a 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations, or
- A population, or collection of local populations, that occurs within a particular bioregion.

The Swift Parrot occurs as a single, migratory population in Australia (Birds Australia 2011). The PMST search undertaken identified that Swift Parrot habitat is present or likely to be present within 10 kilometres of the Project construction footprint (DotE 2015a)). The OEH Wildlife Atlas search identified 109 previous records of the species within 10 kilometres of the Project (OEH 2014a). Parsons Brinckerhoff (2015) determined that there was a moderate likelihood of the species occurring within the Project construction footprint due to the presence of potential habitat.

The Swift Parrot breeds only in Tasmania, and migrates to mainland Australia in autumn (Swift Parrot Recovery Team 2001). This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales but can occur from South Australia to southern Queensland. A key habitat for the species on the coast and coastal plains of New South Wales is Lower Hunter Spotted Gum - Ironbark Forest which is identified as a endangered ecological community within the Project construction footprint. Spotted Gum - Grey Ironbark open forest is another vegetation community present at the site. Within these two communities, Spotted Gum (*Eucalyptus maculata*) is a preferred feed tree. The Project construction footprint and surrounds also contains some Swamp Mahogany (*Eucalyptus robusta*) trees which are also listed as a

EPBC Act - Assessment of Significance
Swift Parrot (*Lathamus discolor*) (Endangered)
preferred feed tree for the species. These tree species provide important foraging and roosting habitat for the species (OEH 2015b). Targeted bird surveys were undertaken by Parsons Brinckerhoff (2014) across the Project construction footprint and surrounds in July 2014. No Swift Parrots were observed during surveys. However the Spotted Gums within the Project construction footprint and surrounds were not flowering at the time of survey (they do not flower each year) and the presence of Swift Parrots is dependent on the presence of flowering. As the Swift Parrot occurs as a single migratory species within Australia, it cannot be considered a geographically distinct regional population, collection of local populations, or a population or collection of local populations that occurs within a particular bioregion. Therefore, within the Project construction footprint if the Swift Parrot where to occur it would not constitute a population of the species.
Will the Project lead to a long-term decrease in the size of a population? As discussed above, within the Project construction footprint the Swift Parrot does not constitute as a population of the species. The Swift Parrot could occur within the Project construction footprint and surrounds on occasion to forage during the winter flowering period. The Project would remove about 39.2 ha of potential foraging habitat for the Swift Parrot and the loss of 195 hollow bearing trees with small sized hollows, which have the potential to provide roosting habitat for this species.. The construction of the bypass is not expected to lead to a decrease in the Swift Parrot population as it is a highly mobile, migratory species that would only visit the site on occasion. The Project would only remove a small amount of potential habitat for Swift Parrots which would still be able to forage within the large areas of similar habitat that surrounds the Project site. It is therefore highly unlikely that the Project would result in the long-term decrease in the size of the population.
Reduce the area of occupancy of the species
The Project would remove about 39.2 ha of native vegetation which could constitute as Swift Parrot foraging habitat. This would include 195 suitable hollow bearing trees which could be used for roosts. The Project would only remove a small amount of potential foraging habitat for Swift Parrots which would still be able to forage within the large areas of similar habitat that surrounds the Project site. Swift Parrots are highly mobile, migratory species with extremely large ranges which breed in Tasmania and occur from South Australia to southern Queensland during winter. This nomadic species moves through a variety of vegetation types across the landscape in response to seasonal availability of foot. The small amount of potential foraging habitat to be removed as a result of the Project is therefore not expected to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations
The Project would remove about 39.2 ha of potential foraging habitat for the Swift Parrot in a linear construction footprint for the construction of a road. Road construction footprints have the potential to fragment populations of species. The Project would divide one isolated patch of forest into three smaller patches of forest within an urban landscape. However, Swift Parrots are highly mobile, migratory species that are considered as one distinct population within Australia. The Project would not inhibit movement of this highly mobile species through the landscape as it would continue to have access to other potential foraging areas surrounding the site. Therefore the Project would not fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species
There is no critical habitat listed for this species. The National Recovery Plan for the Swift Parrot (Birds Australia 2011) identities priority habitats for conservation. These include habitats which are used:

EPBC Act - Assessment of Significance

Swift Parrot (*Lathamus discolor*) (Endangered)

- For nesting
- By large proportions of the Swift Parrot population
- Repeatedly between seasons (site fidelity)
- For prolonged periods of time (site persistence)

195 hollow bearing trees would be removed as a result of the Project, these trees would provide potential roosting sites for Swift Parrot. Hollow bearing trees suitable for Swift Parrot roosting would remain within the study area which could provide alternative roosting habitat for Swift Parrots during the winter flowering period. Although there are a large number of records within 10 kilometres of the Project construction footprint, it is not known to be utilised by a large proportion of the Swift Parrot population, or repeatedly between seasons, or for long periods of time. Birdlife Australia (2013) has mapped the Project construction footprint as low - medium habitat value for Swift Parrots.

Foraging habitat in NSW is considered to be critical to the survival of the species. The Hunter-Central Rivers is identified as a priority habitat for conservation management of Swift Parrot roosting and foraging resources (Birds Australia 2011). Swift Parrots may forage in the Project construction footprint and surrounds during winter as Spotted Gum and Swamp Mahogany are two important feed trees for the Swift Parrot that are present within the Project construction footprint. The Project would only impact a small portion of the resources available in the locality. 298.1 ha of forest adjacent to the Project construction footprint would remain affected by the Project. The Project construction footprint is also directly north of Blackbutt Reserve in which a further 298.1 ha of similar vegetation type would remain. To Project is only three kilometres east from a large patch of forest (11,000 ha) conserved within Blue Gum Hills Regional Park, which connects with Mount Sugarloaf and Heaton State Forest. The Project would therefore be highly unlikely to adversely affect any habitat critical to the survival of the species.

Disrupt the breeding cycle of a population

The Swift Parrot does not breed in NSW but rather migrates annually between its winter habitat in south-eastern mainland Australia and is summer breeding habitat in Tasmania (DotE 2015b). The species may forage during winter flowering periods in the Project construction footprint and surrounds, but is not likely to depend on the resources present. Given the large areas of similar foraging habitat that is present in the locality. The removal of 39.2 ha of potential foraging habitat for this species is therefore unlikely to impact the lifecycle of the species such that a viable local population is placed at risk of extinction.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project would decrease and fragment the availability of foraging habitat within the locality. It is estimated that 39.2 ha of potential foraging habitat would be removed as a result of the Project. The foraging habitat to be removed would be in a linear construction footprint for the construction of a road and would result in the fragmentation of one large area of forest into three smaller patches. As the species is highly mobile and migratory, the road would not create a barrier to movement on the species. The Swift Parrot would still be able to access patches of foraging habitat in the surrounding area. Therefore the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat such that it would lead to a decline in the species.

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Swift Parrot (*Lathamus discolor*) (Endangered)
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat
The proposed activity would involve the permanent removal of a linear strip of 39.2 ha of potential habitat. There is potential the Project could result in the spread of existing weeds or introduction of new weed species within the Project construction footprint and surrounds due to edge effects during both construction and operation of the Project. Increases in weed incidences in the Project construction footprint are not likely to significantly impact potential Swift Parrot foraging habitat in the Project construction footprint. A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project to limit the potential for spread of invasive weed species to areas outside of the Project construction footprint which may adversely alter existing foraging habitat for the Swift Parrot. Traces of feral animals (Fox and Rabbit) were observed during surveys, and is potential for cats and dogs to occur within the Project construction footprint and surrounds due to the close proximity to urban dwellings. The Project is not likely to increase the number of feral animals utilising the area. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential habitat for this species.
Introduce disease that may cause the species to decline
Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats. In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint. With the adoption of appropriate mitigation measures as outlined above, the Project is considered unlikely to introduce disease that may cause this species to decline.
Interfere with the recovery of the species
The National Recovery Plan for the Swift Parrot (Birdlife Australia, 2011) identifies four key objectives which are: • Identify the extent and quality of habitat • Manage and protect Swift Parrot habitat at the landscape scale • Monitor and manage the impact of collisions, competition and disease • Monitor population and habitat The Project is not consistent with managing and protecting Swift Parrot habitat at the landscape scale as it would remove 39.2 ha potential foraging habitat within an identified priority region (Birdlife Australia 2011),. Although the Project construction footprint and surrounds was mapped as low – medium habitat value for Swift Parrots (Birdlife Australia 2011), resources in urban areas are important for the species in a highly fragmented landscape. Habitat loss and alteration through land clearing presents the greatest threat to the Swift Parrot. The species is highly mobile with a large home range, and resources would remain within the locality. Within the context of the remaining

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Swift Parrot (*Lathamus discolor*) (Endangered)
similar habitat for this species in the locality, it is highly unlikely that the removal of 39.2 ha of potential foraging habitat would interfere with the recovery of the species.
Conclusion of Assessment of Significance:
The Project would remove 39.2 ha of potential foraging habitat for the Swift Parrot. The Project is not likely to have a significant impact on Swift Parrot as: • No breeding habitat would be impacted as a result of the Project • The species are highly mobile with large home ranges and would visit the Project construction footprint and surrounds only on a seasonal basis when preferred feed trees are flowering. • The species would continue to be able to move through the project corridor and surrounds in which ha of forest adjacent to the Project would be unaffected, and the extensive amounts of resources to the west of the Project. • There are large areas of similar habitat in the locality that could be used by this species as foraging habitat. Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 39.2 ha of native vegetation) that cannot be avoided or mitigated.

Regent Honeyeater (*Anthochaera phrygia*)

The Regent Honeyeater is a migratory species which has a widespread, patchy distribution in south eastern Australia. The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia.

In NSW, the breeding distribution it is confined to two main breeding areas, within the Capertee Valley and Bundarra-Barraba regions and surrounding fragmented woodland. In some years, flocks converge on flowering coastal woodlands and forests (OEH 2014b). A key habitat for the species on the coast and coastal plains of New South Wales is Lower Hunter Spotted Gum - Ironbark Forest which provides important foraging habitat when box-ironbark forests are drought affected (Menkhorst et al. 1999). Preferred feed trees for this species include Spotted Gum (*Eucalyptus maculata*), and Swamp Mahogany (*Eucalyptus robusta*) both of which occur within the Project construction footprint and surrounds. These trees provide important foraging and roosting habitat for the species during flowering periods.

EPBC Act - Assessment of Significance

Regent Honeyeater (*Anthochaera phrygia*) (Endangered)

According to the DotE (2013) 'significant impact criteria' for endangered species, an action is likely to have a significant impact on an 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

Does the Regent Honeyeater within the Project construction footprint constitute a population of a species?

