Transport for NSW

Ecological Assessment for proposed substation at Lindfield

22 July 2014

PARSONS BRINCKERHOFF

Document information

Client: Transport for NSW

Title: Ecological Assessment for proposed substation at Lindfield

Document No: 2176502A-ECO-RPT-001

Date: 22 July 2014

Rev	Date	Details
	18/12/2013	First Draft
A	16/04/2014	Second Draft
B	09/07/2014	Amendments of draft for survey of additional proposed works
C	22/07/2014	Amendments following TfNSW review

Author, Reviewer and Approver details

Prepared by:	Tanya Bangel	Date: 22/07/2014	Signature:
Reviewed by:	Alex Cockerill	Date: 22/07/2014	Signature:
Approved by:	Paul Greenhalgh	Date: 22/07/2014	Signature:

Distribution

Transport for NSW, Parsons Brinckerhoff file, Parsons Brinckerhoff Library

Document owner

Parsons Brinckerhoff Australia Pty Limited

ABN 80 078 004 798

Level 27 Ernst & Young Centre
680 George Street, Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001
Australia
Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
Email: sydney@pb.com.au
www.pbworld.com

Certified to ISO 9001, ISO 14001, AS/NZS 4801
A GRI Rating: Sustainability Report 2011

Contents

Contents (Continued)

Page number

List of tables

List of figures

List of appendices

Executive summary

In future, Sydney Trains intends to increase trains on the North Shore Line. A new traction power substation is required to allow for an increase in the capacity along the North Shore Line for additional train services to be run and will support the delivery of the North West Rail Link. Therefore, a new substation is proposed to be constructed at Lindfield to supply the North Shore Line. The proposal also includes ancillary electrical works generally between Killara Station and the Clanville Road overbridge in Lindfield.

The proposed substation will be located on Lindfield Avenue at the intersection with Strickland Avenue in Lindfield, approximately 300 metres to the south of Lindfield Station. The site is within the existing rail corridor between the North Shore Line up-track (i.e. travelling towards Sydney central business district (CBD)) and Lindfield Avenue. In addition, the works comprise ancillary electrical works, including the installation of aerial earth wires to existing power poles generally between Killara Station and Russell Avenue, Lindfield and the realignment of existing overhead wiring generally between Russell Avenue and the Clanville Road overbridge.

This biodiversity assessment describes the type and condition of vegetation and associated fauna habitat within an area proposed to be cleared for the construction of the proposed substation in Lindfield and associated electrical works. The assessment outlines the site's ecological values including habitat for species, populations and ecological communities listed under the (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The study area included the main works site (where the substation will be constructed) which is located on Lindfield Avenue at the intersection with Strickland Avenue in Lindfield, approximately 300 metres to the south of Lindfield Station (within the existing rail corridor between the North Shore Line up-track (i.e. travelling towards Sydney central business district (CBD)) and Lindfield Avenue). In addition, the study area also included a narrow section within the rail corridor that contains existing power poles generally between Russell Avenue and Killara Station.

Vegetation of ecological significance recorded in the study area included the Blue Gum High Forest threatened ecological community (0.36 ha) listed as Critically Endangered under the TSC Act and Sydney Turpentine Ironbark Forest threatened ecological community (0.58 ha) listed as Endangered under the TSC Act. Both communities within the study area were highly modified as a result of previous land clearing and invasion of weed species. As a result of their low condition these communities did not meet the Commonwealth condition criteria for the Critically Endangered Blue Gum High Forest of the Sydney Basin Bioregion or the Sydney Turpentine Ironbark Forest of the Sydney Basin as listed under the EPBC Act. Therefore, it is considered unlikely that the proposal will significantly impact on any threatened ecological communities.

The study area contained some native plant species however was dominated in most areas by a variety of introduced species, the most dominant of which included Privet species (*Ligustrum* spp*), Camphor Laurel (*Cinnamomum camphora**), Asparagus Fern (*Asparagus aethiopicus**), Wandering Jew (*Tradescantia albiflora**), Balloon Vine (*Cardiospermum grandiflorum**), Blue Morning Glory (*Ipomea indica**) and Chilean Needle Grass (*Nassella neesiana**).

No threatened species or populations of plant were recorded during vegetation surveys of the study area. No threatened species were recorded within the study area during the field survey however one Grey-headed Flying-fox individual (listed under the TSC Act and EPBC Act) was recorded within close proximity and is likely to utilise habitat within the study area. The field surveys for fauna were limited to opportunistic recordings of birds, reptiles and habitat assessment.

Vegetation within the study area was of low conservation importance as it provided potential habitat only for species that are adapted to disturbed urban landscapes such as bats and birds. This habitat does provide marginal foraging habitat for a number of threatened animal species such as Powerful Owl and a variety of bats.

The vegetation within the study area adjoins the rail corridor and local arterial roads which heavily fragment the vegetation. As a result, the vegetation within the study area is isolated and only connects to planted street trees. Although there are only small patches of vegetation within the study area it plays a minor role in maintaining local connectivity between larger remaining patches of habitat in the broader locality. These linkages may be used by highly mobile species (such as bats and birds).

Based on the presence of suitable habitat within the study area, five species of animal (Grey-headed Flying-fox, Eastern Free-tail Bat, Eastern Bent-wing Bat, Yellow-bellied Sheath-tail Bat, Powerful Owl and Little Lorikeet) are considered to have a moderate or greater likelihood of occurrence. These species are listed as threatened under the TSC Act and EPBC Act and therefore a significance assessment under the TSC Act and EPBC Act was undertaken (refer Appendix E in Technical Paper 4). Based on the assumption that the 'Additional aerial earth (overhead) wires only' section of the proposed will require the removal of vegetation to the north of Lindfield Station, construction of the proposal at Lindfield will require the removal of up to 2.31 hectares of potential foraging habitat (which includes the 0.94 ha of native vegetation and 1.37 ha of exotic vegetation recorded on site) for these species. In the likelihood that power poles are not replaced as part of the proposal, the area of vegetation required to be removed will be reduced. Based on the small area of degraded habitat to be impacted, these species are considered unlikely to be significantly affected by the proposal. Overall, the potential impact from the proposal on the species is not considered significant with regard to its context and intensity.

No other matters of national environmental significance are likely to be impacted by the proposal. An EPBC Act referral is not, therefore, considered to be required for the proposal.

As outlined in the TfNSW *'Vegetation Offset Guide'* (Transport for NSW 2014) a project requires offsets where there are residual impacts associated with vegetation clearing, and the impact of the proposed clearing is not deemed 'significant' for the purposes of section 111 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The vegetation clearing for the proposal would require native vegetation clearing (up to approximately 0.94 ha) that has been assessed as not 'significant'. Therefore, biodiversity offsets in accordance with the TfNSW '*Vegetation Offset Guide'* will be required if the native vegetation is removed.

1. Introduction

1.1 Background

This report provides an assessment of the potential ecological impacts associated with the proposed construction of the proposed substation at Lindfield and associated electoral works (the proposal) (Figure 1.1). The proposal includes excavation of the existing soil and vegetation clearing to allow for the construction of the proposed substation, high voltage realignment, building works, installation of aerial earth wires to existing power poles and relocation of street lights, signalling, traction power and cables.

This report examines flora and fauna assemblages and their habitats within the site and identifies the ecological impacts associated with the construction and operation of the proposed activity. It summarises the proposed mitigation measures and provides assessments of significance required under the (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act), (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2 The proposal

In future, Sydney Trains intends to increase trains on the North Shore Line. A new traction power substation is required to allow for an increase in the capacity along the North Shore Line for additional train services to be run and to support the delivery of the North West Rail Link. Therefore, a new substation is proposed to be constructed at Lindfield to supply the North Shore Line. The proposal also includes ancillary electrical works generally between Killara Station and the Clanville Road overbridge in Lindfield.

The proposed substation will be located on Lindfield Avenue at the intersection with Strickland Avenue in Lindfield, approximately 300 metres to the south of Lindfield Station. The site is within the existing rail corridor between the North Shore Line up-track (i.e. travelling towards Sydney central business district (CBD)) and Lindfield Avenue. In addition, the works comprise ancillary electrical works, including the installation of aerial earth wires to existing power poles generally between Killara Station and Russell Avenue, Lindfield and the realignment of existing overhead wiring generally between Russell Avenue and the Clanville Road overbridge.

The key features of the proposal are:

- construction and operation of a new traction power substation at Lindfield in order to continue to power the Sydney Trains network (in particular the North Shore Line). Components of the substation would generally include:
  - construction of two new rectifier transformers
  - installation of switchgear room containing switchgear and switchboards, batteries and changers, voice and data communications equipment
  - installation of the rectifier and reactor unit(s)
  - office and associated facilities
  - earthworks and construction of a retaining wall on the western side of the substation site, adjacent to the rail line

- construction of a new driveway access to the substation site from Lindfield Avenue and a paved surface area to provide car parking for approximately four vehicles within the proposed substation compound
- security and permanent maintenance lighting within and external to the building
- landscaping and vegetation surrounding the proposed substation building, generally to the east and south of the site
- realignment of the existing 33 kilovolt (kV) and 11 kV overhead wiring (OHW), to a new combined services route (CSR), generally between power pole P57 (to the south of Lindfield Station near the intersection with Russell Avenue, Lindfield and power pole P49 (to the north of the Clanville Road overbridge)
- relocation and installation of signalling cable and communication cable to the substation to connect with existing cables along the North Shore Line
- installation of feeder and return cabling to the OHW system on the North Shore Line
- relocation of street lighting and power routes to provide access to the substation for construction and maintenance (including future replacement of substation equipment)
- installation of an aerial earth wire to the top of the existing (Sydney Trains) power poles, generally between Killara Station and Russell Avenue, Lindfield.

Minor enabling works are expected to be undertaken in late 2014. Service relocation will commence in mid-2015 with construction of the substation expected to commence in early 2016 (subject to Transport for NSW's determination of the Review of Environmental Factors) with testing and commissioning anticipated in August 2017. The substation site is expected to be handed over to Sydney Trains in late 2017.

1.3 Study area

The study area (Figure 1.1) investigated for potential biodiversity values associated with the proposed area of works that include:

- Main works sites:
  - Substation construction site – study area included the rail way corridor located on Lindfield Avenue at the intersection with Strickland Avenue in Lindfield, approximately 300 metres to the South of Lindfield Station.
  - Relocation of HV cables to ground level – study area included the rail corridor generally between power pole 57 (to the south of Lindfield Station) and power pole 49 (to the north of the Clanville Road overbridge).
- Additional aerial earth (overhead) wires only area - study area included an eight metre wide section between Russell Avenue, Lindfield and Killara Station along Strickland Avenue. This section included the road, footpath and an additional 3 metres from the footpath that contained the power poles.

Location information for the study area is outlined in Table 1.1.

Table 1.1 Study area location

Location information	Study area
Bioregion	Sydney Basin bioregion
Botanical subregion	Central Coast
Local government area	Ku-ring-gai Council
Catchment Management Authority, subregion	Sydney Metropolitan CMA, Pittwater (Part B) sub-region

Note: Indicative only, subject to detailed design.

Figure 1.1 Study area location

1.4 Legislative context

1.4.1 Commonwealth legislation

1.4.1.1 (Commonwealth) Environment Protection and Biodiversity Conservation Act 1999

Under the EPBC Act, any action that has, would have, or is likely to have a significant impact on a Matter of National Environmental Significance or on Commonwealth land, triggers the Act and may require assessment and approval from the Commonwealth Minister for the Environment.

The nine Matters of National Environmental Significance protected under the EPBC Act are (Department of the Environment 2014c):

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines)
- a water resource, in relation to coal seam gas development and large coal mining development.

1.4.2 State legislation

NSW legislation relevant to the protection of biodiversity is described below. These statutory instruments provide conditions, matters for consideration and requirements to seek authorisation (licences and approvals) to undertake various actions and activities.

1.4.2.1 (NSW) Threatened Species Conservation Act 1995

The (NSW) Office of Environment and Heritage (OEH) administers the TSC Act. The objectives of the TSC Act are to protect certain classes of threatened wildlife including threatened species, threatened populations and threatened ecological communities. Under the TSC Act, any action that has, would have, or is likely to have a significant impact, triggers the Act and requires a species impact statement to be prepared for projects assessed under Part 4 and Part 5 of the EP&A Act. The content of a species impact statement is outlined in Sections 110–112 of the TSC Act and includes requesting Director-General's requirements.

1.4.2.2 (NSW) Fisheries Management Act 1994

The (NSW) *Fisheries Management Act 1994* (FM Act) establishes provisions for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. The FM Act also covers the identification and management of key threatening processes which affect threatened species or could cause other species to become threatened (Department of Industry and Investment 2010).

The Minister would need to be notified of any proposed dredging (Part 7 Division 3 of the *Fisheries Management Act 1994*) or reclamation works in accordance with Section 199 of the Act. Part 7, Division 8 clause 219 and 220 of the FM Act relate to the blockage of a fish passage. If this is required at any stage during the works, a permit is to be sought from the Minister for Trade and Investment under the Act.

1.4.2.3 (NSW) Noxious Weeds Act 1993

The (NSW) *Noxious Weeds Act 1993* establishes a system for the identification and control of noxious weeds in NSW. The Act divides noxious weeds into four categories which determine the level of control required. Responsibility for the control of noxious weeds lies with the owner and/or occupier of private land and Crown land, local councils and other public authorities on land they occupy. Under the Act, the Minister for Trade and Investment may declare a plant to be a noxious weed. Control notices can be issued by the Minister and local control authorities to ensure obligations are met.

1.4.2.4 (NSW) National Parks and Wildlife Act 1974

The (NSW) *National Parks and Wildlife Act 1974* is administered by OEH. It contains provisions that relate to the protection of native terrestrial fauna and some flora and endangered ecological communities. Under the Act it is an offence to harm threatened biodiversity unless the action is licensed under the TSC Act or is essential for carrying out an activity by a determining authority within the meaning of the EP&A Act if the determining authority has complied with that Part.