According to DotE (2013), a 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

The PMST search undertaken identified that Regent Honeyeater habitat is present or likely to be present within 10 kilometres of the Project (DotE 2015a)). The OEH Wildlife Atlas search identified 13 records of the species within 10 kilometres of the Project (OEH 2015a). Parsons Brinckerhoff (2015) determined that there was a moderate likelihood of the species occurring within the Project construction footprint due to the presence of potential habitat.

The Regent Honeyeater is a migratory species which has a widespread, patchy distribution in south eastern Australia. In NSW the breeding distribution it is confined to two main breeding areas, within the Capertee Valley and Bundarra-Barraba regions and surrounding fragmented woodland. In some years flocks converge on flowering coastal woodlands and forests (OEH 2014b). A key habitat for the species on the coast and coastal plains of New South Wales is Lower Hunter Spotted Gum - Ironbark Forest which provides important foraging habitat when box-ironbark forests are drought affected (Menkhorst et al. 1999).Preferred feed trees for this species include Spotted Gum (*Eucalyptus maculata*), and Swamp Mahogany (*Eucalyptus robusta*) both of which occur within the Project construction footprint and surrounds. These trees provide important foraging and roosting habitat for the species during flowering periods.

Targeted bird surveys were undertaken by Parsons Brinckerhoff (2014) across the Project construction footprint and surrounds in July 2014. No Regent Honeyeaters were observed during surveys. However the Spotted Gums within the Project construction footprint and surrounds were not flowering at the time of survey (they do not flower each year) and the presence of Regent Honeyeaters is dependent on the presence of flowering.

As the species has a large home range and is migratory, the Project construction footprint and surrounds does not contain a geographically distinct regional population, collection of local populations, or a population, that occurs within a particular bioregion. Therefore within the Project

construction footprint, if this species were to occur it would not constitute as a population of the species.

Will the Project lead to a long-term decrease in the size of a population?

As discussed above, there is no known population of Regent Honeyeaters within the Project construction footprint and surrounds. The Regent Honeyeater could migrate to the Project construction footprint and surrounds to forage during the winter flowering period. The Project would remove about 39.2 ha Spotted Gum forest which is known to be important foraging habitat for this species when box-ironbark forests are drought affected (Menkhorst et al. 1999).

The Regent Honeyeater is a highly mobile species with a very large range. Regent Honeyeaters would still be able to forage in large areas of habitat surrounding the Project that would be unaffected by the construction of the bypass. Therefore it is highly unlikely that the Project would result in a long-term decrease in the size of a population of the species.

Reduce the area of occupancy of the species

As discussed above, there is no known population of Regent Honeyeaters within the Project construction footprint and surrounds. The Regent Honeyeater may migrate to the Project construction footprint to forage during the winter flowering period. The Project would remove about 39.2 ha of Spotted Gum Forest which is known to be important refuge habitat for this species when box-ironbark forests are drought affected (Menkhorst et al. 1999).

The Project would slightly decrease the amount of available foraging habitat in the locality. However, the Regent Honeyeater is a highly mobile species with a very large range, and minimal species records have been made within the locality. Regent Honeyeaters would still be able to forage in large areas of similar habitat surrounding the Project. Therefore the Project would not result reduce the area of occupancy of a population of the species.

Fragment an existing population into two or more populations

As discussed above, there is no known population of Regent Honeyeaters within the Project construction footprint and surrounds. The Project would remove about 39.2 ha of potential foraging habitat for the Regent Honeyeater in a linear construction footprint for the construction of a road. This would divide the patch of forest into three smaller patches of forest, which has the potential to fragment populations of species. However Regent Honeyeaters are highly mobile species with large home ranges. The Project would not inhibit movement for this highly mobile species and it would still be able to access the remaining patches of forest surrounding the Project. Therefore the Project is highly unlikely to fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of the species

There is no critical habitat listed for this species. Stands of White box, Yellow Box, Yellow Gum and Mugga Ironbark growing on high quality sites with relatively predictable and copious nectar production have been identified as critical to the survival of the Regent Honeyeater (Menkhorst et al 1999). None of these species occur within the Project construction footprint and surrounds.

Lower Hunter Spotted Gum Ironbark Forest however is known to be important refuge habitat when box-ironbark forests are drought affected (Menkhorst et al. 1999). About 39.2 ha of this vegetation type would be removed by the Project. However, 11.5 ha of this community would remain unaffected adjacent to the Project construction footprint. The Project is located immediately north-west of Blackbutt Reserve which contains about 180 ha of remnant vegetation, and three kilometres east of Blue Gum Hills Regional Park (about 11,000 ha), which connects with Mount Sugarloaf and Heaton State Forest. The Project would therefore be unlikely to adversely affect any habitat critical to the survival of the species.

As no known critical habitat exists within the Project construction footprint and surrounds, and only a small amount of potential foraging habitat within the locality would be removed as a result of the

EPBC Act - Assessment of Significance
Regent Honeyeater (*Anthochaera phrygia*) (Endangered)
Project, the Project would therefore not adversely affect any habitat critical to the survival of the species.
Disrupt the breeding cycle of a population
There are two known breeding areas for Regent Honeyeater within NSW; Capertee Valley and Bundarra-Barraba regions (OEH 2015b). It is thought that the long-term survival of the species in the Capertee Valley is underpinned by the availability of Spotted Gum forests in the Hunter Valley and Swamp Mahogany forests on the central coast as a refuge during drought (DotE 2015b).There have been sporadic records of breeding attempts in the Hunter region, but no known attempts near the Project construction footprint and surrounds as it is not preferred breeding habitat. The species may forage on occasion within in the Project construction footprint and surrounds. Spotted Gum forests in the Hunter region act as important refuges when their preferred habitat is affected by drought. The Project would remove 39.2 ha of potential foraging habitat for this species. Given that over 11 000 ha of similar foraging habitat would still remain within the Blue Gum Hills Regional Park only three kilometres west of the Project, and, and there have been no known breeding attempts in the Project construction footprint and surrounds, the Project is unlikely to disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The Project would slightly decrease and fragment the availability of habitat within the locality. It is estimated that 39.2 ha of potential foraging habitat would be removed as a result of the Project, in particular 4.1 ha of Lower Hunter Spotted Gum Ironbark Forest, which is known to be important refuge habitat for this species when box-ironbark forests are drought affected (Menkhorst et al. 1999).. This vegetation would be removed along a linear construction footprint and would result in the fragmentation of one large area of forest into three smaller patches. The fragmentation of this vegetation is unlikely to impact on the Regen Honeyeater as the species is highly mobile and migratory and would be able to readily transverse any gaps created in the canopy by the construction of the road. Furthermore, the Regent Honeyeater would still be able to access patches of similar foraging habitat in the surrounding area. Therefore the Project is unlikely to lead to a decline in the species.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat
The proposed activity would involve the permanent removal of a linear strip of 39.2 ha of potential foraging habitat. There is potential the Project could result in the spread of existing weeds or introduction of new weed species within the Project construction footprint due to edge effects during both construction and operation of the Project. Increases in weed incidences in the Project construction footprint are not likely to significantly impact potential Regent Honeyeater habitat in the Project construction footprint. A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project to limit the potential for spread of invasive weed species to areas outside of the Project construction footprint which may adversely alter existing foraging habitat for the Regent Honeyeater. Traces of feral animals (Fox and Rabbit) were observed during surveys, and is potential for cats and dogs to occur within the Project construction footprint and surrounds due to the close proximity to urban dwellings. The Project is not likely to increase the number of feral animals utilising the area. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential habitat for this species.

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Regent Honeyeater (*Anthochaera phrygia*) (Endangered)

Introduce disease that may cause the species to decline

Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats.

In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint.

With the adoption of appropriate mitigation measures as outlined above, the Project is considered unlikely to introduce disease that may cause this species decline.

Interfere with the recovery of the species

Long term recovery objectives listed in the National Recovery Plan for the Regent Honeyeater 2016 (DoE, 2016) identified two key objectives to be achieved:

- Reverse the long-term population trend of decline and increase the numbers of Regent Honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years; and to
- Enhance the condition of habitat across the Regent Honeyeater range to maximise survival and reproductive success, and provide refugia during periods of extreme environmental fluctuation.

None of the objectives listed are particularly relevant to the Project. The removal of 39.2 ha of potential foraging habitat is not expected to interfere with the recovery of the species. No breeding habitat will be removed by the Project.

Conclusion of Assessment of Significance:

The Project would remove 39.2 ha of potential foraging habitat for the Regent Honeyeater. The Project is not likely to have a significant impact on the Regent Honeyeater as:

- No known breeding habitat would be impacted as a result of the Project.
- The species is highly mobile, nomadic and likely to only visit the Project construction footprint on occasion to forage.
- The Regent Honeyeater would still be able to move through and forage in remaining habitat surrounding the Project.
- There are large areas of similar habitat in the locality that could be used by this species as foraging habitat.

Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 39.2 ha of native vegetation) that cannot be avoided or mitigated.

Vulnerable Flora Species

Black-eyed Susan (*Tetratheca juncea*)

Tetratheca juncea is a low shrub that grows as a single stem or clumps of stems arising from a single rootstock, with as many as 200-500 individual stems arising from a single clump (DSEWPC 2011). Hanging pink flowers with a distinctive dark centre appear between July and January (Benson & McDougall 2001; Harden 1992), with a peak in flowering between the start of September to the end of October (Driscoll 2009).

This species is found in sandy, occasionally moist heath and in dry sclerophyll vegetation communities endemic to coastal NSW (Harden 1992). Furthermore, this species is shown to have a preference for ridges in areas 0-200 metres in altitude with an annual rainfall of 1,000-1,200 mm and restricted to open forest of *Angophora costata*, *Eucalyptus haemastoma*, *E. globoidea*, *Corymbia gummifera* and *E*. *capitellata* (Benson & McDougall 2001). The preferred substrates are: sandy skeletal soil on sandstone, sandy-loam soils, low nutrients; and clayey soil from conglomerates, pH neutral (DotE 2015c).

Tetratheca juncea can reproduce through asexual rhizomal spread and sexual pollination, seed development and germination (Driscoll 2003; Payne 2001a). *Tetratheca juncea* is rhizomatous and propagates asexually from rootstock to form plant clumps of up to 0.5 m^2 (DotE 2015c). *Tetratheca juncea* flowers between July and January, with peak flowering occurring between early September and late October (Driscoll 2009).

The range of this species has contracted to an area extending about 110-125 km north-south from Wyong north to Bulahdelah, and inland 50 km east-west to the edge of the Sugarloaf Range (NPWS 2000; Payne 2001a; Driscoll 2003 & Gross et al 2003). The current extent of occurrence is estimated to be between 1594 and 1861 square kilometres (TSSC 2005). Most populations occur in the Wyong and Lake Macquarie LGAs with isolated but widespread populations at Cessnock, Maitland, Newcastle, Port Stephens and the Great Lakes LGAs (Payne 2001b; TSSC 2005). The total population size for this species has previously been estimated to be between 9,881 and 11,893 plant clumps (about 10,000 individuals) however more recent research suggests that this figure may be a gross underestimate (TSSC 2005). In 2000, 45 populations comprising 1,600 clumps were located in state conservation areas, including Awabakal Nature Reserve, Glenrock State Recreation Area (SRA), Lake Macquarie Recreation Area, Jilliby SRA and Munmorah SRA (TSSC 2005).

Regional context

The Project occurs within the eastern portion of the known distributional range for *Tetratheca juncea*. Analysis of records from the NSW OEH Wildlife Atlas Database (OEH 2014) shows that populations within the wider locality (defined as the area within a 10 km radius of the Project construction footprint) occur within the following locations:

- About 2.5 km to the south-west in the Garden Suburb area;
- About 3.5 km to the south-east in the Adamstown/Merewether area;
- About 2 km to the west in the Glendale area;
- About 4 km to the west in the Elermore Vale/Edgeworth area; and
- About 1 km to the west in the Cardiff Heights area.

Targeted surveys undertaken within the Project construction footprint and surrounds revealed a large population comprising 10,381 plant clumps of this species. This population is located within the central coast metapopulation for *Tetratheca juncea* as indicated in the Referral Guidelines for *Tetratheca juncea* (DSEWPC 2011), which extends from Karuah in the north, to the coast in the east, Wyong in the south and Mullbring in the west.

The population in the study area contains five subpopulations, three within Blackbutt Reserve and the remaining two subpopulations recorded to the west of Lookout Road. A breakdown of the number of plants recorded within each subpopulation is provided in Table 1.

Table 1 Number of *Tetratheca juncea* plant clumps within each subpopulation

Subpopulation (location)	**No. of *Tetratheca juncea* plant clumps**
Subpopulation 1 (west of lookout road and partially within the Project construction footprint)	8,176
Subpopulation 2 (west of lookout road and outside the Project construction footprint)	4
Subpopulation 3 (Blackbutt Reserve and outside the Project construction footprint)	5
Subpopulation 4 (Blackbutt Reserve and outside the Project construction footprint)	2,162
Subpopulation 5 (Blackbutt Reserve and outside the Project construction footprint)	34
Total number of plant clumps	**10,381**

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Black-eyed Susan (*Tetratheca juncea*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Do the *Tetratheca juncea* plants identified within the construction footprint, constitute an important population?

Tetratheca juncea has previously been recorded within the locality (OEH 2014b) and the Project construction footprint and a total of 846 plant clumps were recorded within the construction footprint during targeted surveys. Locations of all records identified within the Project construction footprint and surrounds are provided in Figure 4 (Attachment 1) and Figure 4.1 (Attachment 5).

An important population of *Tetratheca juncea* is defined by any of the following criteria as set out by the referral guidelines (DSEWPC 2011):

1. Has greater than 1,000 plant clumps.
2. An area of habitat with an average estimated plant clump density of 20 clumps per ha or greater.
3. Occurs in rare habitat (as defined by section 3 of the referral guidelines).
4. Occurs in an area of 'important habitat' as defined in Maps 4a and 4b (of the referral guidelines) and has greater than 500 plant clumps.
5. Occurs at or near the distributional limits of *Tetratheca juncea.*
6. Occurs in close proximity to a protected area (eg National Park) where *Tetratheca juncea* is known to occur. Close proximity refers to:
    (a) Within 500 m if connected by a suitable habitat corridor such as native vegetation.
    (b) Within 100 m over disturbed habitat or non-native vegetation.

The Project construction footprint meets criteria 1, 2, 3 and 6. Within the Project construction footprint (to the west of Lookout Road) there are over 1,000 plant clumps (8,180 plant clumps in

subpopulations 1 and 2) and an average of 207 plant clumps per ha. A portion of the population occurs in rare habitat of HU622 Smooth-barked Apple – Sydney Peppermint – Turpentine open forest and the Project construction footprint occurs within 100 metres of Blackbutt Reserve in which a known population of this species occurs.

In addition, the Project construction footprint may also meet criteria 4. Whilst the Project construction footprint is not mapped within important habitat, it is mapped within modelled habitat for this species within Map 2 of the referral guidelines.

In conclusion, the recorded population of *Tetratheca juncea* (comprising 10,381 plant clumps) meets several of the above criteria and is deemed to be an important population as defined under the EPBC Act. The construction footprint comprises a total of 846 *Tetratheca juncea* plant clumps which are part of an identified important population.

Will the proposal lead to a long-term decrease in the size of the important population?

The Project would result in the removal of 846 plant clumps of *Tetratheca juncea*. As stated previously, the total population size for this species in NSW has previously been estimated to be between 9,881 and 11,893 plant clumps (about 10,000 individuals) however more recent research suggests that this figure may be a gross underestimate (TSSC 2005), which is particularly evident considering the total number of plant clumps recorded within the Project construction footprint and surrounds alone was 10,381. A tally of known populations listed on the Species Profile and Threats Database for *Tetratheca juncea* (DotE 2015c) shows that recorded numbers for this species is in excess of 56,000, with the largest numbers recorded within the Wyong and Lake Macquarie local government areas.

It is clear from this information that the total population size for *Tetratheca juncea* is considerably larger than current estimates. Regardless, the removal of 846 plant clumps would result in the permanent removal of a portion of an important population of *Tetratheca juncea* (comprising 10,381 plant clumps) and consequently will lead to a long-term decrease in the size of an important population.

According to DotE (2008), additional research is required on the reproductive biology of *Tetratheca juncea*, including the issue of poor recruitment and limited information is available on the translocation potential or success for this species. Previous attempts at translocation have not proved successful and consequently this approach should be regarded as experimental and is not recommended as a management strategy or mitigation measure (DotE 2015c). Plants have been successfully propagated from cuttings and seed however further research into the reproduction biology, seed viability, appropriate fire regime for germination, dependence on mycorrhiza and reasons for poor seed set before this can be used in rehabilitation Projects. Based on this current knowledge regarding recruitment and estimated population size, it is assumed that the removal of 846 individuals would lead to a long-term decrease in the size of an important population of *Tetratheca juncea*.

Reduce the area of occupancy of an important population

The identified *Tetratheca juncea* population (comprising 10,381 plant clumps) occurs within the eastern portion of the central coast metapopulation as indicated in the referral guidelines for the species (DSEWPC 2011). The Project would involve the removal of about 39.2 ha of native vegetation containing 846 *Tetratheca juncea* plant clumps. The construction footprint has been selected to try to reduce impacts on the local population by avoiding plant clumps where possible. Regardless, the removal of these plant clumps from the central portion of an identified important population located in the eastern extent of the species known distributional range will reduce the area of occupancy of an important population for this species.

Fragment an existing important population into two or more populations

The Project would involve the removal of 846 *Tetratheca juncea* plant clumps from the central portion of an identified important population comprising 10, 381 plant clumps. As stated previously,

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Black-eyed Susan (*Tetratheca juncea*) (Vulnerable)
the population comprises five subpopulations and the Project would remove 846 plant clumps from Subpopulation 1 which comprises 8,176 plant clumps. A subpopulation is defined as plant clumps that are separated by distances of less than 500 m within suitable habitat or less than 100 m in degraded habitat or non-native vegetation (DSEWPC 2011). The removal of these plant clumps would fragment occurrences of *Tetratheca juncea* within Subpopulation 1 and also increase distances between the remaining plant clumps of Subpopulation 1 and other subpopulations located within Blackbutt Reserve. Consequently the construction footprint could result in the fragmentation of an existing important population into two separate populations.
Adversely affect habitat critical to the survival of the species
No critical habitat has been listed for this species on the Register of Critical Habitat. According to the DotE (2013), habitat critical to the survival of a species refer to areas that are necessary: • For activities such as foraging, breeding, roosting or dispersal; • For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species e.g. pollinators); • To maintain genetic diversity and long-term evolutionary development, or • For the reintroduction of populations of recovery of the species or ecological community. The Project would result in the removal of 846 plant clumps from an important population of *Tetratheca juncea*, however consideration of the points above shows that this population is unlikely to be critical to the survival of this species, as a whole given that a number of other populations are known within the distributional range of this species (most notable within the Wyong and Lake Macquarie LGAs), some of which are in conservation areas. Consequently, the impacts associated with the Project are considered unlikely to adversely affect habitat that is critical to the survival of this species.
Disrupt the breeding cycle of an important population
The Project would result in the removal of about 39.2 ha of native vegetation comprising 846 plant clumps of *Tetratheca juncea*. This would result in the fragmentation of an identified important population and create a barrier to the movement of pollinators between subpopulations to the east and west of the Project. As mentioned previously, the flowers produce no nectar attractive to pollinators and pollination is reliant on bees collecting nectar and pollen from a number of other plant species nearby (Driscoll 2003). Consequently, the Project could also potentially reduce the area of suitable floral assemblages and nesting resources required by pollinators and consequently lead to a decline in pollinator numbers. The combination of pollinator limitation and fragmentation of disjunct populations could potentially lead to minimal genetic variation within and between subpopulations and therefore potentially disrupt the breeding cycle of 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
A total of 39.2 ha of native vegetation, that provides habitat for 846 plant clumps of *Tetratheca juncea* would be removed as a result of the Project. Whilst the Project would result in a decrease in the local population and the extent of potential habitat, it is considered that the overall impacts are not to the extent that the species, as a whole, is likely to decline given its total known distributional range and that total population numbers for this species are expected to be higher than is currently known.