Under the Act it is an offence to harm threatened species: buy, sell or possess threatened species: damage critical habitat: or damage the habitat of a threatened species without approval under the Act. Under Section 171 of the Act the Chief Executive of OEH may authorise the harming of threatened and protected flora and fauna species and habitats. It is a defence to prosecution under the Act if the offence is necessary for carrying out an activity that has received development consent under the EP&A Act.

1.5 Study aims

The overall objective of this study was to assess the impacts of the proposal on the biodiversity values of the site and surrounds. Specifically, the ecological assessment aimed to:

- Determine and describe the characteristics and condition of the vegetation communities and flora and fauna habitats.
- Determine the occurrence, or likelihood of occurrence within the study area, of threatened species, populations and communities (biodiversity) listed under the TSC Act, FM Act and EPBC Act.
- Undertake significance assessments for threatened biodiversity that occur or have potential habitat within the study area.
- Propose further investigations and/or amelioration measures to mitigate impacts on the ecological values of the study area.

2. Methodology

This ecological assessment included desk-based searches of relevant databases and historical records, as well as a field inspection of the study area. This section outlines the specific methods used to survey and assess biodiversity within and surrounding the study area.

2.1 Personnel

The contributors to the preparation of this paper, their qualifications and roles are listed in Table 2.1.

Table 2.1 Study team

Name	Qualifications	Position and role
Tanya Bangel	BSc (Hons)	Ecologist– field surveys, report preparation
Alex Cockerill	BSc (Hons)	Principal Ecologist - report review

All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the (NSW) *National Parks and Wildlife Regulations 2002*, Section 132C of the NPW Act (License Number: SL100630) as well as an animal research authority issued by the Department of Trade and Investment.

2.2 Database searches

The aim of this background research was to identify threatened flora and fauna species, populations and ecological communities; Commonwealth listed Migratory species and critical habitat recorded previously or predicted to occur in the vicinity of the study area.

This allowed the known habitat requirements to be compared with those of the study area to determine the likelihood of occurrence of threatened biodiversity.

This assessment included a review of:

- research papers, books and other published data
- aerial photographs
- southeast NSW Native Vegetation Classification Mapping (SCIVI) (Tozer 2003)
- TfNSW '*Vegetation Offset Guide*' (Transport for NSW 2014)
- database searches (refer Table 2.2 and Appendix A and B).

Table 2.2 Database searches

Database	Date of search	Search area	Reference
Bionet Atlas of NSW Wildlife	26 June 2014	10 km locality search	Office of Environment and Heritage (2014b)
PlantNet Database	26 June 2014	10 km locality search	Royal Botanic Gardens (2014)
EPBC Protected Matters Search Tool	26 June 2014	10 km locality search	Department of the Environment (2014b)
Noxious Weeds Database	26 June 2014	Ku-ring-gai Council	Department of Trade and Investment Regional Infrastructure and Services (2014)

(1) Flora and Fauna database searches were completed as a radius (10 km) unless otherwise stated, around the following co-ordinates: GDA94, Zone 56, 330567, 6260962.

2.2.1 Nomenclature

Names of vegetation communities used in this report are based on the dominant species and structure of the community. The names used follow names of threatened species ecological communities listed under the TSC Act and/or EPBC Act. These names are cross-referenced with those used in the most relevant vegetation mapping for the study area which in this case is 'Native Vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands' (Tozer *et al.* 2006) and cross-referenced with those of the OEH vegetation types database (Office of Environment and Heritage 2012).

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with reference to PlantNet (Royal Botanic Gardens 2014) for recent taxonomic changes. Scientific names are used for plants in this report. Scientific and common names (where appropriate) are provided in plant lists in Appendix A and C. Introduced species are denoted with an asterisk (*).

Names of vertebrate fauna follow the Australian Fauna Directory maintained by the Department of the Environment (Department of the Environment 2013a). Common names are used in this report for species of animal. Scientific names are included in species lists found in Appendix B.

For threatened species, the names used in the OEH Threatened Species Website (Office of Environment and Heritage 2014c) are also provided in the tabulated data in Appendices A and B where these differ from the names used by Harden, PlantNet and the Australian Faunal Database.

2.3 Field survey

The study area was inspected during daylight hours by an ecologist on 28 November 2013 (Main works – substation construction site are from outside of the rail corridor) and 24 June 2014 (Entire main works area from within the rail corridor and the additional aerial earth (overhead) wires only area from outside of the rail corridor). These surveys were structured primarily to assess the extent and condition of vegetation and fauna habitat, especially for the threatened species and ecological communities.

2.3.1 Species of plant and vegetation communities

2.3.1.1 Main works area

The floristic diversity, possible presence of threatened species and identity of vegetation communities was assessed using quadrat and random meander surveys.

Quadrat surveys involved the identification of all vascular plant species within selected 20 metre x 20 metre areas representing each vegetation community present.

Random meander transects were completed in accordance with the technique described by Cropper (1993) whereby the recorder walks in a meandering pattern throughout the site. Attributes recorded during random meander transects included variation in species composition and vegetation structure, the presence or absence of threatened or noxious species of plant and boundaries between vegetation communities.

The random meander surveys were used as a method of searching for threatened species of plant throughout the main works area covering all major native vegetation occurrences. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

2.3.1.2 Additional aerial earth (overhead) wires only area

A visual inspection of the vegetation was made from the roadside adjacent to the rail corridor. This visual inspection sought to primarily assess the extent and condition of vegetation. Where vegetation was obscured from view, the vegetation was extrapolated. During the inspection native and exotic plant species present were recorded.

The vegetation communities were identified in accordance with the OEH Biometric vegetation types database (Gibbons et al. 2008) and correlated with any endangered ecological communities listed under either the TSC Act and/or EPBC Act.

2.3.2 Vegetation condition

The condition of vegetation was assessed using parameters such as structural intactness, native species diversity, evidence of disturbance, weed invasion and plant health. Random meander surveys were the primary method of data collection for the vegetation community identification and condition assessment.

Three categories were used to describe the condition of vegetation communities:

- **Good:** 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.
- **Moderate:** Vegetation generally still retains its structural integrity, but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.
- **Low:** Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover, with very few shrubs. Exotic species, such as introduced pasture grasses or weeds, replace much of the indigenous ground cover. Environmental weeds are often co-dominant with the original indigenous species.

2.3.3 Fauna habitat assessment

Fauna habitat assessments were undertaken to assess the likelihood of threatened species of animal (those species known or predicted to occur within the locality from the literature and database review) occurring within the study area. Fauna habitat characteristics assessed included:

- Structure and floristics of the canopy, understorey and ground vegetation, including the presence of flowering and fruiting trees providing potential foraging resources.
- Presence of hollow-bearing trees providing roosting and breeding habitat for arboreal mammals, birds and reptiles.
- Presence of the ground cover vegetation, leaf litter, rock outcrops and fallen timber and potential to provide protection for ground-dwelling mammals, reptiles and amphibians.
- Presence of waterways (ephemeral or permanent) and water bodies.

The following criteria were used to evaluate the condition of 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 or greatly reduced (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 clearing in the past.

2.4 Likelihood-of-occurrence assessment

The likelihood of threatened and migratory and threatened species populations occurring within the study area was assessed against the criteria outlined in Table 2.3.

Species subject to likelihood-of-occurrence assessments were those identified during the desktop and field-based investigations and any additional species considered to have had the potential to occur in the professional opinion of contributors to this assessment.

Table 2.3 Likelihood of occurrence assessment

Likelihood-of-occurrence	Criteria
Low	▪ Have not been recorded previously in the study area and surrounds which are beyond the current known geographic range. ▪ Are dependent on specific habitat types or resources that are not present in the study area. ▪ Are considered extinct in the locality.
Moderate	▪ Have been recorded previously in the study area and surrounds infrequently (i.e. vagrant individuals). ▪ 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 utilise resources within the study area opportunistically during variable seasons or migration.

Likelihood-of-occurrence	Criteria
High	■ Have been previously recorded in the study area. ■ Are dependent on 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 study area or surrounds during regular seasonal movements or migration.
Recorded	■ Recorded in the study area during current field study.

2.4.1 Significance assessments

Significance assessments were carried out for threatened species, populations or communities listed under the TSC Act or EPBC Act that were known or predicted to occur in the proposal locality (within a 10 km radius from the study area), that had a moderate to high likelihood of occurring within the study area, based on suitable habitat and that were likely to be impacted upon by the construction.

For species or communities listed under the TSC Act, significance assessments were completed by addressing the factors of Part 3A of the EP & A Act following the *Threatened species assessment guidelines: The assessment of significance* (Department of Environment and Climate Change 2007). For species or communities listed under the EPBC Act, significance assessments were completed in accordance with the *Matters of National Environmental Significance Significant impact guidelines 1.1 EPBC Act* (Department of the Environment 2013b).

For species or communities listed under both TSC Act and EPBC Act, assessments of significance were completed separately following the two guidelines.

2.5 Limitations

The ‘Main works area’ survey was conducted within the rail corridor. Within the ‘Main works area’ study area access was restricted to areas where safe to do so (i.e. without being exposed to danger from trains). Field surveys for the ‘Additional aerial earth (overhead) wires only’ between Russel Avenue, Linfield and Killara Station were restricted to within the road corridor as access was not available from within the rail corridor. Where access was restricted, the vegetation community and condition was extrapolated from a distance. The precautionary approach was taken in assessing the likelihood of threatened plant and animal species occurring within the study area. Due to the generally poor condition of vegetation, the likelihood of such species occurring is low.

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. Also, it should be recognised that site conditions, including the presence of threatened species, can change with time.

3. Existing environment

3.1 Landscape context

The study area is located within the Pittwater subregion of the Sydney Metropolitan Catchment Management Authority, within the broader Sydney Basin bioregion (Thackway & Cresswell 1995). The Sydney Basin Bioregion lies on the central east coast of NSW, extending from just north of Batemans Bay to Nelson Bay on the Central Coast, and almost as far as Mudgee in NSW. The bioregion has a total area of 3,624,008 ha occupying 4.53 per cent of the State.

The Pittwater subregion consists of Triassic Hawkesbury Sandstone, with ridges of Ashfield Shale and Narrabeen sandstones in exposed gullies. The climate of the area is temperate. Dominant vegetation includes eucalypt woodlands and open forests.

This region is located within the urban areas of northern Sydney. These areas have been heavily influenced by previous clearing for residential, industrial and associated infrastructure developments. This extensive clearing and development has resulted in a heavily modified urban environment which predominantly only retains small areas of native vegetation.

3.2 Land use

The study area includes the section of rail corridor immediately south of Killara Station to north of Clanville Road that runs adjacent along Lindfield Avenue in Lindfield, NSW. The study area is bordered by the railway line, Killara station to the north, arterial roads and residential development. This rail way corridor has been greatly disturbed as a result of previous land uses including residential development and associated infrastructure (railway lines and roads) and weed invasion.

3.3 Vegetation communities

The desktop assessment of previous vegetation mapping identified that no native vegetation communities has been mapped in the study area. The field surveys assessment identified that the vegetation within the study area comprised of three vegetation communities the distribution of which are related to geological, topographical, and geomorphological characteristics and previous land use. The vegetation communities in the study area (Figure 3.1 and Table 3.1) were:

- Blue Gum High Forest
- Sydney Turpentine Ironbark Forest derived scrubby regrowth
- Cleared and disturbed land.

Figure 3.1a Vegetation types

Figure 3.2b Vegetation types

Table 3.1 Identified vegetation communities

Field verified vegetation community	Threatened ecological community	OEH Vegetation class database (Gibbons *et al.* 2008)	Plant Community Types (Gibbons *et al.* 2008)	Area within study area (ha)
Blue Gum High Forest[1]	Critically Endangered ecological community (TSC Act[2]). Does not meet the condition criteria for the EPBC Act listed Critically Endangered ecological community[3] (refer to section 4.1).	North Coast Wet Sclerophyll Forests	ME001: Sydney Blue Gum - Blackbutt - Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin	0.36
Sydney Turpentine Ironbark Forest	Endangered ecological community (TSC Act[4]). Does not meet the condition criteria for the EPBC Act listed Critically Endangered ecological community[5] (refer to section 4.1).	Cumberland Dry Sclerophyll Forests	HN604: Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin	0.32
Sydney Turpentine Ironbark Forest derived scrubby regrowth[1]				0.26
Cleared and disturbed land	-	-		1.37

(1) Associated threatened ecological community, subject to condition criteria being met for EPBC and TSC Acts. See section 4 for condition criteria justification.
(2) Endangered ecological community, Blue Gum High Forest in the Sydney Basin Bioregion (TSC Act).
(3) Critically Endangered community, Blue Gum High Forest of the Sydney Basin Bioregion (EPBC Act)
(4) Endangered ecological community, Sydney Turpentine-Ironbark Forest (TSC Act).
(5) Critically endangered Ecological community, Turpentine-Ironbark Forest of the Sydney Basin Bioregion (EPBC Act).
(6) OEH Plant Community Type (Office of Environment and Heritage 2012)

A detailed summary of the community including structure and dominant species recorded and vegetation habitat assessments is provided below.

3.3.1 Blue Gum High Forest

This vegetation type occurred only in the section between Russel Avenue, Lindfield Station and Killara Station (Figure 3.1). The vegetation recorded within the study area contains plant canopy, shrub layer and groundcover species characteristic of Blue Gum High Forest.

This disturbed vegetation type was in low ecological condition. This vegetation community has been extensively modified by past land use and as a consequence has lost most of its native species and is significantly structurally modified with low density of native vegetation cover. Exotic species are dominant and have replaced the vast majority of the indigenous shrub layer and groundcover (Table 3.2).