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Black-eyed Susan (*Tetratheca juncea*) (Vulnerable)
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Weed invasion is identified as one of the main threats to the survival of *Tetratheca juncea* given that weeds can compete with resources such as light and water and smother plant clumps (DotE 2015c). A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project to limit the potential for introduction or spread of invasive weed species to areas outside of the Project construction footprint which are known to (or may potentially) provide habitat for *Tetratheca juncea*. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the Project construction footprint. Phythophthora (*Phythophthora cinnamomi*), a soil borne water mould that produces infection in plants has also been identified as a threat to the survival of *Tetratheca juncea* and is discussed further below.
Introduce disease that may cause the species to decline
The plant pathogen, Phythophthora (*Phythophthora cinnamomi*), is a declared key threatening process under the NSW *Threatened Species Conservation Act 1995* (TSC Act). *Tetratheca juncea* is listed as a species that may be adversely affected by direct infestation of Phythophthora or habitat degradation associated with this pathogen (DotE 2015c). Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation (which could introduce the pathogen via contaminated soil/water on machinery and shoes etc) unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats. In order to minimise the potential for the introduction or spread of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) should be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the construction footprint. These measures relate to the vegetation clearing and construction stages of the Project only and should accompany measures that ensure plant and machinery does not enter any areas of retained vegetation outside of the construction footprint. It is envisaged that once the Project has been constructed, these measures would no longer be required. With the adoption of appropriate mitigation measures as outlined above, the Project is unlikely to introduce disease that may cause this species, as a whole, to decline.
Interfere substantially with the recovery of the species
No recovery plan has been developed for *Tetratheca juncea*. In lieu of a formal recovery plan, the Department of the Environment (2015c) lists the following key management actions to assist this species: <u>Habitat loss, fragmentation and disturbance</u> • Protect and actively manage large populations and those at the limit of the species range through conservation covenanting and the preparation of site specific vegetation management plans • Monitor known populations to identify key threats

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- Identify populations of high conservation priority
- Improve vegetative connectivity within and between populations through revegetation and regeneration programs
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- Ensure stormwater infrastructure and associated development involving substrate or vegetation disturbance do not adversely impact on *Tetratheca juncea* and manage any associated hydrological change, such as increased runoff
- Minimise factors that promote habitat degradation such as large edge-area ratios

Invasive weeds

- Undertake weed control activities at priority sites on private and public land
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on *Tetratheca juncea*

A number of mitigation measures will be outlined in the EIS and an EMP and adopted to address the key management actions as outlined above where relevant. The Project has been subject to rigorous re-design and realignment to reduce and avoid impacts to significant populations of *Tetratheca juncea.* The primary threat to *Tetratheca juncea* is habitat clearing for urban development (Gross et al 2003). The Project would result in the removal of 846 *Tetratheca juncea* plant clumps considered to be part of an important population (comprising 10,381 plant clumps) for this species. The removal of these plant clumps would result in a decrease in the known local population and availability of potential habitat however, it is considered that the overall impacts would not be to the extent that they would substantially interfere with the recovery of the species, particular with the adoption of appropriate mitigation measures and an appropriate offset package to compensate for residual impacts.

Conclusion of Assessment of Significance:

Despite careful design consideration to avoid impacts to *Tetratheca juncea* where possible and the proposed mitigation measures, the Project is likely to have a significant impact on an important population of *Tetratheca juncea* given that there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of the species;
- Reduce the area of occupancy of an important population;
- Fragment an existing important population into two or more populations; and
- Potentially disrupt the breeding cycle of an important population.

The FBA process has been applied to this Project to determine an appropriate offset for residual impacts to this species (i.e. the removal of 846 plant clumps) that cannot be avoided or mitigated.

Leafless Tongue-orchid (*Cryptostylis hunteriana*)

Cryptostylis hunteriana is a small perennial terrestrial orchid that lacks leaves and receives its nourishment from dead organic matter (saprophytic) in partnership with a mycorrhizal fungus (Brown 2007; Jones 2006).

The distribution of the Leafless Tongue-orchid extends from Orbost in East Gippsland in Victoria through coastal NSW and up in to the Tin Can Bay area of southern Queensland (Backhouse & Jeanes 1995; Brown 2007; Jones 2006).In NSW, the Leafless Tongue-orchid occurs between Batemans Bay and Nowra with additional records in Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, Ben Boyd National Park (DECC 2005), the Catherine Hill Bay area, Dolphin Point and Bulahdelah (Brown 2007).

Cryptostylis hunteriana has been reported to occur in a wide variety of habitats including heathlands, heathy woodlands, sedgelands, Xanthorrhoea plains, dry sclerophyll forests, forested wetlands, freshwater wetlands, grasslands, grassy woodlands, rainforests and wet sclerophyll forests (grassy sub-formation) (Backhouse & Jeanes 1995; Bell 2001; Jones 2006). Soils are generally considered to be moist and sandy, however, this species is also known to grow in dry or peaty soils (Backhouse & Jeanes 1995; Bell 2001; Brown 2007; Jones 2006; Riley & Banks 2002). Within the Project construction footprint, Smooth-barked Apple – Red Bloodwood open forest and Smooth-barked Apple – Sydney – Peppermint – Turpentine open forest communities are considered potential habitat for *Cryptostylis hunteriana*.

Targeted surveys were undertaken for *Cryptostylis hunteriana* in these vegetation communities during the flowering period (October and November) in 2014 but did not identify any individuals. There is potential habitat for *Cryptostylis hunteriana* to occur at the site.

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Leafless Tongue-orchid (*Cryptostylis hunteriana*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Does *Cryptostylis hunteriana* within the Project construction footprint constitute an important population?

Under the DotE (2013) significant impact guidelines, an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified 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.

The PMST search undertaken identified that *Cryptostylis hunteriana* habitat is present or likely to be present within 10 kilometres of the Project (DotE 2015a). The OEH Wildlife Atlas identified the closest record as 15 kilometres from the Project near Awaba (OEH 2015a). Parsons Brinckerhoff (2015) determined that there was a moderate likelihood of the species occurring within the Project construction footprint due to the presence of potential habitat.

Cryptostylis hunteriana has been reported to occur in a wide variety of habitats including heathlands, heathy woodlands, sedgelands, Xanthorrhoea plains, dry sclerophyll forests, forested wetlands, freshwater wetlands, grasslands, grassy woodlands, rainforests and wet sclerophyll forests (grassy sub-formation) (Backhouse & Jeanes 1995; Bell 2001; Jones 2006). Soils are generally considered to be moist and sandy, however, this species is also known to grow in dry or peaty soils (Backhouse & Jeanes 1995; Bell 2001; Brown 2007; Jones 2006; Riley & Banks 2002). Within the Project construction footprint, Smooth-barked Apple – Red Bloodwood open forest and Smooth-barked Apple – Sydney – Peppermint – Turpentine open forest communities are considered potential habitat for *Cryptostylis hunteriana*. Parsons Brinckerhoff (2015) undertook

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Leafless Tongue-orchid (*Cryptostylis hunteriana*) (Vulnerable)
targeted surveys for *Cryptostylis hunteriana* in these vegetation communities during the flowering period (October and November) in 2014 but did not identify any individuals. As there are no previous records of the species within 15 kilometres of the Project area (OEH 2015a) and no individuals were identified at the site during surveys, key source populations for breeding or dispersal, and populations necessary for maintaining genetic diversity are therefore not likely to exist within the Project construction footprint. The range of *Cryptostylis hunteriana* extends from Gibraltar Range National Park in the north to Orbost in Victoria in the south (OEH 2015b). If any individuals were to occur within the Project boundary, they would not be considered to be near the limit of the species range. Therefore if *Cryptostylis hunteriana* were to occur within the construction footprint it would not be considered an important population as it would not be important for breeding or dispersal, necessary to maintain genetic diversity of the species, or at the limit of the species range.
Will the Project lead to a long-term decrease in the size of the important population? Although the Project site contains suitable habitat for *Cryptostylis hunteriana a* targeted survey for this species undertaken during the known flowering period did not record any individuals within the Project construction footprint and surrounds. However as *Cryptostylis hunteriana* does not flower every season and it is sometimes difficult to find known populations even when considerable search effort is applied, an assessment of significance has been prepared as a precautionary measure (Bell, 2001) The Project would directly affect the species with the removal of about 18.7 ha of potential habitat for the species. In the unlikely event that this species is present at the site, the Project could indirectly impact on individuals through the introduction of edge effects which could lead to increased weed invasion in adjoining vegetation. The introduction of invasive species may in turn lead to *Cryptostylis hunteriana i*ndividuals being out-competing for resources and consequently a reduction in the size of the population. These impacts are discussed in more detail below. Targeted surveys did not record this species and it has not previously been recorded within 15 km of the site as indicated by the NSW Wildlife Atlas search. As discussed above, even if it does occur, the area would not constitute an important population of *Cryptostylis hunteriana* species and therefore a long-term decrease of any important population of this species is considered unlikely.
Reduce the area of occupancy of an important population
The area does not contain an important population of this species. Within the Project construction footprint, Smooth-barked Apple – Red Bloodwood open forest and Smooth-barked Apple – Sydney – Peppermint – Turpentine open forest communities are considered potential habitat for *Cryptostylis hunteriana.* About 18.7 ha of potential habitat for the species would be removed as a result of the Project. In the unlikely event that individuals were to occur, this could potentially reduce the area of occupation of the species. As discussed above, there is unlikely to be an important population of *Cryptostylis hunteriana* within the Project construction footprint as the potential habitat is not at the limit of the species range and would be unlikely to be critical for the breeding and dispersal of the species. The Project is therefore unlikely to reduce the area of occupancy for an important population.
Fragment an existing important population into two or more populations
The area does not contain an important population of this species. The Project involves constructing a road through an isolated patch of forest, which would result in fragmentation of the forest into three smaller patches of vegetation. The two vegetation types that are potentially suitable habitat for *Cryptostylis hunteriana* (Smooth-barked Apple – Red Bloodwood open forest and Smooth-barked Apple – Sydney – Peppermint – Turpentine open forest) would become further fragmented as a result of the Project.

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Leafless Tongue-orchid (*Cryptostylis hunteriana*) (Vulnerable)
There is no evidence this species (or an important population of this species) occurs within the Project area nor are there any records of this species known from nearby the proposed action, therefore it is considered unlikely to fragment important populations of *Cryptostylis hunteriana.* Furthermore the gap in the canopy created by the Project would not interfere with the movement of pollenating insects or other dispersal mechanisms for this species. Therefore the fragmentation an existing important population into two or more populations is unlikely.
Adversely affect habitat critical to the survival of the species
There is no critical habitat listed for *Cryptostylis hunteriana* by the NSW Office of Environment and Heritage (OEH 2015b). According to the DotE (2013), habitat critical to the survival of a species refer to areas that are necessary: • For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species eg. pollinators) • To maintain genetic diversity and long-term evolutionary development, or • For the reintroduction of populations of recovery of the species or ecological community. As discussed above, there is unlikely to be a population of *Cryptostylis hunteriana* within the Project construction footprint. Consequently, the impacts associated with the Project are considered unlikely to adversely affect any of the criteria relating to habitat critical to the survival of a species.
Disrupt the breeding cycle of an important population
As discussed above, there is unlikely to be an important population of *Cryptostylis hunteriana* within the construction footprint. *Cryptostylis hunteriana* pollination uses pseudocopulation by the male Ichneumon Wasp (*Lissopimpla excelsa*) (Brown 2007; Riley & Banks 2002). Leafless Tongue-orchid seed is spread either by wind transportation or by seeds being dropped once the flower head has fallen over (Brown 2007; Clements 2008 pers. comm.). In the unlikely event that individuals were present at the site, these processes would not be affected. Therefore, it is unlikely that the Project would disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The Project would not directly impact any known *Cryptostylis hunteriana* individuals. The Project would impact about 18.7 ha of Smooth-barked Apple – Red Bloodwood open forest and Smooth-barked Apple – Sydney – Peppermint – Turpentine open forest which is considered potential habitat for *Cryptostylis hunteriana* within the Project construction footprint. The construction of the bypass would fragment one large isolated patch of forest into three smaller patches of forest. However, as no individuals were observed, and large amounts of forest would remain surrounding the Project construction footprint (about 298.1 ha) which would contain potential habitat for the species it is considered unlikely that the availability or quality of habitat would be reduced to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Weed invasion by *Chrysanthemoides monilifera* (Bitou Bush) is a known threat to the survival of *Cryptostylis hunteriana* in the Southern Rivers Catchment Management Authority (DotE 2015b). This species was recorded within the Project construction footprint and surrounds (Parsons Brinckerhoff 2015); however it is not a known threat to the species within the Hunter region.