Table 3.2 Blue Gum High Forest description

Blue Gum High Forest			
Conservation significance	Yes. Consistent with the TSC Act listing for Blue Gum High Forest (listed as Critically Endangered).		
Condition	**Low.** The majority of this community resembles heavily degraded Blue Gum Hugh Forest with a sparse canopy of the occasional native species and a high diversity of introduced species in the shrub and groundcover layers. This vegetation was subject to high disturbance from edge effects, existing roads/railway lines, foot paths and weed invasion. Occurred only within the Additional aerial earth (overhead) wires only area.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy	18-22	20-40	Dominated by *Eucalyptus saligna X botryoides* and sub-canopy of juvenile eucalypts, *Allocasuarina torulosa* and *Jacaranda mimosifolia**.
Shrub cover	1–3	0-20	Dominated by exotic shrub species including *Ligustrum* spp.*, *Senna pendula*, Lantana camara** and *Solanum mauritianum** with the occasional *Acacia floribunda, Acacia salicina* and *Banksia ericifolia.*
Ground cover	0–1	80–100	Dominated by exotic grass, herb and climbers including *Tradescantia albiflora*, Ehrharta erecta*, Plantago lanceolata*, Sida rhombifolia*, Paspalum dilatatum*, Cardiospermum grandiflorum*, Ipomoea indica*, Rubus fruiticosis** and with scattered native individuals such as *Pteridium esculentum, Lomandra longifolia, Eustrephus latifolius, Cynodon dactylon,* and *Themeda australis.*

3.3.2 Sydney Turpentine Ironbark Forest

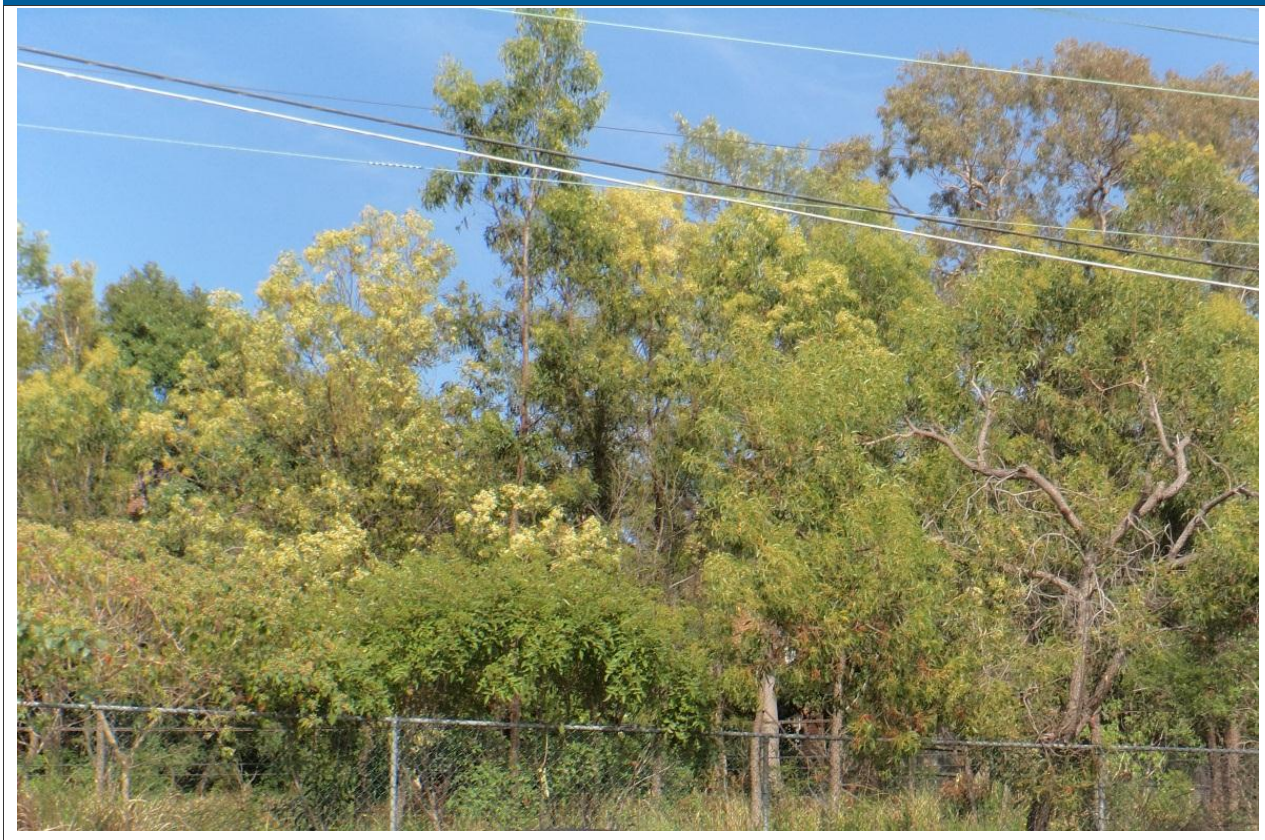
This vegetation type occurred a large area of the study area (Figure 3.1a and Figure 3.1b). Two conditions of this vegetation community were recorded; Sydney Turpentine Ironbark Forest and Sydney Turpentine Ironbark Forest derived scrubby regrowth. Vegetation recorded within the study area contains plant canopy, shrub layer and groundcover species characteristic of Sydney Turpentine Ironbark Forest. The derived scrubby regrowth lacked a canopy and was dominated by exotic species.

This disturbed vegetation type was in low and moderate ecological condition. This vegetation community has been extensively modified by past land use and as a consequence has lost most of its native species and is significantly structurally modified with generally a low density of native vegetation cover. Exotic species are dominant and have replaced the vast majority of the indigenous shrub layer and groundcover (Table 3.3).

Table 3.3 Sydney Turpentine Ironbark Forest description

Sydney Turpentine Ironbark Forest			
Conservation significance	Yes. Consistent with the TSC Act listing for Sydney Turpentine-Ironbark Forest.		
Condition	**Low.** The majority of this community resembles Sydney Turpentine Ironbark Forest without a canopy and high exotic plant diversity which is subject to high disturbance from edge effects, existing roads/railway lines, foot paths and weed invasion. **Moderate.** This vegetation resembles Sydney Turpentine Ironbark Forest with a moderate diversity of native plant species however is also heavily disturbed from edge effects, existing roads/railway lines, foot paths and weed invasion. Occurred only within the additional aerial earth (overhead) wires only area.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Canopy **Low.** **Moderate.**	 4–9 8-15	 30–60 10-30	**Low.** Dominated by regrowth *Acacia parramattensis, Acacia falcata, Cinnamomum camphora** with scattered individuals of *Allocasuarina littoralis* and *Jacaranda mimosifolia**. **Moderate.** Dominated by *Eucalyptus paniculata, Eucalyptus resinifera* subsp. *resinifera* and *Angophora floribunda* with scatter individuals of *Allocasuarina littoralis* and *Jacaranda mimosifolia**.
Shrub cover **Low.** **Moderate.**	 0.4–3 0.4-3	 20–60 20-30	**Low.** Dominated co-dominated by both exotic and native shrub species including *Ligustrum* spp.*, *Lantana camara*, Olea europaea ssp.cuspidata *, Rubus fruiticosus*, Indigofera australis, Acacia floribunda* and *Leptospermum juniperina.* **Moderate.** Dominated by native shrub species including *Acacia floribunda, Acacia falcata, Banksia* spp., *Persoonia linearis, Pittosporum undualtum*, *Leucopogon juniperinis* and *Acacia parramattensis*.
Ground cover **Low.** **Moderate.**	 0–1 0-1	 90–100 90-100	**Low.** Dominated by exotic grass, herb and climbers including *Tradescantia albiflora*, Ehrharta erecta*, Plantago lanceolata*, Sida rhombifolia*, Bromus catharticus*, Paspalum dilatatum*, Ageratina adenophora** and with scattered native individuals such as *Pteridium esculentum, Lomandra longifolia, Eustrephus latifolius, Dichondra repens, Cynodon dactylon, Eustrephus latifolius* and *Themeda australis.* **Moderate.** Dominated by native grass, herb and climbers including *Themeda australis, Cynodon dactylon, Lomandra longifolia, Imperata cylindrica, Pteridium esculatum, Laxmannia gracilis* with a few exotic individuals such as *Sida rhombifolia** and *Ehrata erecta**.
Low condition Sydney Turpentine Ironbark Forest derived scrubby regrowth			

Sydney Turpentine Ironbark Forest



Moderate condition Sydney Turpentine Ironbark Forest

3.3.3 Cleared and disturbed land

This vegetation type occupied areas predominantly along the access tracks, footpaths and areas adjacent to private residences within the study area (Table 3.4). These areas have been subjected to substantial human disturbance including full clearing for the construction of the railway line, adjacent roads, residential properties and access tracks into the rail corridor. Other disturbances include rubbish dumping and weed invasion. This community is mapped in Figure 3.1a and Figure 3.1b.

This cleared and disturbed land vegetation community was in low ecological condition. This vegetation community has been extensively modified by past land use and as a consequence has lost most of its native species and is significantly structurally modified with minimal native vegetation cover. Exotic species are dominant and have replaced the vast majority of the indigenous canopy, shrub layer, and groundcover.

Table 3.4 Cleared and disturbed land description

Cleared and disturbed land			
Conservation significance	No. This vegetation is not consistent with any threatened ecological communities.		
Condition	**Low.** The majority of this community contains a high diversity of exotic plant diversity which is subject to high disturbance from edge effects, existing roads/railway lines, foot paths and weed invasion. This vegetation type does not contain a canopy or shrub layer and is dominated by exotic herb, grass and forb plant species.		
Strata	**Height range (m)**	**Foliage cover (%)**	**Dominant species**
Ground cover	0–0.4	90–100	Dominated by exotic grass, herb and climbers including *Tradescantia albiflora*, Ehrharta erecta*, Plantago lanceolata*, Sida rhombifolia*, Bromus catharticus*, Paspalum dilatatum*, Ageratina adenophora*, Cardiospermum grandiflorum*, Ipomea inidica** with the occasional native individuals such as *Lomandra longifolia, Dichondra repens,* and *Cynodon dactylon.*

3.4 Species of plant

One-hundred and four plant species were recorded within the study area. Of these, 50 were native (48%) and 54 (52%) were introduced species (Appendix C).

Of the 54 exotic species that were recorded within the study area, 15 species of plant are listed under the *Noxious Weeds Act 1993* for the Ku-ring-gai Council noxious weed control area (Table 3.5). Of these species six species (*Asparagus aethiopicus*, Asparagus asparagoides*, Asparagus offinalis*, Lantana camara*, Nassella neesiana** and *Rubus fruiticosus*)* are listed as Weeds of National Significance (Australian Weeds Committee 2013).

Table 3.5 Noxious weeds identified on the site

Common name	Scientific name	*Noxious Weeds Act 1993* control class1	Weed of National Significance
African Olive	*Olea europaea subsp. cuspidata*	4	
Asparagus	*Asparagus officinalis*	4	Yes
Asparagus fern	*Asparagus aethiopicus**	4	Yes
Balloon Vine	*Cardiospermum grandiflorum*	4	
Bamoo	*Phyllostachys sp.*	4	
Blackberry	*Rubus fruticosus**	4	Yes
Blue Morning Glory	*Ipomoea indica*	4	
Bridal Creeper	*Asparagus asparagoides*	4	Yes
Broad-leaf Privet	*Ligustrum lucidum**	4	
Camphor laurel	*Cinnamomum camphora**	4	
Chilean needle grass	*Nassella neesiana**	4	Yes
Lantana	*Lantana camara**	4	Yes
Micky Mouse Bush	*Ochna serrulata*	4	
Moth Vine	*Araujia sericifera*	4	
Narrow-leaved Privet	*Ligustrum sinense**	4	

(1) Control categories under the Noxious Weeds Act 1993: 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 (Department of Trade and Investment Regional Infrastructure and Services 2014).

3.5 Fauna habitat

The quality of vertebrate fauna habitats is typically correlated with the patch size, configuration, structure, species composition and connectivity of the vegetation communities present at a given site and the presence of non-biological features such as rock outcrops and water bodies. Therefore, the fauna habitats present in the study area is generally in low condition as it is heavily disturbed as a result of previous land use.

Two broad habitat type of terrestrial fauna habitat, cleared land with scattered immature trees was found within the study area. This habitat is described below.

3.5.1 Cleared land with scrubby regrowth

Cleared land with scrubby regrowth occurs throughout the study area as a result of substantial human disturbance such as clearing for residential development and associated infrastructure (railway and roads). This habitat type predominantly contains exotic species however, does contain a number of native species resembling the Sydney Turpentine Ironbark Forest shrub layer.

Native vegetation in this habitat type is restricted to sparse to moderately dense, shrubs and groundcover plants within otherwise exotic vegetation.

This habitat is only likely to provide habitat for native and introduced fauna species that are adapted to open/scrubby environments and tolerant of human disturbance. Many such native species (e.g. Australian Magpie, Magpie-lark, Willie Wagtail and Welcome Swallows) have increased in abundance in response to human disturbance of habitats.

This habitat type is in low condition and generally of very limited value to threatened fauna species aside from highly mobile species those that utilise open spaces such as bat and bird species.

3.5.2 Forest

Forest occurred only within the additional aerial earth (overhead) wires only section of the study area. This habitat has been subject to substantial human disturbance such as clearing for residential development and associated infrastructure (railway and roads) and invasion of exotic species. This habitat type predominantly contains exotic species however, does contain a number of native species resembling the Blue Gum High Forest and Sydney Turpentine Ironbark Forest.

Native vegetation in this habitat type is restricted to sparse to moderately dense canopy, shrubs and groundcover plants generally within otherwise exotic vegetation, some areas containing high diversity of native shrub and groundcover species.

The canopy of this habitat type consists of moderately dense cover of immature and semi-mature trees. The canopy provides marginal foraging habitat for nectar-feeding and seed feeding animals. The trees are unlikely to provide habitat for hollow-dependent species.

This habitat is only likely to provide habitat for native and introduced fauna species that are adapted to high disturbed and fragmented environments and tolerant of human disturbance. Many such native species (e.g. Australian Magpie, Magpie-lark, Willie Wagtail and Welcome Swallows) have increased in abundance in response to human disturbance of habitats.

This habitat type is in low condition providing limited value to threatened fauna species aside from highly mobile species those that utilise open spaces such as bat and bird species.

3.6 Wildlife connectivity corridors

Wildlife corridors can be defined as ‘retained and/or restored systems of (linear) habitat which, at a minimum enhances connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation’ (Wilson & Lindenmayer 1995). Corridors can provide ecological functions at a variety of spatial and temporal scales, from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions.

Corridors serve a number of different functions in terms of conservation including:

- Providing increased foraging area for wide-ranging species.
- Providing cover for movement between habitat patches, and enhancing the movement of animals through sub-optimal habitats.
- Reducing genetic isolation.
- Facilitating access to a mix of habitats and successional stages to those species which require them for different activities (for example, foraging or breeding).
- Providing refuge from disturbances such as fire.
- Providing habitat in itself.
- Linking wildlife populations and maintaining immigration and recolonisation between otherwise isolated patches. This in turn may help reduce the risk of population extinction.

Vegetation and associated fauna habitat within the study area is in low to moderate condition. The vegetation within the study area adjoins the rail corridor and local arterial roads which heavily fragment the vegetation within the study area. As a result, the vegetation within the study area is predominantly isolated and only connected to planted street trees.

Although there are only small degraded patches of vegetation within the study area, this plays a minor role in maintaining local connectivity between larger remaining patches of habitat in the broader locality. These linkages may be used by highly mobile species (such as bats and birds) that would not move across the open landscape matrix. For example, to minimise predation risk many bird species will preferentially move along forested roadside corridors between habitats in preference to flying across open areas (Bennett 1990, 1993).

The contribution of the study area to local connectivity is quite low as a result of its fragmented nature and the barriers created by the railway line, roads and residential development.

3.7 Species of animal

A total of 16 species of animal was recorded in the study area (Appendix D), of which, 14 were native. Birds accounted for 12 species (75 per cent), while mammals were represented by three individuals and reptiles by one species.

Most of the species recorded are typical of disturbed environments within a highly modified urban landscape in addition to more intact habitats. No threatened species were recorded within the study area during the field survey within the study area however one Grey-headed Flying-fox individual (listed under the TSC Act and EPBC Act) was recorded within close proximity and is likely to utilise habitat within the study area (Figure 3.1). The field surveys for fauna were limited to opportunistic recordings of birds, reptiles and habitat assessment.

4. Species, population and communities of conservational concern

This section details the threatened biodiversity and other species of conservation concern recorded or likely to occur in the study area, based on those found within the locality and the nature of the habitats observed within the existing environment (section 3).

4.1 Threatened ecological communities

Threatened ecological communities (critically endangered, endangered and vulnerable) are listed under the TSC Act, FM Act and EPBC Act.

Two threatened ecological communities where recorded within the study area. These communities included:

- Blue Gum High Forest – listed as Critically Endangered under the TSC Act and the EPBC Act.
- Sydney Turpentine Ironbark Forest – Listed as Endangered under the TSC Act and Critically Endangered under the EPBC Act.

More details of these vegetation communities are provided below.

4.1.1 Blue Gum High Forest

4.1.1.1 NSW listed Blue Gum High Forest in the Sydney Basin Bioregion

Blue Gum High Forest in the Sydney Basin Bioregion is listed as Endangered under the NSW TSC Act.

The vegetation within the study area consists of some canopy, shrub and groundcover species characteristic of the Endangered Blue Gum High Forest vegetation community as listed in the NSW Scientific Committee Final Determination (Office of Environment and Heritage 2014a). The vegetation community recorded within the study area represented Blue Gum High Forest that has become highly fragmented and as a result has a highly modified structure dominated by introduced species.

The Blue Gum High Forest vegetation recorded within the study area (the edge of this community occurred within the “additional aerial earth (overhead) wires only” section of the study area) contained a number of plant species characteristic to the Blue Gum High Forest listed as Critically Endangered under the TSC Act. The works to be conducted within this community are only likely to disturb a small area of groundcover species (predominantly exotic) surrounding each power pole. No vegetation will be removed from these areas unless any power poles require replacement. No canopy species will be removed as part of the project.

4.1.1.2 Commonwealth listed Blue Gum High Forest of the Sydney Basin Bioregion

Blue Gum High Forest of the Sydney Basin Bioregion is listed as critically endangered under the Commonwealth EPBC Act.

To be listed as critically endangered under the Commonwealth EPBC Act, the vegetation must be consistent with the criteria outlined in the Commonwealth Listing Advice on Blue Gum High Forest of the Sydney Basin Bioregion (Department of the Environment 2014a). The criteria are listed below:

- The vegetation contains some characteristic components from all structural layers (tree canopy, small tree/shrub midstorey, and understorey).
- Tree canopy cover is greater than 10 per cent and remnant size is greater than one hectare.
- However, remnants with tree canopy cover less than 10 per cent are also included in the ecological community, if the fragments are greater than one hectare in size and occur in areas of native vegetation in excess of five hectares in area.

Although the vegetation within the study area does contain characteristic canopy species (over 10 per cent) and a small number of shrub and groundcover plant species, the vegetation is however less than one hectare and does not occur in areas of vegetation in excess of five hectares. Therefore, the vegetation is not consistent with the Commonwealth listed for Blue Gum High Forest of the Sydney Basin Bioregion.

4.1.2 Sydney Turpentine Ironbark Forest

Two conditions of Sydney Turpentine-Ironbark Forest were recorded within the study area. These included:

- Sydney Turpentine Ironbark Forest – contained some characteristic canopy, shrub and groundcover species.
- Sydney Turpentine Ironbark Forest derived shrubby regrowth – contained some characteristic shrub and groundcover species only.

4.1.2.1 NSW listed Sydney Turpentine-Ironbark Forest

Sydney Turpentine-Ironbark Forest which is listed as endangered under the TSC Act.

The vegetation within the study area consists of some canopy, shrub and groundcover species characteristic of the endangered Sydney Turpentine Ironbark Forest vegetation community as listed in the NSW Scientific Committee Final Determination (NSW Scientific Committee 1998). The vegetation community recorded within the study area represented predominantly Sydney Turpentine Ironbark Forest derived shrubby regrowth which contained no canopy species. As this condition did not contain any characteristic canopy tree species it is only marginal for conclusion under the TSC Act listing as a soil seed bank may be persistent.

The vegetation recorded within the study area contained a number of plant species characteristic to the Sydney Turpentine-Ironbark Forest as listed as endangered under the TSC Act.

4.1.2.2 Commonwealth listed Turpentine-Ironbark forest in the Sydney Basin Bioregion

Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion is listed as Critically Endangered under the Commonwealth EPBC Act.

To be listed as critically endangered under the Commonwealth EPBC Act, the vegetation must be consistent with the criteria outlined in the Commonwealth Listing Advice on Turpentine-Ironbark Forest of the Sydney Basin Bioregion (Department of Environment and Conservation 2004). The criteria are listed below:

- The vegetation contains some characteristic components from all structural layers (tree canopy, small tree/shrub midstorey, and understorey).
- Tree canopy cover is greater than 10 per cent and remnant size is greater than one hectare.
- However, remnants with tree canopy cover less than 10 per cent are also included in the ecological community, if the fragments are greater than one hectare in size and occur in areas of native vegetation in excess of 5 hectares in area.

Although the vegetation within the study area does contain some characteristic canopy, shrub and groundcover plant species it is less than one hectare in size and does not occur in areas of vegetation in excess of five hectares. Therefore, the vegetation is not consistent with the Commonwealth listed for Sydney Turpentine-Ironbark Forest.

4.2 Endangered populations

Endangered populations are listed under Schedule 1, Part 2 of the TSC Act. Results of the desk-top assessment indicate that no endangered populations have the potential to occur in the study locality (Appendices A and B).

4.3 Threatened species of plant

Fifty species of threatened plant listed under the TSC Act and/or the EPBC Act are known to occur or are predicted to occur within and surrounding the study area. Details of these species and their habitat requirements are provided in Appendix A.

No threatened species of plant was recorded during the current survey which was limited to a visual inspection from the road corridor. Based on the presence of suitable habitat all these species are considered to have a low likelihood of occurrence based on the availability of habitat. Full details of species requirements and reasons for not considering impacts of the proposal further are provided in Appendix A.

4.4 Threatened species of animal

Sixty-four species of threatened animal listed under the TSC Act and/or the EPBC Act are known to occur or predicted to occur within and surrounding the study area. Details of these species and their habitat requirements are provided in Appendix B.

Based on the presence of suitable habitat, six species are considered to have a moderate or greater likelihood of occurrence (Table 4.1). Significance assessments as required under the EP&A Act were completed for these six species (Appendix E).

The remaining species are considered to have a low likelihood of occurrence based on the availability of habitat. Full details of species requirements and reasons for not considering impacts of the proposal further are provided in Appendix B.

Table 4.1 Threatened species of animal with potential to occur within the study area

Scientific name	Scientific name	TSC Act[1]	EPBC Act[2]	Likelihood of occurrence
Birds				
Ninox strenua	Powerful Owl	V		**Moderate**
Glossopsitta pusilla	Little Lorikeet	V		**Moderate**
Bats				
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V		**Moderate**
Mormopterus norfolkensis	Eastern Free-tail Bat	V		**Moderate**
Pteropus poliocephalus	Grey- headed Flying-fox	V	V	**High** – recorded in proximity to study area.
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V		**Moderate**

(1) TSC Act = *Threatened Species Conservation Act 1995*, V = Vulnerable, E1 = Endangered.
(2) EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*, E = Endangered.

4.5 Migratory species

Migratory species are protected under international agreements to which Australia are a signatory, including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA), the Republic of Korea Australia Migratory Bird Agreement (RoKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered to comprise 'Matters of National Environmental Significance' and are protected under the EPBC Act.

Based on the findings of the desk-top assessment (Department of the Environment 2014b), a total of 33 Migratory species have been recorded or have the potential to occur in the study area locality (Appendix B). No Migratory species were recorded during field surveys the site does contain potential habitat however for the White-throated Needletail.

While terrestrial Migratory species of bird may potentially use the area, the site would not be classed as 'important habitat' as defined EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of the Environment Water Heritage and the Arts 2010) as the site does not contain:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species.
- Habitat utilised by a migratory species which is at the limit of the species range.
- Habitat within an area where the species is declining.

As such, it is not likely that the proposed activity would significantly affect Migratory species and this group is not considered further.

4.6 Critical habitat

Critical habitat is listed under the TSC Act and/or the EPBC Act. Critical habitat is the whole or any part or parts of an area or areas of land comprising habitat critical to the survival of an endangered species, population or ecological community.

There is no listed critical habitat in the study area and none is likely to be affected by the proposal.

5. Potential impacts

Potential impacts to biodiversity resulting from the construction and operation phases of the proposed activity are considered in this section and summarised in Table 5.1. Potential impacts are described below and mitigation measures to ameliorate these impacts are discussed in section 7. Assessments of significance for threatened biodiversity that occur or have potential habitat in the study area (discussed in section 4) are provided in Appendix E and summarised in section 6.

Table 5.1 Potential impacts associated with the proposal

Potential impact	Potential phase of impact	
	Construction	Operation
Loss of vegetation (including threatened ecological communities/habitats	●	
Direct loss of individuals of threatened species and populations	●	
Potential environmental impact of noise on wildlife	●	●
Weed and pest invasion	●	●
Erosion and sedimentation	●	

5.1 Loss of vegetation/habitat

Clearing of native vegetation is listed as a Key Threatening Process under both the TSC Act and the EPBC Act. Based on the assumption that the 'Additional aerial earth (overhead) wires only' section of the proposal will impact the vegetation to the north of Lindfield Station the construction of the proposal will require the removal of approximately 0.94 ha of native vegetation (Table 5.2). In the likelihood that power poles are not replaced as part of the proposed this area of vegetation removed will be reduced. Measures to minimise impacts to threatened biodiversity affected by the loss of vegetation and associated habitat are described in section 6.

Table 5.2 Potential loss of native vegetation within the subject site

Vegetation community/Fauna habitat	Vegetation clearing (ha)
Vegetation community	
Blue Gum High Forest	0.36
Sydney Turpentine Ironbark Forest	0.26
Sydney Turpentine Ironbark – scrubby regrowth	0.32
Total area of endangered ecological communities[1]	**0.94**
Cleared and disturbed land	1.37
Total area of vegetation to be impacted	**2.31**
Fauna habitat	
Cleared land with scrubby regrowth	1.69
Forest	0.62
Total Fauna habitats	**2.31**

(1) Area of native vegetation likely to be impacted by the project and with potential to require biodiversity offsets. This native vegetation forms part of the endangered ecological community, Sydney Turpentine-Ironbark Forest and critically endangered Blue Gum High Forest as listed under the TSC Act.

Loss of vegetation and habitats result in a range of direct and indirect impacts to vegetation communities and species of plant and animal including:

- Reduction in the extent of vegetation communities and associated habitats.
- Loss of local populations of species.
- Fragmentation or isolation of remnants of vegetation communities or local populations of individual species.
- Increased edge effects and habitat for invasive species.
- Reduction in the viability of ecological communities resulting from loss or disruption of ecological functions (e.g. increased desiccation, light penetration, herbivore, weed invasion, predation, parasitism).
- Destruction of flora and fauna habitat and associated loss of biological diversity (habitat removal may include removal of hollow bearing trees, loss of leaf litter layer, and resultant changes to soil biota).
- Soil exposure and altered water flow patterns resulting in increased erosion and sedimentation.

The proposal would have an impact on fauna habitats with the removal or modification of approximately 2.31 hectares of habitat which is in low to moderate condition and may provide some marginal foraging habitat for several threatened species of birds and bats.