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Leafless Tongue-orchid (*Cryptostylis hunteriana*) (Vulnerable)

The Project may affect the composition of the habitat by opening up areas for weed invasion and by transmitting weed propagules into the area during construction

A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project. These measures will seek to limit the potential for introduction and/or spread of invasive weed species to areas outside of the construction footprint which may potentially provide habitat for *Cryptostylis hunteriana*. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the construction footprint.

Introduce disease that may cause the species to decline

There are no known diseases which could affect the survival of *Cryptostylis hunteriana*.

The plant pathogen, Phythophthora (*Phythophthora cinnamomi*) could indirectly impact the species from habitat degradation associated with this pathogen. Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation (which could introduce the pathogen via contaminated soil/water on machinery and shoes etc) unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats.

In order to minimise the potential for the introduction or spread of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the construction footprint.

With the adoption of appropriate mitigation measures as outlined above, the Project is unlikely to introduce disease that may cause this species, as a whole, to decline.

Interfere substantially with the recovery of the species

No recovery plan has been developed for *Cryptostylis hunteriana*. The DotE (2015b) lists the following as threats to the survival of the species:

- Development
- Weeds – Bitou Bush
- Changes in soil moisture
- Fire

OEH (2015b) lists the following threats for the species:

- Development pressure on sites where it occurs.
- Some populations are threatened by road works.
- Walkers on trail trampling adult plants; causes plant mortality.
- National Parks burning resulting in unplanned, high intensity fires within the species' habitat.
- Fire spreading from local RFS hazard-reduction burns potentially causing plant mortality.
- Weed invasion following disturbance (e.g. by roadworks) of perennial grasses and other herbaceous weeds which compete for space and resources.

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Leafless Tongue-orchid (*Cryptostylis hunteriana*) (Vulnerable)
In the unlikely event that the species occurrs at the site, the Project would contribute to development pressure on the species and potentially introduce weed species into the site through edge effects. The impacts of invasive species have been discussed above. A number of mitigation measures would be adopted as outlined in the EIS and an EMP to address the potential environmental impacts of the Project and minimise where possible.
Conclusion of Assessment of Significance:
About 18.7 ha of potential habitat would be removed as a result of the Project. The Project is unlikely to have a significant impact on an important population of *Cryptostylis hunteriana* given that: • There is unlikely to be an important population within the construction footprint as no plants were recorded during targeted surveys and there are no records of the species within 15 kilometres of the construction footprint (OEH 2015a). • In the unlikely event that *Cryptostylis hunteriana* did occur within the construction footprint, a large amount of forest (298.1 ha) would remain within the patch of forest surrounding the Project construction footprint that would contain potential habitat for the species and would not be impacted by the Project. • A number of mitigation measures would be adopted and outlined in the EIS and an EMP to minimise the potential impacts of the Project on this species, including weed invasion. Furthermore, the FBA process has been applied to this Project to determine an appropriate offset for residual impacts to this species that cannot be avoided or mitigated, i.e removal of 18.7 ha of potential habitat for this species..

Newcastle Double Tail (*Diuris praecox*)

Diuris praecox is a terrestrial orchid with two or three linear leaves. *Diuris praecox* occurs between Ourimbah and Nelson Bay on the New South Wales coast (DECCW 2005) and has also been identified on the Wallarah Peninsula, near Lake Macquarie in NSW (Conacher Travers 2006). *Diruis praecox* inhabits sclerophyll forests, often on hilltops and slopes, which have a grassy to fairly dense understorey (DECCW 2005).

No individuals were identified at the site during surveys. It was determined that there is potential habitat within Smooth-barked Apple and Spotted Gum forests within the Project construction footprint.

EPBC Act - Assessment of Significance

Newcastle Double Tail (*Diuris praecox*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Does *Diuris praecox* within the Project construction footprint constitute an important population?

Under the DotE (2013) significant impact guidelines, an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified 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.

The PMST search undertaken identified that *Diuris praecox* habitat is present or likely to be present within 10 kilometres of the Project (DotE 2015a). The OEH Wildlife Atlas identified one record four kilometres from the Project at Glenrock Reserve, and seven further records within 10 kilometres of the Project (OEH 2015a). Parsons Brinckerhoff (2015) determined that there was a moderate likelihood of the species occurring within the Project construction footprint due to the presence of potential habitat.

Diuris praecox occurs between Ourimbah and Nelson Bay on the New South Wales coast (DECCW 2005) and has also been identified on the Wallarah Peninsula, near Lake Macquarie in NSW (Conacher Travers 2006). *Diruis praecox* inhabits sclerophyll forests, often on hilltops and slopes, which have a grassy to fairly dense understorey (DECCW 2005). Parsons Brinckerhoff (2015) undertook targeted surveys for *Diuris praecox* across the Project construction footprint in 2014 during the flowering period for this species (August) but did not identify any individuals.

As the closest record of the species is four kilometres from the Project area (OEH 2015) and no individuals were identified at the site during surveys, key source populations for breeding or dispersal, and populations necessary for maintaining genetic diversity are therefore not likely to exist within the Project construction footprint.

Diuris praecox has a restricted range between Ourimbah and Nelson Bay. The Project construction footprint is in the middle of the species range. If any individuals were to occur within the Project footprint, they would not be considered to be near the limit of the species range.

Therefore if *Diuris praecox* were to occur within the construction footprint it would not be considered an important population as it would not be important for breeding or dispersal, necessary to maintain genetic diversity of the species, or at the limit of the species range.

Will the Project lead to a long-term decrease in the size of the important population?

Although the Project construction footprint contains suitable habitat for *Diuris praecox a* targeted survey for this species undertaken during the known flowering period did not record any individuals within the Project construction footprint and surrounds. The Project would directly impact the species with the removal of 34.7 ha of potential habitat for the species.

EPBC Act - Assessment of Significance
Newcastle Double Tail (*Diuris praecox*) (Vulnerable)
In the unlikely event that this species is present at the site the Project could indirectly impact the population through the introduction of edge effects which could lead to increased weed invasion in adjoining vegetation. The introduction of invasive species may in turn lead to *Diuris praecox* individuals being out-competed for resources and consequently a reduction in the size of the population. These impacts are discussed in more detail below. As discussed above, targeted surveys did not record this species and it has not previously been recorded within four kilometres of the site as indicated by the NSW Wildlife Atlas search it is considered a low probability that an important population of *Diuris praecox* species would exist within the site and therefore a long-term decrease of any important population of this species is considered unlikely.
Reduce the area of occupancy of an important population
Within the Project construction footprint, Smooth-barked Apple forests and Spotted gum forest communities are considered potential habitat for *Diuris praecox.* About 34.7 ha of potential habitat for the species would be removed as a result of the proposal. In the unlikely event that a population was to occur, this could potentially reduce the area of occupation of the species. As discussed above, there is unlikely to be an important population of *Diuris praecox* within the Project construction footprint as the potential habitat is not at the limit of the species range and would be unlikely to be critical for the breeding and dispersal of the species. The Project is therefore unlikely to reduce the area of occupancy for an important population.
Fragment an existing important population into two or more populations
The Project involves constructing a road through an isolated patch of forest, which would result in fragmentation of the forest into three smaller patches. The vegetation types that are potentially suitable habitat for *Diuris praecox* (Smooth-barked Apple forests and Spotted Gum forests) would become further fragmented as a result of the Project. There is no evidence this species (or an important population of this species) occurs within the proposal area nor are there any records of this species known from nearby the proposed action. Furthermore the gap in the canopy created by the Project would not interfere with the movement of pollenating insects or other dispersal mechanisms for this species. Therefore the fragmentation an existing important population into two or more populations is unlikely.
Adversely affect habitat critical to the survival of the species
There is no critical habitat listed for this species by the NSW Office of Environment and Heritage (OEH 2015). According to the DotE (2013), habitat critical to the survival of a species refer to areas that are necessary: • For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species e.g. pollinators) • To maintain genetic diversity and long-term evolutionary development, or • For the reintroduction of populations forrecovery of the species or ecological community. As discussed above, there is unlikely to be a population of *Diuris praecox* within the i construction footprint. Consequently, the impacts associated with the Project are considered unlikely to adversely affect any of the criteria relating to habitat critical to the survival of a species.
Disrupt the breeding cycle of an important population
As discussed above, there is unlikely to be an important population of *Diuris praecox* within the Project construction footprint. The pollination and seed dispersal processes undertaken by *Diuris*

EPBC Act - Assessment of Significance
Newcastle Double Tail (*Diuris praecox*) (Vulnerable)
praecox are not well documented. In the unlikely event that individuals were present at the site, these processes are unlikely to be affected as the proposal would not interfere with the movement of pollenating insects or other dispersal mechanisms for this species. Therefore, it is unlikely that the Project would disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The Project would not directly impact any known *Diuris praecox* individuals. The Project would result in the removal of about 34.7 ha of Smooth-barked Apple forests and Spotted Gum forests which are considered potential habitat for *Diuris praecox* within the Project construction footprint. The construction of the bypass would fragment one large isolated patch of forest into three smaller patches of forest. However, as no individuals were observed and about 298.1 ha of potential habitat would remain surrounding the Project construction footprint, it is considered unlikely that the availability or quality of habitat would be reduced to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
The proposal may affect the composition of the habitat by opening up areas for weed invasion and by transmitting weed propagules into the area during construction A number of mitigation measures will be adopted as outlined in the EIS and CEMP for the Project. These measures will seek to limit the potential for introduction and/or spread of invasive weed species to areas outside of the Project construction footprint which may potentially provide habitat for *Diuris praecox*. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the Project construction footprint.
Introduce disease that may cause the species to decline
There are no known diseases which could affect the survival of *Diuris praecox*. The plant pathogen, Phythophthora (*Phythophthora cinnamomi*) could indirectly impact the species from habitat degradation associated with this pathogen. Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation (which could introduce the pathogen via contaminated soil/water on machinery and shoes etc) unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats. In order to minimise the potential for the introduction or spread of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint. With the adoption of appropriate mitigation measures as outlined above, the Project is unlikely to introduce disease that may cause this species, as a whole, to decline.