5.2 Direct loss of animals and plants

Fauna injury or death could occur as a result of the proposed activities during the construction phase, particularly when vegetation and habitats are being cleared.

While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile may have difficulty moving over relatively large distances. Species of animal that may be at particularly high risk of injury or death during vegetation clearing include microchiropteran bats, reptiles, nestling birds and frogs. Although the relatively small area of habitat in the study area is effectively degraded from past clearing and isolated in some areas there is potential for animals to be injured during vegetation removal.

Measures would be in place to minimise the likelihood of death or injury of wildlife, however, these cannot prevent such losses. The impact of such losses in relation to threatened species was considered in the assessments of significance (Section 6 and Appendix E).

5.3 Habitat fragmentation, isolation and barrier effects

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with the occurrence of a new habitat type in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the species remaining within the fragments (Bennett 1990, 1993; Johnson *et al.* 2007).

In addition to the loss of total habitat area, the process of fragmentation can affect species within the newly created fragments in a number of ways, including barrier effects, genetic isolation, and edge effects. The degree to which these potential impacts affect the flora and fauna within the newly created fragments depends on a number of variables, including distance between the fragments, local environmental conditions, the species present and any proposed mitigation measures. Some of the potential impacts are summarised below.

Due to the existing highly fragmented nature of the study area it is considered unlikely that the proposed construction would increase fragmentation, isolation or barrier effects further.

5.4 Potential environmental impact of noise on wildlife

Many animals detect and depend on sound to communicate, navigate, evade danger and find food, but human-made noise can alter the behaviour of animals or interfere with their normal functioning (Bowles 1997). In some cases it can harm their health, reproduction, survivorship, habitat use, distribution, abundance, or genetic composition (Forman *et al.* 2000). However, variation in ambient noise, such as from wind or other animals, is part of the natural environment and many animals display behavioural adaptations to this variation. For example, certain species of frogs avoid vocalising during loud calling by cicadas or other frogs and some species will time their calls during brief periods of silence (Schwartz & Henderson 1991).

During construction, noise levels will increase in the study area and surrounds due to ground disturbance, machinery operation and vehicle movements and vegetation clearing. This may cause disturbance for some fauna. A number of factors are thought to influence the reaction of animals to noise including the volume, the frequency and the characteristic of the noise (e.g. short and percussive versus long and constant).

The study area is already affected by noise levels associated with vehicle movements along the railway corridor and adjacent arterial roads. How fauna occupying the local area will respond to increased noise is not known, but given the degree of current habitat disturbance and existing noise environment, it is not likely to be significant.

5.5 Weed and pest invasion

Construction within the study area has the potential to disperse weeds into areas where they do not currently occur. The most likely causes of weed dispersal associated with the proposed construction would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery. This may, in turn, reduce the habitat quality of the sites for threatened species. Spread of weeds during the operation phase would relate generally to the vehicles travelling along access tracks.

The vegetation within the study area had a moderate abundance of weeds, which was spread throughout the study area.

The invasion of exotic perennial grasses, such as *Nassella neesiana**, *Bromus catharticus*, Paspalum dilatatum** and *Pennisetum clandestinum** which were recorded within the existing road corridor, is recognised as a Key Threatening Process under the TSC Act.

The invasion and establishment of escaped garden plants, exotic vines and scramblers and other exotic species (i.e. *Lantana camara* and *Olea europaea* subsp. *cuspidata*) which were recorded within the existing rail corridor are recognised as Key Threatening Processes under the TSC Act.

Given the moderate level of weed invasion, and the presence of 15 noxious weeds, within the majority of the rail corridor, construction and to a lesser extent, operation phase, has the potential to spread weeds from the study area to other sites. Therefore mitigation measures relating to weed control have been outlined in section 7 of this report.

5.6 Erosion and sedimentation

Excavation and earthworks undertaken during the construction phase would expose soils that have the potential to enter surrounding areas of vegetation, possibly resulting in sedimentation and dispersal of weeds, if not properly managed. Erosion during the operation stage of the proposal would generally relate to maintenance activities and is likely to be minor if properly managed and the mitigation measures in section 7 are adhered to.

5.7 Key threatening processes

Key threatening processes are listed under Schedule 3 of the TSC Act and EPBC Act. A process is defined as a key threatening process if it threatens or may threaten the survival, abundance, or evolutionary development of a native species or ecological community. A process can be listed as a key threatening process if it could cause a native species or ecological community to become eligible for adding to a threatened list (other than conservation dependant), or cause an already listed threatened species or community to become more endangered, or if it adversely affects two or more listed threatened species or ecological communities.

The proposal has the potential to contribute to the following threatening processes:

- *Threatened Species Conservation Act 1995* Key Threatening Processes:
  - invasion of native plant communities by exotic perennial grasses (refer section 5.5)
  - clearing of native vegetation (refer section 5.1)
  - loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (refer section 5.5)
  - invasion, establishment and spread of *Lantana camara* (refer section 5.5)
  - invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata* (refer section 5.5)
  - invasion and establishment of exotic vines and scramblers (refer section 5.5)
- *Environment Protection and Biodiversity Conservation Act 1999* Key Threatening Processes:
  - land clearance (refer section 5.1)
  - loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (refer section 5.5).

The proposal will result in the loss of native vegetation and thus contribute to the Key Threatening Process of clearing of native vegetation and land clearance. The proposal is not likely to significantly increase the introduction or spread of exotic weed species, if undertaken in accordance with mitigation measures provided in section 7.

6. Significant assessments

Impact assessments were completed based on the known and likely presence of threatened species, populations and communities (Appendix A and B), the potential impacts of the development (section 5), and the mitigation measures proposed (section 7). Impact assessments were completed for all of the threatened biodiversity considered to have a moderate or higher likelihood to occur (Table 4.1). Completed significance assessments are provided in Appendix E.

A summary of significance assessments undertaken for threatened biodiversity is provided below in Table 6.1. Due to the small area and highly modified condition of the vegetation and habitat recorded within the study area the impact assessments concluded that the proposal is not likely to have a significant impact on any threatened biodiversity, nor would it interfere with their recovery, assuming the mitigation measures outlined in section 7 are put in place.

Table 6.1 Summary of threatened biodiversity for which significant assessments were undertaken and their likelihood of being significantly affected by the proposal

Species	Common name	TSC Act	EPBC Act	Significant impact?
Endangered ecological communities				
Blue Gum High Forest		CE		**No**
Sydney Turpentine Ironbark Forest		E		**No**
Birds				
Ninox strenua	Powerful Owl	V		**No**
Glossopsitta pusilla	Little Lorikeet	V		**No**
Bats				
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V		**No**
Mormopterus norfolkensis	Eastern Free-tail Bat	V		**No**
Pteropus poliocephalus	Grey- headed Flying-fox	V	V	**No**
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V		**No**

(1) CE = Critically Endangered, E = Endangered, V = Vulnerable

7. Mitigation measures

The following measures would be implemented during construction and maintenance activities to ensure ecological impacts are minimised:

- Biodiversity offset requirements:
  - Although the impacts to threatened biodiversity are not considered to be significant, the proposed project would result in residual impacts that cannot be avoided or mitigated. Based on the worst case scenario (i.e. vegetation within the entire 'Additional aerial earth (overhead) wires only' section of the project area will require removal in addition to the main works area), these impacts are associated with the clearing of 0.94 ha of native vegetation To mitigate these residual impacts it would be necessary to develop an offset strategy in accordance with the requirements of TfNSW *'Vegetation Offset Guide'* (Transport for NSW 2014), in particular the offset strategy should aim to;
    - Replace/offset 100% of any native vegetation cleared
    - Achieve a neutral or beneficial long-term ecological outcome when native vegetation is cleared
  - The final offset strategy and quantum of offset requirement will be developed in consultation with TfNSW on completion of construction.
- Implement pre-clearing protocols, including:
  - Check for the presence of flora and fauna species and habitat on site before clearing begins such as the presence of bird nests.
  - Prior to construction, site personnel should be adequately informed of environmental management procedures including, but not limited to, issues related to flora and fauna management, weed control, erosion and sediment control.
  - Establish exclusion zones to protect vegetation and fauna habitat outside of the assessed and approved clearing limits, including the threatened ecological communities recorded within the study area. Vegetation to be retained are to be clearly defined on ground and 'no go zones' clearly signposted and fenced to prevent unauthorised clearing and vehicular and/foot traffic.
- Implement clearing and construction protocols, including:
  - Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation.
  - Avoid excessive soil disturbance.
  - When accessing construction sites, contractors should only use designated access tracks.
- Implement flora and fauna control measures including:
  - Clearing of vegetation would be minimised, to only vegetation that is absolutely required to be removed in order to undertake work.
  - Replace power poles only were necessary and appropriate to do so as to reduce impacts to biodiversity.
  - Noxious weeds within the study area such as *Ligustrum lucidum** (Broad-leaved Privet), *Cinnamomum camphora** (Camphor Laurel), *Asparagus aethiopicus** (Asparagus Fern), *Asparagus asparagoides** (Bridal Creeper), *Asparagus officinalis** (Asparagus), *Olea europaea* subsp. *cuspidata** (African Olive), *Cardiospermum grandiflorum** (Balloon Vine), *Phyllostachys sp.** (Bamboo), *Ochna serrulata** (Micky Mouse Bush), *Ipomoea indica** (Blue Morning Glory), *Lantana camara** (Lantana), *Ligustrum* spp. (Privet), *Nassella neesiana** (Chilean Needle Grass), *Tradescantia albiflora** (Wandering Dew) and *Rubus fruiticosus** (Blackberry) as identified in Section 3.4 would be managed in accordance with the *Noxious Weeds Act 1993.*

- Weed species within the study area should be managed in order to control them from further spread. Management techniques may include immediate weed removal and disposal without stockpiling, disposal of weed-contaminated soils at appropriate weed disposal facilities and to ensure that all equipment is cleaned prior to and on completion of works to ensure weeds are not introduced or spread to other locations.

8. Conclusion

The vegetation within the study area adjoins the rail corridor and local arterial roads which heavily fragment the vegetation within the study area. As a result, the vegetation within the study area is in low condition, isolated and only connects to planted street trees. Although there are only small patches of vegetation within the study area it plays a minor role in maintaining local connectivity between larger remaining patches of habitat in the broader locality. These linkages may be used by highly mobile species (such as bats and birds).

Vegetation of ecological significance recorded in the study area included the Blue Gum High Forest threatened ecological community (0.36 ha) listed as Critically Endangered under the TSC Act and Sydney Turpentine Ironbark Forest threatened ecological community (0.58 ha) listed as Endangered under the TSC Act. Both communities within the study area were highly modified as a result of previous land clearing and invasion of weed species. As a result of their low condition these communities did not meet the Commonwealth condition criteria for the Critically Endangered Blue Gum High Forest of the Sydney Basin Bioregion or the Sydney Turpentine Ironbark Forest of the Sydney Basin as listed under the EPBC Act. Therefore, it is considered unlikely that the proposal will significantly impact on any threatened ecological communities.

No threatened species or populations of plant were recorded during vegetation surveys of the study area.

No threatened species were recorded within the study area during the field survey within the study area however one Grey-headed Flying-fox individual (listed under the TSC Act and EPBC Act) was recorded within close proximity and is likely to utilise habitat within the study area. The field surveys for fauna were limited to opportunistic recordings of birds, reptiles and habitat assessment.

Vegetation within the study area was of low conservation importance as it provided potential habitat only for species that are adapted to disturbed urban landscapes such as bats and birds. This habitat does provide marginal habitat for a number of threatened animal species such as Powerful Owl and a variety of bats.

Based on the presence of suitable foraging habitat within the study area, five species of animal (Grey-headed Flying-fox, Eastern Free-tail Bat, Eastern Bent-wing Bat, Yellow-bellied Sheathtail Bat, Powerful Owl and Little Lorikeet) are considered to have a moderate or greater likelihood of occurrence. These species are listed as threatened under the TSC Act and EPBC Act and therefore a significance assessment under the TSC Act and EPBC Act was undertaken (refer Appendix E in Technical Paper 4). Based on the assumption that the 'Additional aerial earth (overhead) wires only' section of the proposed will require the removal of vegetation to the north of Lindfield Station, construction of the proposal at Lindfield will require the removal of up to 2.31 hectares of potential foraging habitat (which includes the 0.94 ha of native vegetation and 1.37 ha of exotic vegetation recorded on site) for these species. In the likelihood that power poles are not replaced as part of the proposal, the area of vegetation required to be removed will be reduced. Based on the small area of degraded habitat to be impacted, these species are considered unlikely to be significantly affected by the proposal. Overall, the potential impact from the proposal on the species is not considered significant with regard to its context and intensity.

No other matters of national environmental significance are likely to be impacted by the proposal.
An EPBC Act referral is not, therefore, considered to be required for the proposal.

As outlined in the TfNSW *'Vegetation Offset Guide'* (Transport for NSW 2014) a project requires offsets where there are residual impacts associated with vegetation clearing, and the impact of the proposed clearing is not deemed 'significant' for the purposes of section 111 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The vegetation clearing for the proposal would require native vegetation clearing (up to approximately 0.94 ha) that has been assessed as not 'significant'. Therefore, biodiversity offsets in accordance with the TfNSW '*Vegetation Offset Guide'* will be required if the native vegetation is removed.

9. References

Australian Weeds Committee 2013, *Weeds of National Significance*, viewed 2/12/2013 2013, <http://www.weeds.org.au/WoNS/>.

Bennett, AF 1990, *Habitat corridors: Their role in wildlife management and conservation*, Arthur Rylah Institute for Environmental Research, Melbourne.

Bennett, AF 1993, 'Fauna Conservation in Box and Ironbark Forests: A Landscape Approach', *Victorian Naturalist*, vol. 110, no. 1, pp. 15-23.