EPBC Act - Assessment of Significance
Newcastle Double Tail (*Diuris praecox*) (Vulnerable)
Interfere substantially with the recovery of the species
No recovery plan has been developed for *Diuris praecox*. The DotE (2015b) states that the species is threatened by loss and fragmentation of habitat; especially through clearing for urban development, weed invasion, uncontrolled track expansion and impacts from recreational use within its habitat (DECCW 2005). In the unlikely event that the species occurred at the site, the Project would contribute to clearing for development and potentially introduce weed species into the site through edge effects. The impacts of invasive species have been discussed above. The Project is not likely to contribute to uncontrolled track expansion and impacts from recreational use within its habitat. A number of mitigation measures would be adopted and outlined in the EIS and an EMP to ameliorate any potential impacts.
Conclusion of Assessment of Significance:
About 34.7 ha of potential habitat would be cleared as a result of the Project. The Project is unlikely to have a significant impact on an important population of *Diuris praecox* given that: • There is unlikely to be an important population within the construction footprint as no plants were recorded during targeted surveys and there are no records of the species within four kilometres of the indicative Project boundary (OEH 2015a). • In the unlikely event that *Diuris praecox* did occur within the Project construction footprint, 298.1 ha of forest would remain surrounding the Project construction footprint which would contain potential habitat for the species. • A number of mitigation measures would be adopted and outlined in the EIS and an EMP to minimise the potential impacts of the Project on this species, including weed invasion. Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 34.7 ha of potential habitat for this species) that cannot be avoided or mitigated.

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

The *Grevillea parviflora* subsp*. parviflora* occurs on ridge crests, upper slopes or flat plains in both low-lying areas between 30–65 m above sea level (particularly in the Lower Hunter Valley and Lake Macquarie) and on higher topography between 200–300 m above sea level south of Sydney (NPWS 2002). Annual rainfall across the subspecies' range is between 800–1000 mm (Benson & McDougall 2000).

Grevillea parviflora subsp*. parviflora* is sporadically distributed throughout the Sydney Basin. There are at least 21 known populations, of which, three are thought to be extinct and several need to be confirmed (NPWS 2002).

A total of 109 individuals were recorded within the Project construction footprint and surrounds within Smooth-barked Apple – Red Bloodwood open forest.

EPBC Act - Assessment of Significance

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

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Do the *Grevillea parviflora* subsp*. parviflora* plants identified within the Project construction footprint constitute an important population?

Under the DotE (2013) significant impact 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.

A total of 109 individuals of *Grevillea parviflora* subsp. *parviflora* were recorded within the Project construction footprint and surrounds during targeted surveys (Parsons Brinckerhoff 2014). These are located 20 – 100 metres to the western side of the alignment and occur as two distinct sub-populations about 80 metres apart from each other. The species occurred in areas immediately adjacent to walking tracks and within remnant Smooth-barked Apple – Red Bloodwood open forests within the Project construction footprint and surrounds (Parsons Brinckerhoff 2015).

Grevillea parviflora subsp*. parviflora* is sporadically distributed throughout the Sydney Basin. There are at least 21 known populations, of which, three are thought to be extinct and several need to be confirmed (NPWS 2002). The population identified in the Project construction footprint and surrounds is not included in the list of 21 known populations.

Populations with less than 20 plants are considered small, 50 – 100 plants are considered medium size with large populations containing greater than 200 plants (DotE 2015b). Sites of particular significance for *Grevillea parviflora* subsp. *parviflora* would include any population with greater than 50 plants; a population with a varied age structure including active recruitment of seedlings; and an area of intact habitat away from high disturbance areas (NPWS 2002). Though the age structure and recruitment was not recorded during surveys, 109 individuals could be considered a significant population and therefore could be considered a key source population for breeding or dispersal, and necessary to maintain genetic diversity of the species.

Although *Grevillea parviflora* subsp*. parviflora* has a small distribution, is sporadically distributed throughout the Sydney Basin, the northern limit of the species is at Heddon Greta in the Lower Hunter Valley. The southern and western limit is Bargo and the eastern limit is Awaba. The population identified within the Project construction footprint and surrounds is not considered to be near the limit of the species range.

EPBC Act - Assessment of Significance
Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*) (Vulnerable)
The population is considered an important population as it may be important for breeding or dispersal and necessary to maintain genetic diversity of the species.
Will the Project lead to a long-term decrease in the size of the important population? The Project would not directly impact any known *Grevillea parviflora* subsp. *parviflora* individuals. The construction footprint is located at least 20 - 100 metres from known individuals of *Grevillea parviflora* subsp. *parviflora*. Although not relevant to the locality, the interim Lake Macquarie *Grevillea parviflora* subsp. *parviflora* Planning and Management Guidelines recommend that a minimum buffer area of 20 metres around populations is considered reasonable to reduce adverse impacts from adjoining development or land use (Lake Macquarie City Council 2013). The Project could indirectly impact *Grevillea parviflora* subsp*. parviflora* through ground disturbance and the introduction and /or spread of exotic species. These potential indirect impacts are unlikely to result in a long-term decrease in the population as mitigation measures will be adopted and outlined in the EIS and CEMP for the Project to limit the potential for introduction or spread of invasive weed species into known or potential habitat for *Grevillea parviflora* subsp. *parviflora*. Furthermore, *Grevillea parviflora* subsp. *parviflora* is known to like low levels of disturbance and within the Project construction footprint and surrounds it was found growing alongside disturbed tracks. There is the potential that the Project could introduce localised disturbances which could provide opportunities for the species to colonise new habitats.
Reduce the area of occupancy of an important population
The Project would not directly impact any known *Grevillea parviflora* subsp. *parviflora* individuals. The construction footprint is located at least 20 - 100 metres from two known sub-populations of *Grevillea parviflora* subsp. *parviflora*. The interim Lake Macquarie *Grevillea parviflora* subsp*. parviflora* Planning and Management Guidelines recommend that a minimum buffer area of 20 metres around populations is considered reasonable to reduce adverse impacts from adjoining development or land use (Lake Macquarie City Council 2013). The Project would impact about 16.8 ha of Smooth-barked Apple – Red Bloodwood open forest which is considered potential habitat for *Grevillea parviflora* subsp. *parviflora* within the Project construction footprint. The construction of the bypass would not reduce the current area of occupancy of the population (as no known individuals would be removed) but could limit the potential for the species to colonise into new areas of forest to the east of the Project footprint in the future. However, due to limited natural seed dispersal abilities (probably <-2 m, NPWS 2002) and the specific habitat requirements, the potential for the species to colonise new areas is already limited. As no individuals would be impacted as a result of the Project and about 298.1 ha of forest would remain in the surrounds which would contain potential habitat for the species, it is considered unlikely that the Project would reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations
The Project would not directly impact any known *Grevillea parviflora* subsp. *parviflora* individuals. There are two sub-populations located about 80 metres apart on the western side of the alignment between 20 to 100 metres west of the Project construction footprint. The interim Lake Macquarie *Grevillea parviflora* subsp. *parviflora* Planning and Management Guidelines recommend that a minimum buffer area of 20 metres around populations is considered reasonable to reduce adverse impacts from adjoining development or land use (Lake Macquarie City Council 2013). The Project would impact about 16.8 ha of Smooth-barked Apple – Red Bloodwood open forest which is potential habitat for *Grevillea parviflora* subsp. *parviflora*. The construction of the bypass fragments one large isolated patch of forest into three smaller patches, which has the potential to fragment sub-populations of species. However, the Project would not fragment the two known sub-

populations (as they are both on the western side of the alignment) and there are no other known sub-populations that have been recorded within the Project construction footprint and surrounds despite targeted surveys. Therefore it is considered unlikely that the Project would result in the fragmentation of an important population.

Adversely affect habitat critical to the survival of the species

No critical habitat has been listed for this species on the Register of Critical Habitat.

According to the DotE (2013), habitat critical to the survival of a species refer to areas that are necessary:

- For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species eg. pollinators);
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations of recovery of the species or ecological community.

No known individuals would be impacted as a result of the Project, and the construction footprint is at least 20 metres from known individuals. Consequently, the impacts associated with the Project are considered unlikely to adversely affect habitat that is critical to the survival of this species.

Disrupt the breeding cycle of an important population

The flowers of *Grevillia parviflora* subsp. *parviflora* are insect pollinated and one to two seeds are produced (Benson & McDougall 2000). However, the ability of the species to disperse seed is limited to areas of less than two metres (NPWS 2002). More commonly the species suckers readily from rhizomes, particularly after disturbances like fire (DotE 2015). The Project would not remove and known *Grevillea parviflora* subsp. *parviflora* plants as the Project would be located at minimum 20 metres to the east of the known population. The Project would not interfere with the movement of pollenating insects or other dispersal mechanisms for this species. It is therefore unlikely that the Project would disrupt the breeding cycle of 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

The Project would not directly impact any known *Grevillea parviflora* subsp*. parviflora* individuals. All records of the species within the study are between 20 to 100 metres west of the Project construction footprint. The interim Lake Macquarie *Grevillea parviflora* subsp. *parviflora* Planning and Management Guidelines recommend that a minimum buffer area of 20 metres around populations is considered reasonable to reduce adverse impacts from adjoining development or land use (Lake Macquarie City Council 2013). There are two sub-populations located about 80 metres apart on the western side of the alignment.

The Project would impact about 16.8 ha of Smooth-barked Apple – Red Bloodwood open forest which is potential habitat for *Grevillea parviflora* subsp*. parviflora*. The construction of the bypass would fragment one large isolated patch of forest into three smaller patches of forest and would decrease the availability of habitat within the Project construction footprint. However the species is known to like low levels of disturbance so there is potential that the species could colonise new habitats that might be created as a result of the Project. About 298.1 ha of forest would remain which would contain potential habitat for the species. Therefore it is considered unlikely that the availability or quality of habitat would be reduced to the extent that the species is likely to decline.

EPBC Act - Assessment of Significance

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

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Weed invasion is a threat to the survival of *Grevillea parviflora* subsp. *parviflora* as weeds can compete with resources such as light and water. *Imperata cylindrica* (Blady Grass) is a weedy species present at the site (Parsons Brinckerhoff 2015) which is known to reduce the available habitat for the species (NPWS 2002).

A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project to limit the potential for introduction and/or spread of invasive weed species to areas outside of the Project construction footprint which may potentially provide habitat for *Grevillea parviflora* subsp. *parviflora*. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species becoming established.

Introduce disease that may cause the species to decline

There are no known diseases which could affect the survival of *Grevillea parviflora* subsp. *parviflora*.

The plant pathogen Phytophthora (*Phythophthora cinnamomi*) could indirectly impact the species from habitat degradation associated with this pathogen. Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation (which could introduce the pathogen via contaminated soil/water on machinery and shoes etc) unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats.

In order to minimise the potential for the introduction or spread of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint.

With the adoption of appropriate mitigation measures as outlined above, the Project is unlikely to introduce disease that may cause this species, as a whole, to decline.

Interfere substantially with the recovery of the species

No recovery plan has been developed for *Grevillea parviflora* subsp. *parviflora*. The DotE (2015) lists the following as threats to the survival of the species:

- Habitat loss, fragmentation and disturbance
- Invasive weeds
- Recruitment and disturbance frequency

The Project could contribute to habitat loss, fragmentation, disturbance and invasive weeds. These have been discussed above. A number of mitigation measures will be adopted as outlined in the EIS and an EMP to address these issues and minimise the impacts where possible. As no individuals would be removed as a result of the Project, and works would occur at least 20 metres from the known population, the Project is unlikely to interfere with the recovery of the species.

Conclusion of Assessment of Significance:

The Project is unlikely to have a significant impact on an important population of *Grevillea parviflora* subsp*. parviflora* given that:

EPBC Act - Assessment of Significance
Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*) (Vulnerable)
• No individuals would be removed as a result of the Project. • Works would occur at least 20 metres from identified plants, which is considered reasonable to reduce adverse impacts from adjoining development or land use (Lake Macquarie City Council 2013). • About 298.1 ha of forest would remain adjacent to the Project construction footprint which would contain potential habitat for the species. • Mitigation measures will be adopted and outlined in the EIS and EMP to minimise the indirect impacts of the Project on *Grevillea parviflora* subsp*. parviflora*. Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 16.8 ha of potential habitat) that cannot be avoided or mitigated.

Heath Wrinklewort *(Rutidosis heterogama)*

Rutidosis heterogama grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (OEH 2015b) from near Cessnock to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes.

There are no previous records of the species within five kilometres of the Project area (OEH 2015a) and no individuals were identified at the site during surveys. There is some potential habitat for the species within Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest – both atypical variant and *Eucalyptus fergusonii* variant.

EPBC Act - Assessment of Significance

Heath Wrinklewort (*Rutidosis heterogama*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Does *Rutidosis heterogama* within the construction footprint constitute an important population?

Under the DotE (2013) significant impact 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.

The PMST search undertaken identified that *Rutidosis heterogama* habitat is present or likely to be present within 10 kilometres of the Project (DotE 2015a) and the OEH Wildlife Atlas search identified records five kilometres from the site at Glenrock State Conservation Area (OEH 2015a). Parsons Brinckerhoff (2015) has determined that there was a moderate likelihood of the species occurring within the Project construction footprint due to the presence of potential habitat.

Rutidosis heterogama grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (OEH 2015b). Within the Project construction footprint the species could occur in Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest – both atypical variant and *Eucalyptus fergusonii* variant. Targeted surveys across the Project construction footprint and surrounds were undertaken for the species during September and October 2014, which is its known flowering period.

As there are no previous records of the species within five kilometres of the Project area (OEH 2015a) and no individuals were identified at the site during surveys, key source populations for breeding or dispersal, and populations necessary for maintaining genetic diversity are not likely to exist within the Project construction footprint and surrounds.

Rutidosis heterogama is present in three regions within NSW, one of which is around the Central Coast area of NSW. This patch extends from Karuah, to Gosford in the south, to Murrurundi in the west. There is also another patch inland from the Central Coast. If any individuals were to occur within the Project boundary, they would not be considered to be near the limit of the species range.

If *Rutidosis heterogama* were to occur within the construction footprint it would not considered an important population as it would not be a population that is important for breeding or dispersal, necessary to maintain genetic diversity of the species, or at the limit of the species range.

EPBC Act - Assessment of Significance
Heath Wrinklewort (*Rutidosis heterogama*) (Vulnerable)
Will the Project lead to a long-term decrease in the size of the important population? As discussed above, there is unlikely to be an important population of *Rutidosis heterogama* within the construction footprint. The Project would not impact any known *Rutidosis heterogama* plants. In the unlikely event that a population was to occur within the construction footprint, the Project would result in the removal of about 16 ha of potential habitat for the species. In addition to the removal of this habitat the Project may result in indirect impacts that may cause the species to decrease in population size. These could include the introduction of edge effects which could lead to increased weed invasion, altered hydrology and or ground disturbance. These impacts are discussed in more detail below. As an important population is not likely to occur at the site, the Project would not lead to a long-term decrease in an important population.
Reduce the area of occupancy of an important population
As discussed above, there is unlikely to be an important population of *Rutidosis heterogama* within the construction footprint. The Project would result in the removal of about 16 ha of potential habitat for the species which could potentially reduce the area of occupation of the species. However, despite targeted surveys for the species during the flower period, it was not identified within the Project construction footprint and surrounds. There is no information available regarding colonisation and seed dispersal for this species. Opportunities for the species to migrate into the Project construction footprint and surrounds would be unlikely, due to the isolated nature of the site. As an important population is not likely to occur at the site, the Project is unlikely to reduce the area of occupancy for an important population.
Fragment an existing important population into two or more populations
As discussed above, there is unlikely to be an important population of *Rutidosis heterogama* within the construction footprint. The Project involves constructing a road through an isolated patch of forest, which would result in fragmentation of the forest into three smaller patches of vegetation. The two vegetation types that are potentially suitable habitat for *Rutidosis heterogama* (Spotted Gum - Broad-leaved Ironbark grassy open forest, Spotted Gum - Grey Ironbark open forest – both atypical variant and *Eucalyptus fergusonii* variants) would become fragmented as a result of the Project. 298.1 ha of forest surrounding the Project construction footprint would remain unaffected by the Project. In the unlikely event that a population was to occur at the site, the removal of potential habitat could result in the fragmentation of a population. However despite targeted surveys, no individuals were identified at the site and therefore the fragmentation an existing important population into two or more populations is not likely to occur.
Adversely affect habitat critical to the survival of the species
There is no critical habitat listed for this species by the NSW Office of Environment and Heritage (OEH 2015b). According to the DotE (2013), habitat critical to the survival of a species refer to areas that are necessary: • For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species eg. pollinators) • To maintain genetic diversity and long-term evolutionary development, or • For the reintroduction of populations of recovery of the species or ecological community. As discussed above, there is unlikely to be a population of *Rutidosis heterogama* within construction footprint. Consequently, the impacts associated with the Project are considered

unlikely to adversely affect any of the features above relating to habitat that is critical to the survival of this species.

Disrupt the breeding cycle of an important population

As discussed above, there is unlikely to be an important population of *Rutidosis heterogama* within the construction footprint. There is no information available regarding colonisation and seed dispersal for this species. Opportunities for the species to migrate into the Project construction footprint and surrounds would be unlikely, due to the isolated nature of the site. As there are unlikely to be any individuals within the construction footprint and the Project would not interfere with the movement of pollenating insects or other dispersal mechanisms for this species it is unlikely that the Project would disrupt the breeding cycle of 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

The Project would not directly impact any known *Rutidosis heterogama* individuals. The Project would impact about 16 ha of Spotted Gum - Broad-leaved Ironbark grassy open forest and Spotted Gum - Grey Ironbark open forest – both atypical variant and *Eucalyptus fergusonii* variants which is considered potential habitat for *Rutidosis heterogama* within the construction footprint. The construction of the bypass would fragment one large isolated patch of forest into three smaller patches of forest, which would fragment the available habitat within the Project construction footprint and surrounds.

About 298.1 ha of forest surrounding the Project construction footprint would remain unaffected by the Project which would contain potential foraging habitat for the species. As no individuals were observed, and large amount alternate potential habitat would remain in the locality, it is considered unlikely the removed of 16 ha of potential habitat would decrease the availability or quality of habitat would be reduced to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Rabbits are an invasive species which are present at the site and known to impact *Rutidosis heterogama.* The Project is not likely to increase the number of feral animals utilising the area. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the construction footprint.

There are no known invasive flora species which specifically impact upon *Rutidosis heterogama.* Weed species (such as Lantana) have the potential to smother *Rutidosis heterogama* and out-compete them for resources. The likelihood of weed invasion could be increased due to edge effects resulting from the Project.

A number of mitigation measures will be adopted and outlined in the EIS and CEMP for the Project. These measures will seek to limit the potential for introduction or spread of exotic species to areas outside of the construction footprint which may potentially provide habitat for *Rutidosis heterogama*. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat outside of the construction footprint.

Introduce disease that may cause the species to decline

There are no known diseases which could affect the survival of *Rutidosis heterogama*. The plant pathogen, Phythophthora (*Phythophthora cinnamomi*) could indirectly impact the species from habitat degradation associated with this pathogen.

Pathogens such as Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation

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Heath Wrinklewort (*Rutidosis heterogama*) (Vulnerable)
disturbance and increased visitation (which could introduce the pathogen via contaminated soil/water on machinery and shoes etc) unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats. In order to minimise the potential for the introduction or spread of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the construction footprint. With the adoption of appropriate mitigation measures as outlined above, the Project is unlikely to introduce disease that may cause this species, as a whole, to decline.
Interfere substantially with the recovery of the species
No recovery plan has been developed for *Rutidosis heterogama*. The DotE (2015b) lists the following as known and perceived threats to the survival of the species: • Grazing pressures and associated habitat changes • Habitat loss and modification due to clearance of native vegetation and pasture improvements • Habitat loss, modification and/or degradation • Loss and/or fragmentation of habitat and/or subpopulations • Human induced disturbance due to unspecified activities • Competition and/or habitat degradation from invasive species, including Rabbits • Predation, competition, habitat degradation and/or spread of pathogens by introduced species • Inappropriate and/or changed fire regimes (frequency, timing, intensity) • Habitat loss, modification and fragmentation due to urban development • Development and/or maintenance of roads The Project would contribute to the loss of potential habitat for this species and has the potential to degrade potential habitat by introducing weed species into the site through edge effects. However the Project is unlikely to substantially interfere with the recovery of the species as there were no individuals identified at the site and mitigation measures would be adopted to minimise any indirect impacts associated with the Project.
Conclusion of Assessment of Significance:
About 16 ha of potential habitat would be removed as a result of the Project. The Project is unlikely to have a significant impact on an important population of *Rutidosis heterogama* given that: • There is unlikely to be an important population within the construction footprint as no plants were recorded during targeted surveys and there are no records of the species within five kilometres of the construction footprint (OEH 2015). • 298.1 ha of forest would remain unaffected by the Project which contains potential habitat that could be utilised by *Rutidosis heterogama.* • A number of mitigation measures would be adopted and outlined in the EIS and an EMP to prevent indirect impacts associated with the Project.