Bowles, AE 1997, 'Responses of wildlife to noise', in RL Knight & KJ Gutzwiller (eds), *Wildlife and Recreationists: Coexistence through Management and Research*, Island Press, Washington D.C.

Department of Environment and Climate Change 2007, *Threatened species assessment guidelines. The assessment of significance*, Department of Environment and Climate Change, Hurstville.

Department of Environment and Conservation 2004, *Endangered Ecological Community Information: Sydney Turpentine Ironbark Forest*, Department of Environment and Conservation, Hurstville.

Department of Industry and Investment 2010, *Profiles for species, populations and ecological communities*, Department of Industry and Investment, 2010, <http://pas.dpi.nsw.gov.au/Species/Species_Home.aspx>.

Department of the Environment 2013a, *Australian Faunal Directory*, viewed 29 November 2013, <http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/home>.

Department of the Environment 2013b, *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* Department of the Environment, Canberra.

Department of the Environment 2014a, *Blue Gum High Forest of the Sydney Basin Bioregion*, viewed 26 June 2014, <http://www.environment.gov.au/node/14558>.

Department of the Environment 2014b, *EPBC Protected Matters Search Tool*, Department of the Environment 2014, <http://www.environment.gov.au/epbc/pmst/>.

Department of the Environment 2014c, *Matters of national environmental significance*, viewed 7 May 2014, <http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999/what>.

Department of the Environment Water Heritage and the Arts 2010, *EPBC Act Policy Statement 1.2 Significant Impact Guidelines - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies*, Department of the Environment Water Heritage and the Arts,, Canberra.

Department of Trade and Investment Regional Infrastructure and Services 2014, *Noxious Weeds Declaration Page*, viewed 19 March 2014, <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed/noxious-app-application>.

Forman, RTT, Sperling, D, Bissonette, JA, Clevenger, AP, Cutshall, CD, Dale, VH, Fahrig, L, France, R, Goldman, CR, Heanue, K, Jones, JA, Swamson, FJ, Turrentine, T & Winter, TC 2000, *Road Ecology. Science and Solutions.*, Island Press, Washington.

Gibbons, P, Ayers, D, Seddon, J, Doyle, S & Briggs, S 2008, *BioMetric 2.0. A terrestrial biodiversity assessment tool for the NSW Native Vegetation Assessment Tool* NSW Department of Environment and Climate Change, Canberra.

Harden, G 1992, *Flora of New South Wales Volume 3*, University of New South Wales Press Ltd., Kensington.

Harden, G 1993, *Flora of New South Wales Volume 4*, University of New South Wales Press Ltd., Kensington.

Harden, G 2000, *Flora of New South Wales Volume 1 (Revised Edition)*, University of New South Wales Press Ltd., Kensington.

Harden, G 2002, *Flora of New South Wales Volume 2 (Revised Edition)*, 2nd edn, vol. 2, University of New South Wales Press Ltd., Kensington.

Johnson, M, Reich, P & Mac Nally, R 2007, 'Bird assemblages of a fragmented agricultural landscape and the relative importance of vegetation structure and landscape pattern', *Wildlife Research*, vol. 34, no. 3, pp. 185-93.

NSW Scientific Committee 1998, *Final determination to list Sydney Turpentine-Ironbark Forest as an Endangered ecological community*, National Parks and Wildlife Service, Hurstville.

Office of Environment and Heritage 2012, *Vegetation Types Database*.

Office of Environment and Heritage 2014a, *Blue Gum High Forest in the Sydney Basin Bioregion - critically endangered ecological community listing*, viewed 26 June 2014, <http://www.environment.nsw.gov.au/determinations/BlueGumHighForestEndSpListing.htm>.

Office of Environment and Heritage 2014b, *NSW Bionet Atlas of NSW Wildlife*, viewed 19 March 2014, <http://www.bionet.nsw.gov.au/>.

Office of Environment and Heritage 2014c, 'Threatened species, populations and ecological communities of NSW online database'.

Royal Botanic Gardens 2014, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, <http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm>.

Schwartz, A & Henderson, RW 1991, *Amphibians and Reptiles of the West Indies: descriptions, distributions, and natural history*, University of Florida Press, Gainesville.

Thackway, R & Cresswell, ID 1995, *An Interim Biogeographic Regionalisation of Australia*, Australian Nature Conservation Agency, Canberra.

Tozer, M 2003, 'The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities', *Cunninghamia*, vol. 8, no. 1, pp. 1-75.

Tozer, M, Turner, K, Simpson, C, Keith, D, Beukers, P, MacKenzie, B, Tindall, D & Pennay, C 2006, *Native Vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands. Version 1.0*, Department of Environment and Climate Change, Hurstville.

Transport for NSW 2014, *Vegetation Offset Guide 9TP-ST-149/2.0*.

Wilson, A & Lindenmayer, DB 1995, *Wildlife Corridors and the Conservation of Biodiversity: A Review.*, National Corridors of Green Program, Green Australia Ltd., Canberra.

Appendix A

Threatened species of plant

Likelihood of occurrence of threatened species and populations of plants previously recorded, or predicted to occur within 10 km of the study area

Family name	Species name	Common name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Casuarinaceae	*Allocasuarina glareicola*		E	E1	Restricted to the Sydney basin where it occurs north east of Penrith in or near Castlereagh State Forest. Grows on lateritic soil in open forest (Harden 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Casuarinaceae	*Allocasuarina portuensis*		E	E1	Known from only a single population within Sydney Harbour National Park. The single population has declined from only 10 individuals in 1986 to only a single female surviving in 2002, excluding re-introduced individuals (NSW National Parks and Wildlife Service 2004b).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Convolvulaceae	*Wilsonia backhousei*	Narrow-leafed Wilsonia		V	Occurs chiefly in the Sydney district but also common at Jervis Bay (Harden 2000). A salt tolerant species, it is found in intertidal saltmarshes and sometimes on seacliffs (NSW Scientific Committee 2000).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Epacridaceae	*Epacris purpurascens* var. *purpurascens*	-		V	Occurs in Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps (Harden 1992). Usually found in sites with a strong shale influence (NSW National Parks and Wildlife Service 2002b).	Atlas of NSW Wildlife, PlantNet	**Low.** Regrowth vegetation is too disturbed to provide habitat for this species**.**	**No.**
Fabaceae (Faboideae)	*Dillwynia tenuifolia*		V	V	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite (Harden 2002). Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include *Eucalyptus fibrosa, E. sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina* and *Allocasuarina littoralis* (James 1997).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Fabaceae (Faboideae)	*Pultenaea humilis*	Dwarf Bush Pea		V	*Pultenaea humilis* is rare in New South Wales and Tasmania, but relatively common in Victoria. In NSW, *Pultenaea humilis* is currently known from three confirmed localities in the NSW South Western Slopes bioregion. The extent of *Pultenaea humilis* in NSW is estimated to be approximately 6000 km^2. Flowering from October to December; fruiting from November to December. Dry sclerophyll forest, wet heathland or swamps on sand, loam or clay soils (Royal Botanic Gardens 2009).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoes Wattle	V	E1	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with *Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata* and *Angophora bakeri* (NSW National Parks and Wildlife Service 1999a).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Fabaceae (Mimosoideae)	*Acacia gordonii*		E	E1	Occurs in the lower Blue Mountains from Bilpin to Faulconbridge and also in the Glenorie district. Grows on sandstone outcrops and amongst rock platforms in dry sclerophyll forest and heath (Harden 2002; NSW Scientific Committee 1997). Specifically this species occurs in Sydney Sandstone Ridgetop Communities (James 1997).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Fabaceae (Mimosoideae)	*Acacia pubescens*	Downy Wattle	V	V	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravely soils often with ironstones (Harden 2002; NSW National Parks and Wildlife Service 2003).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Fabaceae (Mimosoideae)	*Acacia terminalis* subsp. *terminalis*	Sunshine Wattle	E	E1	Grows in scrub and dry sclerophyll woodland between Botany Bay and the northern foreshore of Port Jackson. The locations from which several of the early collections were made no longer provide habitat, having been cleared for development of the eastern suburbs. Recent collections have been made only from Clifton Gardens, Dover Heights, Parsley Bay, Nielsen Park, Cooper Park, Chifley and Watsons Bay (NSW National Parks and Wildlife Service 2004a).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Geraniaceae	*Pelargonium sp. Striatellum* (G. W. Carr 10345), syn. *Pelargonium sp., Pelargonium sp. 1*	Omeo Stork's-bill	E	E1	Known to occur in New South Wales and Victoria in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes and in the transition zone between surrounding grasslands or pasture and the paludal and aquatic communities. During dry periods, the species is known to colonise exposed lake beds (NSW Scientific Committee 2010).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Family name	Species name	Common name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Haloragaceae	*Haloragis exalata subsp. exalata*	Wingless Raspwort	V	V	Found in the south coast, central coast and north west slopes botanical regions where it appears to require protected and shaded damp situations in riparian habitats (Department of Environment and Climate Change 2008; Harden 1992, 2002).	EPBC search	**Low**. No preferred habitat recorded in the study area.	**No.**
Haloragaceae	*Haloragodendron lucasii*		E	E1	Confined to the Sydney area where it grows in dry sclerophyll open forest on sheltered slopes near creeks on sandstone (Harden 2002). Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. Associated with high soil moisture and relatively high soil-phosphorus levels (Department of Environment and Conservation 2005).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Camarophyllopsis kearneyi*			E1	Small, pale, gilled fungus and is known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney (NSW National Parks and Wildlife Service 2002a).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Hygrocybe anomala* var. *ianthinomarginata*			V	Small, brightly-coloured gilled fungus and has been found in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from Royal and Blue Mountains National Parks (NSW National Parks and Wildlife Service 2002c).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Hygrocybe aurantipes*			V	Small, brightly-coloured gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney and from the Blue Mountains National Park (Mt Wilson) and Hazelbrook and surveys in potentially suitable habitats elsewhere in the Sydney Basin Bioregion have failed to find Hygrocybe aurantipes A. M. Young. At Lane Cove the species occurs not only in leaf litter but also on mossy creek banks, under a closed canopy. The species does not produce basidiomes all year, but non-reproductive hyphal structures occur below ground (NSW National Parks and Wildlife Service 2002d).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Hygrocybe austropratensis*			E1	Small, brightly-coloured gilled fungus and known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney (NSW National Parks and Wildlife Service 2002e).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Hygrocybe lanecovensis*			E1	Small, brightly-coloured gilled fungus and known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney (NSW National Parks and Wildlife Service 2002f).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Hygrocybe reesiae*			V	Small, lilac coloured gilled fungus and is known in New South Wales only from its type locality in the Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from the Blue Mountains National Park (Hazelbrook Area). It is also found in Tasmania (NSW National Parks and Wildlife Service 2002g).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Hygrophoraceae	*Hygrocybe rubronivea*			V	Small, brightly-coloured gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove local government area in Sydney (NSW National Parks and Wildlife Service 2002h).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Lamiaceae	*Prostanthera junonis*	Somersby Mintbush	E	E1	Grows in sclerophyll forest and woodland, usually near the coast, in sandy loamy soils, overlying sandstone. Occurs in Mangrove Mtn and Sydney districts (Harden 1992).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Lamiaceae	*Prostanthera marifolia*		CE	CE	Previously thought to be extinct this species recorded within the Sydney harbor region in 2001. Previously occurred in Mangrove Mountain and Sydney districts usually near the coast. Recorded within sclerophyll forest and woodland in sandy loamy soils on sandstone Occurs in the Springwood area where it grows in woodland on lateritic soils (Harden 1992). The taxonomic status of this name is uncertain (Royal Botanic Gardens 2004).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**

Family name	Species name	Common name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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 2010).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1999a).	Atlas of NSW Wildlife, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Myrtaceae	*Darwinia biflora*		V	V	Occurs from Cheltenham to Hawkesbury River where it grows in heath on sandstone or in the understorey of woodland on shale-capped ridges (Harden 2002). Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma, Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath (Department of Environment and Climate Change 2008).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low.** Regrowth vegetation is too disturbed to provide habitat for this species**.**	**No.**
Myrtaceae	*Darwinia peduncularis*			V	Occurs from Hornsby to Hawkesbury River and west to Glen Davies where it grows in dry sclerophyll forest on sandstone hillsides and ridges (Harden 2002). Known to occur along watercourses (Benson 2001). Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone (Department of Environment and Climate Change 2007).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
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 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).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Myrtaceae	*Eucalyptus nicholii*	Narrow-leaved Black Peppermint	V	V	Occurs from Niangala to Glenn Innes where it grows in grassy sclerophyll woodland on shallow relatively infertile soils on shales and slates, mainly on granite (Harden, 1991; DLWC, 2001). Endemic on the NSW Northern Tablelands, of limited occurrence, particularly in the area from Walcha to Glen Innes; often on porphyry or granite (Brooker and Kleinig 1999).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Myrtaceae	*Leptospermum deanei*		V	V	Only occurs near the watershed of Lane Cove River where it grows on forested slopes (Harden 2002).Woodland on lower hills and slopes or near creeks, sandy alluvial soil or sand over sandstone. Occurs in Riparian Scrub- e.g. *Tristaniopsis laurina, Baechea myrtifolia*, Woodland- e.g. *Eucalyptus haemstoma* and Open Forest - e.g. *Angophora costata, Leptospermum trinervium* and *Banksia ercifolia* (Department of Environment and Climate Change).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1998a). 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).	EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Myrtaceae	*Melaleuca deanei*	Deanes Paperbark	V	V	Occurs in coastal districts, including western Sydney (e.g. Baulkham Hills, Liverpool shires) from Berowra to Nowra where it grows in wet heath on sandstone and shallow/skeletal soils near streams or perched swamps (Harden 2002; James 1997).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**