EPBC Act - Assessment of Significance
Heath Wrinklewort (*Rutidosis heterogama*) (Vulnerable)
Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 16 ha of potential habitat) that cannot be avoided or mitigated.

Magenta Lilly Pilly (*Syzygium paniculatum*)

The Magenta Lilly Pilly is a small to medium sized rainforest tree that grows to 8 m tall. The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (OEH 2015b). The extent of occurrence is about 15 000 km² (TSSC 2008) and the area of occupancy is estimated to be about 180–210 km². The total population is estimated to be between 760–2600 mature plants (TSSC 2008).

Eight plants were recorded within the Project construction footprint and surrounds in Sydney Blue Gum - White Mahogany tall open forest, on the banks of an unnamed creek, which is located about 400 metres west of the Project construction footprint (Parsons Brinckerhoff 2014). It is possible that plants observed have colonised as a result of bird dispersal from nearby gardens as the this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (Parsons Brinckerhoff 2015).

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Magenta Lilly Pilly (*Syzygium paniculatum*) (Vulnerable)

According to the DotE (2013) 'significant impact criteria' for vulnerable species, 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

Do the *Syzygium paniculatum* plants identified within the Project construction footprint and surrounds constitute an important population?

Under the DotE (2013) significant impact 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.

There are three records of *Syzygium paniculatum* within 10 kilometres of the Project construction footprint (OEH 2015a). A further eight plants were recorded within the Project construction footprint and surrounds in Sydney Blue Gum - White Mahogany tall open forest, on the banks of an unnamed creek, which is located about 400 metres west of the Project construction footprint (Parsons Brinckerhoff 2015). It is possible that plants observed have colonised as a result of bird dispersal from nearby gardens as the this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (Parsons Brinckerhoff 2015, DotE 2015).

The individuals recorded within the Project construction footprint and surrounds are not considered a key source population for breeding or dispersal or necessary for maintaining genetic diversity as they do not normally grow in this habitat and have most likely colonised from nearby gardens. The species occurs from Booti Booti (near Forster) south to Conjola State Forest (near Jervis Bay). The extent of occurrence is about 15 000 km² (Floyd 1989; Quinn et al. 1995). The individuals found are not near the limit of the species range. Therefore, *Syzygium paniculatum* in the Project construction footprint is not considered an important population.

Will the Project lead to a long-term decrease in the size of the important population?

As discussed above, *Syzygium paniculatum* at the site is not considered an important population.

The Project would not directly impact any known *Syzygium paniculatum* individuals. There is a small possibility for indirect impacts to the species resulting from the Project. The construction of a road construction footprint could result in edge effects, which could lead to increased weed invasion into the forest. However the species is located nearly 400 metres from the Project construction footprint so indirect impacts are considered highly unlikely. Therefore the Project would not lead to a long-term decrease in an important population.

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Magenta Lilly Pilly (*Syzygium paniculatum*) (Vulnerable)
Reduce the area of occupancy of an important population
As discussed above, *Syzygium paniculatum* at the site is not considered an important population. The Project would not directly impact any known *Syzygium paniculatum* individuals. *Syzygium paniculatum* was found growing in Sydney Blue Gum - White Mahogany tall open forest - *Syncarpia glomulifera* variant. The Project would remove about 4.4 ha of this vegetation type, (although no individuals would be removed). About 298.1 ha of forest adjacent to the Project would remain unaffected, which would contain alternative areas of potential habitat. The construction of the bypass would not reduce the current area of occupancy of the population or limit the potential for the species to colonise into other areas as it was located nearly 400 metres from the Project footprint.
Fragment an existing important population into two or more populations
As discussed above, *Syzygium paniculatum* at the site is not considered an important population. The Project would not directly impact any known *Syzygium paniculatum* individuals and all records of the species within the study are 400 metres west of the Project construction footprint. The construction of the bypass would fragment one large isolated patch of forest into three smaller patches of forest, which has the potential to fragment populations of species. A small patch of Sydney Blue Gum - White Mahogany tall open forest - *Syncarpia glomulifera* variant would become isolated as a result of the Project. There are no records of the species within the small patch of potential habitat that would become isolated as a result of the Project. Therefore it is highly unlikely that the Project would result in the fragmentation of a .this species.
Adversely affect habitat critical to the survival of the species
No critical habitat has been listed for this species on the Register of Critical Habitat. As discussed previously, it is possible that plants observed have colonised as a result of bird dispersal from nearby gardens (Parsons Brinckerhoff 2015) as this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas (DotE 2015b). *Syzygium paniculatum* was found growing in Sydney Blue Gum - White Mahogany tall open forest - *Syncarpia glomulifera* variant within the Project construction footprint and surrounds. The Project would remove about 4.4 ha of this vegetation type, (although no individuals would be removed). About 298.1 ha adjacent to the Project construction footprint would remain unaffected and contain of alternative areas of potential habitat. No known individuals would be impacted as a result of the Project, and the construction footprint is about 400 metres from known individuals. Consequently, the impacts associated with the Project are considered highly unlikely to adversely affect habitat that is critical to the survival of this species.
Disrupt the breeding cycle of an important population
As discussed above, *Syzygium paniculatum* at the site is not considered an important population. The Project would not directly impact any known *Syzygium paniculatum* individuals. All records of the species within the study are 400 metres west of the Project construction footprint. Seed is dispersed by birds and native mammals. The Project is unlikely to impact highly mobile, generalist seed dispersal species within the vicinity of the small patch of *Syzygium paniculatum*. Therefore the breeding cycle of the species is highly unlikely to be impacted by the Project.

EPBC Act - Assessment of Significance
Magenta Lilly Pilly (*Syzygium paniculatum*) (Vulnerable)
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The construction of the bypass would fragment one large isolated patch of forest into three smaller patches of forest, which has the potential to fragment populations of species. The Project would remove 4.4 ha of Sydney Blue Gum - White Mahogany tall open forest - *Syncarpia glomulifera* variant and also result in a small patch becoming isolated to the east of the construction footprint. *Syzygium paniculatum* growing in this vegetation type is uncommon, as previously discussed. There are no records of the species within the small patch of potential habitat that would become isolated as a result of the Project and it is located 400 metres from recorded location of the species. Therefore it is considered unlikely that the Project would decrease the availability of the habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Weeds which are known to pose a threat to *Syzygium paniculatum* and are present at the site include Lantana (*Lantana camara*), Bitou Bush (*Chrysanthemoides monilifera subsp Rotaundata*), Small-leaved Privet (*Ligustrum sinense)* and Asparagus Fern (*Asparagus* spp.) (DotE 2015b). Other known invasive species which affect the species include Creeping Lantana (*Lantana montevidensis*) Japanese Honeysuckle (*Lonicera japonica*) and Indian Morning Glory (*Ipomoea indica*). A number of mitigation measures will be adopted as outlined in the EIS and CEMP for the Project. These measures will seek to limit the potential for introduction or spread of invasive weed species to areas outside of the Project construction footprint which are known to (or may potentially) provide habitat for *Syzygium paniculatum*. Consequently, the Project is considered unlikely to result in the establishment of harmful invasive species in areas of potential or known habitat for this species.
Introduce disease that may cause the species to decline
The plant pathogen Phythophthora (*Phythophthora cinnamomi*) could impact *Syzygium paniculatum*. Phytophthora may occur within the Project construction footprint given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell 2003). Consequently, the Project has the potential to spread Phytophthora as a result of vegetation disturbance and increased visitation (which could introduce the pathogen via contaminated soil/water on machinery and shoes etc) unless appropriate mitigation measures are put in place. Where present, Phytophthora can result in the dieback or modification of native vegetation and damage to fauna habitats. In order to minimise the potential for the introduction or spread of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH 2006) would be adopted during the clearing of vegetation and incorporated into the EMP for the Project. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the Project construction footprint. With the adoption of appropriate mitigation measures as outlined above, the Project is unlikely to introduce disease that may cause this species, as a whole, to decline.
Interfere substantially with the recovery of the species
The National Recovery Plan for Magenta Lilly Pilly (*Syzygium paniculatum*) (OEH, 2012) outlines the overall objective as being to protect known subpopulations of Magenta Lilly Pilly from decline and to ensure that wild populations of the species remain viable in the long term.

EPBC Act - Assessment of Significance

Magenta Lilly Pilly (*Syzygium paniculatum*) (Vulnerable)

Specific objectives idnetified by the plan include:

- Coordinate recovery efforts
- Establish full extent of distribution
- Increase understanding of biology and ecology
- Minimise decline through insitu habitat protection and management
- Reduce impacts of Myrtle Rust
- Maintain a representative ex situ collection
- Recruitment and disturbance frequency
- To raise awareness of the conservation significance of Magenta Lilly Pilly and involve the broader community in the recovery program

The PProject would incrementally add to the removal of habitat for this species as a result of the removal of 4.4ha of potential habitat which is in conflict with one recovery action. As no individuals would be removed as a result of the PProject, the works would occur at 400 metres from the species and the species does not normally grow in this habitat type, the Project is unlikely to interfere with the recovery of the species.

Conclusion of Assessment of Significance:

The Project is unlikely to have a significant impact on an important population of *Syzygium paniculatum* given that:

- The recorded individuals within the Project construction footprint are not an important population and no individuals would be removed as a result of the Project.
- Works would occur 400 metres from identified plants.
- Only a small amount (4.4 ha) of potential habitat would be removed as a result of the Project and about 298.1 ha of forest adjacent to the Project construction footprint would remain unaffected by the Project.
- Mitigation measures will be adopted and outlined in the EIS and an EMP to minimise impacts on threatened species.

Furthermore, the NSW Framework for Biodiversity Assessment (FBA) process has been applied to this Project to appropriately offset residual impacts to this species (i.e. the removal of 4.4 ha of potential habitat) that cannot be avoided or mitigated.

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