Family name	Species name	Common name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	E1	Occurs between Buladelah 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 Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Myrtaceae	*Triplarina imbricata*	Creek Triplarina	E	E1	Occurs along the coast and adjacent ranged in the Tabulum and Nymboida districts where it grows in heath often in damp areas. It has been recorded along watercourses in low open forest in association with *Tristaniopsis laurina* (Harden 2000; NSW National Parks and Wildlife Service 2002i).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1999c).	EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Orchidaceae	*Genoplesium baueri*	Bauers Midge Orchid		V	Grows in sparse sclerophyll forest and moss gardens over sandstone; from the Hunter Valley to Nowra district (Royal Botanic Gardens 2004).	Atlas of NSW Wildlife, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Orchidaceae	*Genoplesium plumosum*		E	CE	Known from two areas, immediately around Tallong township in the Southern Highlands and Morton National Park. In Morton NP the site is 8.5 km south-east of Wingello and less than 0.2 ha in area (Department of Environment and Climate Change 2008). At Tallong the sites are all in remnant bushland but close to rural and residential development (NSW National Parks and Wildlife Service 1999b). This species occurs in heathland with dominant species *Kunzea parvifolia, Calytrix tetragona* and *Dillwynia* spp. Microhabitat is very shallow soils, or within moss covered soils on sandstone conglomerate shelves (Department of Environment and Climate Change 2008). At Tallong, the species may also occur on the margins of dry sclerophyll forest in the same microhabitat (NSW National Parks and Wildlife Service 1999b).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Orchidaceae	*Microtis angusii*		E	E1	Known from few small populations at Sunny Corner near Bathurst, Ingleside and Warringah. Known to occur within Duffy's Forest (Warringah Shire Council 2004).	EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Poaceae	*Deyeuxia appressa*		E	E1	Occurs in the Hornsby area on wet ground. (Harden 1993; Sharp & Simon 2002).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
Proteaceae	*Grevillea caleyi*	Caleys Grevillea	E	E1	Occurs in the Terrey Hills-Belrose area north of Sydney where it grows in woodland on laterized sandstone ridgetops (Harden 2002).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area. No recent records within 10km of the study area.	**No.**

Family name	Species name	Common name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Proteaceae	*Grevillea shiiressii*		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).	EPBC search	**Low**. No preferred habitat recorded in the study area.	**No.**
Proteaceae	*Persoonia hirsuta*	Hairy Geebung	E	E1	Occurs from Gosford to the Royal National Park and Hill Top to Glen Davis and Putty inland where it grows in woodlands and dry sclerophyll forest on sandstone or very rarely on shale (Harden 2002). Typically occurs as isolated individuals or very small populations (NSW Scientific Committee 1998b; Royal Botanic Gardens 2005). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997). Habitat in Castle Hill is considered to be "critical habitat" (James 1997).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low.** No preferred habitat recorded in the study area. No recent records within 10km of the study area.	**No.**
Proteaceae	*Persoonia hirsuta* subsp. *hirsuta*	Hairy Geebung	E	E1	Occurs from Gosford to the Royal National Park and Hill Top to Glen Davis and Putty inland where it grows in woodlands and dry sclerophyll forest on sandstone or very rarely on shale (Harden 2002). Typically occurs as isolated individuals or very small populations (NSW Scientific Committee 1998b; Royal Botanic Gardens 2005). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997). Habitat in Castle Hill is considered to be "critical habitat" (James 1997).	PlantNet	**Low.** Vegetation is too disturbed to provide habitat for this species**.** Species has not been recorded within 10km of the study area in over 10 years.	**No.**
Proteaceae	*Persoonia mollis* subsp. *maxima*		E	E1	Restricted to the Hornsby Heights, Mt Colah area north of Sydney. It occurs on sheltered upper hillsides of narrow gullies of Hawkesbury sandstone characterised his by steep sideslopes, rocky benches and broken scarps, with creeks fed by small streams and intermittent drainage depressions. It grows in moist, tall forest (*Angophora costata, Eucalyptus piperita, Corymbia gummifera*), often with warm temperate rainforest influences (*Syncarpia glomulifera, Ceratopetalum apetalum, Callicoma serratifolia*). Sometimes recorded in low densities on the dry upper-hillsides of gullies and in more exposed aspects in association with *E. haemastoma* and *E. punctata* (NSW National Parks and Wildlife Service 2000a).	EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area. No records of the species within 10km of the study area.	**No.**
Rubiaceae	*Galium australe*	Tangled Bedstraw		E1	Previously presumed extinct in NSW, this species is now known from a number of sites in coastal regions. In NSW, this species has been recorded in moist gullies of tall forest, *Eucalyptus tereticornis* forest, coastal Banksia shrubland, and Allocasuarina nana heathland. In other States the species is found in a range of near-coastal habitats, including sand dunes, sand spits, shrubland and woodland (Department of Environment and Conservation 2005; Royal Botanic Gardens 2005).	PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**
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	**Low**. No preferred habitat recorded in the study area.	**No.**
Sterculiaceae	*Lasiopetalum joyceae*		V	V	Occurs on lateritic to shaley ridgetops of the Hornsby Plateau where it grows in heath and open woodland in sandy soils on sandstone (Fairley, A. & Moore 2002; Harden 2000; NSW Scientific Committee 1999b).	EPBC, PlantNet	**Low.** Vegetation is too disturbed to provide habitat for this species.	**No.**
Thymelaeaceae	*Pimelea curviflora* var. *curviflora*		V	V	Confined to coastal areas around Sydney where it grows on sandstone and laterite soils. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville, but its former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Usually occurs in woodland in the transition between shale and sandstone, often on Lucas Heights soil landscape (Harden 2000; James 1997; James *et al.* 1999; NSW Scientific Committee 1998c).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low**. No preferred habitat recorded in the study area.	**No.**

Family name	Species name	Common name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Thymelaeaceae	*Pimelea spicata*	Spiked Rice-flower	E	E1	This species occurs in two disjunct areas: in coastal districts from Lansdowne to Shellharbour, and in Cumberland Plain Woodland inland to Penrith. In western Sydney it grows on Wianamatta Shales in Greybox - Ironbark Woodland with *Bursaria spinosa* and *Themeda australis*. In the Illawarra, it occurs on well-structured clay soils in grassland or open woodland (Harden 2000; James 1997; NSW National Parks and Wildlife Service 2000b).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Tremandraceae	*Tetratheca glandulosa*	Glandular Pink-bell	V	V	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992). Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar). Common woodland tree species include: *Corymbia gummifera, C. eximia, Eucalyptus haemastoma, E. punctata, E. racemosa*, and/or *E. sparsifolia*, with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae (Department of Environment and Climate Change 2008).	Atlas of NSW Wildlife, EPBC, PlantNet	**Low.** Vegetation is too disturbed to provide habitat for the species. Species has not been recorded within 10km of the study area for over 50 years.	**No.**

Notes:
1. Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the *Environment Protection and Biodiversity Conservation Act*.
2. Listed as an Endangered Population (EP), Vulnerable (V), Endangered (E1), Critically Endangered (CE) or Extinct (E4) under the *Threatened Species Conservation 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 4 of the main report

References

Australian Tropical Rainforest Plants 2010, *Streblus pendulinus*, 2010, <http://keys.trin.org.au:8080/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Streblus_pendulinus.htm>.

Benson, D 2001, *Making bush regeneration work. Watercourses: conservation and regeneration*, Nature Conservation Council Urban Bushland Committee, Sydney.

Benson, D & McDougall, L 1998, 'Ecology of Sydney plant species Part 6: Dicotyledon family Myrtaceae ', *Cunninghamia*, vol. 5, pp. 809-987.

Bishop, T 2000, *Field guide to the orchids of New South Wales and Victoria*, Second edn, University of New South Wales Press Pty. Ltd., Sydney.

Department of Environment and Climate Change *Threatened Species Profile: Leptospermum deanei*, Department of Environment and Climate Change, viewed 9th June 2009 <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10468>.

Department of Environment and Climate Change 2007, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2007, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Department of Environment and Climate Change 2008, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2008, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Department of Environment and Conservation 2005, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2006, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Department of Environment Water Heritage and the Arts 2008, *Approved Conservation Advice for Eucalyptus camfieldii (Camfield's Stringybark)*, Department of Environment Water Heritage and the Arts, Canberra.

Director of National Parks 2010, *Norfolk Island Region Threatened Species Recovery Plan*, Director of National Parks Department of the Environment, Water, Heritage and the Arts, Canberra.

Fairley, A 2004, *Seldom Seen: Rare Plants of Greater Sydney.*, 1st edn, Reed New Holland, Sydney.

Fairley, A & Moore, P 2002, *Native plants of the Sydney district. An identification guide*, Revised Edition edn, Kangaroo Press, Sydney.

Harden, G 1992, *Flora of New South Wales Volume 3*, University of New South Wales Press Ltd., Kensington.

Harden, G 1993, *Flora of New South Wales Volume 4*, University of New South Wales Press Ltd., Kensington.

Harden, G 2000, *Flora of New South Wales Volume 1 (Revised Edition)*, University of New South Wales Press Ltd., Kensington.

Harden, G 2002, *Flora of New South Wales Volume 2 (Revised Edition)*, 2nd edn, vol. 2, University of New South Wales Press Ltd., Kensington.

James, T 1997, *Urban bushland biodiversity survey. Native flora in western Sydney.* , NSW National Parks and Wildlife Service, Hurstville,

James, T, McDougall, L & Benson, D 1999, *Rare bushland plants of western Sydney*, Royal Botanic Gardens, Sydney.

Leigh, J, Boden, R & Briggs, J 1984, *Extinct and Endangered Plants of Australia*, Macmillan, Melbourne.

NSW National Parks and Wildlife Service 1999a, *Acacia bynoeana threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999b, *Genoplesium plumosum threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999c, *Terms of licence under the Threatened Species Conservation Act 1995. Appendix B of the Integrated Forestry Operations Approval for the Upper North East Region.*,

NSW National Parks and Wildlife Service 2000a, *Persoonia mollis ssp. maxima threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2000b, *Pimelea spicata threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002a, *Camarophyllopsis kearneyi (an agaric fungus) - endangered species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002b, *Epacris purpurascens var. purpurascens threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002c, *Hygrocybe anomala var. ianthinomarginata (an agaric fungus) - vulnerable species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002d, *Hygrocybe aurantipes (an agaric fungus) - vulnerable species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002e, *Hygrocybe austropratensis (an agaric fungus) - endangered species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002f, *Hygrocybe lanecovensis (an agaric fungus) - endangered species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002g, *Hygrocybe reesiae (an agaric fungus) - vulnerable species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002h, *Hygrocybe rubronivea (an agaric fungus) - vulnerable species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002i, *Threatened species of the upper north coast of New South Wales - Flora*, NSW National Parks and Wildlife Service, Northern Directorate, Coffs Harbour.

NSW National Parks and Wildlife Service 2003, *Acacia pubescens threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2004a, *Acacia terminalis subsp. terminalis threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2004b, *Allocasuarina portuensis threatened species listing*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1997, *Final determination to list Acacia gordonii as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998a, *Final determination to list Melaleuca biconvexa as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998b, *Final determination to list Persoonia hirsuta as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998c, *Final determination to list Pimelea curviflora var curviflora as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1999a, *Final determination to list Callistemon linearifolius as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1999b, *Final determination to list Lasiopetalum joyceae as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2000, *Final determination to list Wilsonia backhousei as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2002, *Final determination to list Caladenia tessellata as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2010, *Pelargonium sp. - endangered species listing*, NSW Scientific Committee, Hurstville.

Robinson, L 1994, *Field guide to the native plants of Sydney*, Kangaroo Press, Sydney.

Royal Botanic Gardens 2004, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Royal Botanic Gardens 2005, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Royal Botanic Gardens 2009, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, <http://plantnet.rbgsyd.nsw.gov.au/>.

Sharp, D & Simon, BK 2002, *AusGrass: Grasses of Australia, CD-ROM, Version 1.0*, Australian Biological Resources Study, Canberra, and Environmental Protection Agency, Queensland.,

Warringah Shire Council 2004, *http://www.warringah.nsw.gov.au/index.htm*, Warringah Shire Council.

Appendix B

Threatened species of animal

Likelihood of occurrence of threatened species and populations of animals previously recorded, or predicted to occur within 10 km of the study area

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Amphibians							
Heleioporus australiacus	Giant Burrowing Frog	V	V	Exists as two distinct populations: a northern population on the sandstone geology of the Sydney Basin, from Wollemi National Park in the north, south to Jervis Bay; and a southern population in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys where the frog is associated with small headwater and slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from collected water. Also observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised and are surrounded by undisturbed habitat. In the southern population, records appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. It is absent from areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	Atlas of NSW Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Litoria aurea	Green and Golden Bell Frog	V	E1	Has a fragmented distribution of mainly near coastal locations from Lakes Entrance (Victoria) to south of the NSW-Queensland 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 that are more often dry than wet. It is found in small pockets of habitat in otherwise developed areas and has the tendency of often turning up in highly disturbed sites. Fast flowing rivers and streams appear to be one of the few types of water body not utilized for breeding purposes. Habitat attributes associated with the species' presence include that the water body is shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. Permanent waterbodies are also known to be used and there is historical evidence of occupation of large, often deep and permanent bodies of water. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes that favour the species 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 for this purpose is not yet well understood (Department of Environment and Conservation 2004, 2005).	Atlas of NSW Wildlife, EPBC	**Low.** No preferred habitat within the study area and no records of the species within 8km of the study area.	**No.**
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	**Low**. No preferred habitat recorded in the study area.	**No.**
Mixophyes balbus	Stuttering Frog	V	E1	Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (Cogger 2000; NSW Scientific Committee 2003).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Pseudophryne australis	Red-crowned Toadlet		V	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs (Cogger 2000).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Birds							
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 Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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 1999).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Ardea modesta	Eastern Great Egret	M		Great Egrets occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in groups. In Australia, the breeding season of the Great Egret is normally October to December in the south and March to May in the north. This species breeds in colonies, and often in association with cormorants, ibises and other egrets. (Australian Museum 2003).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Arenaria interpres	Ruddy Turnstone	M		Occurs at beaches and coasts with exposed rock, stony or shell beaches, mudflats, exposed reefs and wave platforms (Morcombe 2003).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 & Davies 1996).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 & 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 & Davies 1996) and amongst seaweed, mud and cow-pats (Hobbs 1961). During high tides they may also use sand dunes and claypans.	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Calidris tenuirostris	Great Knot	M	V	Generally a coastal species found on tidal mudflats and sandy ocean shores. A migratory species visiting Australian waters between September and March (Pizzey & Knight 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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 1997).	Atlas of NSW Wildlife	**Low**. **The vegetation on site is likely to be too disturbved to provide habitat for the species.**	**No.**
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 1999a).	Atlas of NSW Wildlife	**Low**. **The vegetation on site is likely to be too disturbved to provide habitat for the species.**	**No.**
Charadrius bicinctus	Double-banded Plover	M		The Double-banded Plover is found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers. It is sometimes associated with coastal lagoons, inland saltlakes, exposed seagrass beds, exposed reefs and rock platforms and coastal sand dunes (Marchant & Higgins 1993).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Cuculus opatus (syn. Cuculus saturatus)	Oriental Cuckoo, Himalayan Cuckoo	M		A non-breeding migrant to Australia, it often inhabits rainforest, vine thickets, wet sclerophyll forest and open woodland and sometimes occurs in mangroves, wooded swamps and as vagrants in gardens (Higgins 1999). The population trend appears to be stable (BirdLife International 2009a).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 2010b).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 dependant 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	**Low**. No preferred habitat recorded in the study area.	**No.**
Diomedea antipedensis	Antipodean Albatross	VM	V	A nomadic marine species that occasionally breeds off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Diomedea dabbena	Tristan Albatross	E		Breeding range now restricted to Inaccessible and Gough Island., having been eliminated from the main island of Tristan de Cunha by 1907. Current global population estimated to contain about 1,000 breeding pairs. There is only one record from Australian waters. Breed biennially in colonies among grass tussocks on isolated subantarctic islands and feed pelagically on squid, fish and crustaceans (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Diomedea epomophora	Royal Albatross	VM		A nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Diomedea exulans	Wandering Albatross	VM	E1	Nomadic marine species, that breeds in small loose colonies among grass tussocks, using a large mud nets, sometimes off the coast of NSW (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Diomedea gibsoni	Gibson's Albatross	VM	V	A nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Fregetta grallaria	White-bellied Storm-Petrel		V	Marine species, breeding on Lord Howe Island (Department of Environment and Climate Change 2007).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1999).	Atlas of NSW Wildlife	**Moderate.** Marginal foraging habitat recorded within the study area.	**Yes.**
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 1997).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	Atlas of NSW Wildlife, EPBC	**Moderate.** Marginal foraging habitat was recorded within the study area.	**No.**
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 Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area, no flowering Eucalypt species recorded within the study area.	**No.**
Limosa lapponica	Bar-tailed Godwit	M		Occurs in coastal mudflats, sandbars, shores of estuaries, salt marsh and sewage ponds (Morcombe 2003).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Macronectes giganteus	Southern Giant-Petrel	EM	E1	A partly nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Macronectes halli	Northern Giant-Petrel	VM	V	Nomadic marine species, that nest as dispersed pairs, often amidst tussocks in dense vegetation. Forages in inshore waters of southern Australia and occasionally visits the coast of NSW (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1999).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Nettapus coromandelianus	Cotton Pygmy-Goose		E1	Found on freshwater lakes, swamps, and large water impoundments. Congregates in flocks on permanent water bodies during the dry season. Lays eggs in the hollow of trees that stand in or beside water. Principal foods are Pondweed Potamogeton seeds and other aquatic vegetation (Garnett & Crowley 2000).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife	**Moderate.** Potential foraging habitat recorded within the study area and there are recordings of the species within 500m of the study area.	Yes.
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 2009b).	Atlas of NSW Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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 1997).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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 2010a; Higgins & 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 Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Polytelis swainsonii	Superb Parrot	V	V	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the inland slopes, Superb Parrots both forage and feed within box woodland, mostly nesting in dead trees (Garnett & Crowley 2000).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Pterodroma neglecta	Kermadec Petrel	V		An oceanic species that forages in the tropical and subtropical pacific ocean (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1997).	Atlas of NSW Wildlife	**Low**. Although marginal foraging habitat is present within the study area there are no recent previous records (most recent 1978) of the species occurring within the broader locality.	**No.**
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 1997).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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	**Low**. No preferred habitat recorded in the study area.	**No.**
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 *et al.* 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 & Davies 1996; Hill *et al.* 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 & De Rebeira 1985).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
Thalassarche bullei	Buller's Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Thalassarche cauta	Shy Albatross	VM	V	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Thalassarche impavida	Cambells Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Thalassarche melanorphis	Black-browed Albatross	VM	V	Nomadic marine species that breeds on subantarctic island outside Australian waters, but moves northwards in non-breeding seasons. The waters off southern Australia between Brisbane and Perth are the principal feeding area of birds (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Thalassarche salvini	Salvin's Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Thalassarche steadi	White-capped Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 & 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 & Davies 1996; Rogers 1999).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Tringa stagnatilis	Marsh Sandpiper	M		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).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 (Pollard 1999).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Macquaria australasica	Macquarie Perch	E		The natural range of Macquarie Perch included the upper and middle reaches of the Murray-Darling basin as well as the Shoalhaven and Hawkesbury Rivers. However, this species has recently been sighted in only a few localities within these river systems. Preferred habitat is deep holes covered with rocks, and spawning occurs above shallow running water. Macquarie Perch is a schooling species (Department of the Environment and Water Resources, 2007).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Prototroctes maraena	Australian Grayling	V		It is a mid-water, freshwater species that occurs most commonly in clear, gravelly streams with a moderate flow. Prefers deep, slow flowing pools (NSW Fisheries 2004).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
Mammals							
Cercartetus nanus	Eastern Pygmy-possum		V	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds' nests and shredded bark in the fork of trees (Turner & Ward 1995).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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).	Atlas of NSW Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 1999e). 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, 1999e).	Atlas of NSW Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
Isoodon obesulus	Southern Brown Bandicoot	E	E1	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire (NSW National Parks and Wildlife Service 1999c).	Atlas of NSW Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 Wildlife	**Moderate.** Potential habitat in the study area and the species has been recorded previously within 1km of the study area.	**Yes.**
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 Wildlife	**Moderate.** Potential habitat in the study area.	**Yes.**
Petaurus australis	Yellow-bellied Glider		V	Restricted to tall, mature eucalypt forest in high rainfall areas of temperate to sub-tropical eastern Australia. Feeds on nectar, pollen, the sap of eucalypts and sometimes insects. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows and year round food resources are available from a mixture of eucalypt species (NSW National Parks and Wildlife Service 1999f, 2003c).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**
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	**Low**. No preferred habitat recorded in the study area.	**No.**
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 favored (NSW National Parks and Wildlife Service 1999b, 2003b). Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW TSC Act.	Atlas of NSW Wildlife, EPBC	**Low.** No preferred habitat in the study area due to the absence of feed trees, fragmentation and highly disturbed nature of the study area.	**No.**

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source[3]	Likelihood of occurrence[4]	Significant assessment required?
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 1999e).	EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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).	Atlas of NSW Wildlife, EPBC	**Low**. No preferred habitat recorded in the study area.	**No.**
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 lilypillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001b)	Atlas of NSW Wildlife, EPBC	**High.** Species was recorded within approximately 20 m of the study area and potential foraging habitat located within the study area.	**Yes.**
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 Wildlife	**Moderate.** Potential foraging habitat located within the study area.	**Yes.**
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	**Low**. No preferred habitat recorded in the study area.	**No.**
Varanus rosenbergi	Heath Monitor (Rosenberg's Goana)		V	Found in coastal heaths, humid woodlands, wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in burrows, hollow logs and rock crevices (Cogger 2000).	Atlas of NSW Wildlife	**Low**. No preferred habitat recorded in the study area.	**No.**

Notes:
1. Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the Environment Protection and Biodiversity Act.
2. Listed as an Endangered Population (EP), Vulnerable (V), Endangered (E1), Critically Endangered (CE) or Extinct (E4) under the Threatened Species Conservation 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
4. Refer to Section 4 of the main report

References

Australian Museum 2003, *Great Egret factsheet*, Australian Museum,

Barrett, G, Silcocks, A, Barry, S, Cunningham, R & Poulter, R 2003, *The New Atlas of Australian Birds*, Royal Australian Ornithologists Union, Hawthorn East, Victoria.

BirdLife International 2009a, *Cuculus optatus. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2*, viewed 18 January 2012.

BirdLife International 2009b, *Numenius minutus. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2*, viewed 18 January 2012.

Churchill, S 1998, *Australian Bats*, Reed New Holland, Sydney.

Churchill, S 2008, *Australian Bats*, 2nd edn, Allen & Unwin, Sydney.

Cogger, HG 2000, *Reptiles and Amphibians of Australia*, Reed Books, Sydney.

Department of Environment and Conservation 2004, *Green and Golden Bell Frog environmental impact assessment guidelines* Department of Environment and Conservation (NSW), Hurstville.

Department of Environment and Conservation 2005, *Draft Recovery Plan for the Green and Golden Bell Frog (Litoria aurea)*, Department of Environment and Conservation (NSW), Hurstville, NSW,

Department of Environment Climate Change and Water 2010a, *Scarlet Robin Petroica boodang - proposed vulnerable species listing*, Department of Environment Climate Change and Water, viewed 20 April 2010, <http://www.environment.nsw.gov.au/determinations/scarletrobinpd.htm>.

Department of Environment Climate Change and Water 2010b, *Varied Sittella Daphoenositta chrysoptera (Latham 1802) - vulnerable species listing*, Department of Environment Climate Change and Water, viewed 20 April 2010, <http://www.environment.nsw.gov.au/determinations/variedsittellaFD.htm>.

Garnett, ST & Crowley, GM (eds) 2000, *The Action Plan for Australian Birds*, Canberra.

Higgins, PJ (ed.) 1999, *Handbook of Australian, New Zealand and Antarctic Birds Volume 4: Parrots to Dollarbirds*, Volume 4: Parrots to Dollarbird, Oxford University Press, Melbourne.

Higgins, PJ & Davies, SJF (eds) 1996, *Handbook of Australian, New Zealand and Antarctic Birds.*, Volume 3 Snipe to Pigeons, Oxford University Press, Melbourne.

Higgins, PJ & Peter, JM (eds) 2002, *Handbook of Australian, New Zealand and Antarctic Birds*, Volume 6: Pardalotes to Shrike-thrushes, Oxford University Press, Melbourne.

Hill, R, Bamford, M, Rounsevell, D & Vincent, J 1988, *Little Terns and Fairy Terns in Australia*, RAOU Report 53, Royal Australasian Ornithologists Union.

Hobbs, JN 1961, 'The birds of south-west New South Wales', *Emu*, vol. 61, pp. 21-55.

Johnston, PG 1995, 'Long-nosed Potoroo', in R Strahan (ed.), *The Mammals of Australia*, Reed New Holland, Sydney, pp. 301-2.

Marchant, S & Higgins, PJ 1990, *Handbook of Australian, New Zealand and Antarctic Birds*, Volume One - Ratites to Ducks, Oxford University Press, Melbourne.

Marchant, S & Higgins, PJ (eds) 1993, *Handbook of Australian, New Zealand and Antarctic Birds Volume 2: Raptors to Lapwings*, vol. 2, Volume 2: Raptors to Lapwings, Oxford University Press, Melbourne.

Morcombe, M 2003, *Field guide to Australian birds*, Steve Parish Publishing, Archerfield, Queensland.

Morton, SR, Brennan, KG & Armstrong, MD 1989, *Distribution and Abundance of Waterbirds in the Alligator Rivers Region, Northern Territory Volume 1.*

NSW Fisheries 2004, *Status and monitoring of the Australian Grayling in NSW*, NSW Fisheries.

NSW National Parks and Wildlife Service 1997, *Submission to the mining warden's inquiry into the renewal of special leases 567 and 568 for the extraction of peat from Wingecarribee Swamp*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999a, *Glossy Black-cockatoo threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999b, *Koala threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999c, *Southern Brown Bandicoot threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999d, *Spotted-tailed Quoll threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999e, *Terms of licence under the Threatened Species Conservation Act 1995. Appendix B of the Integrated Forestry Operations Approval for the Upper North East Region.*,

NSW National Parks and Wildlife Service 1999f, *Yellow-bellied Glider threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2001a, *Giant Burrowing Frog threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2001b, *Grey-headed Flying Fox threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002, *Threatened Species of the Upper North Coast of New South Wales - Fauna*, NSW National Parks and Wildlife Service, Northern Directorate, Coffs Harbour.

NSW National Parks and Wildlife Service 2003a, *Brush-tailed Rock Wallaby Warrumbungles endangered population threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003b, *Draft Recovery Plan for the Koala*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003c, *Recovery Plan for the Yellow-bellied Glider (Petaurus australis)*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2000, *Final determination to list Littlejohn's tree Frog as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2003, *Final determination to list the Stuttering Frog as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

Office of Environment and Heritage 2011, *Threatened species, populations and ecological communities of NSW online database*, NSW Government, <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx>.

Pizzey, G & Knight, F 1997, *Field Guide to the Birds of Australia*, Harper and Collins, Sydney.

Pollard, D 1999, 'Black Cod- Species Notes', *The Newsletter of the Marine Parks Authority Summer 1999/Autumn 2000. Volume Issue No. 1*.

Rogers, D 1999, 'Roost choice in the waders of Roebuck Bay: is avoiding heat stress their main consideration?', *Stilt*, vol. 35, p. 65.

Saunders, D & De Rebeira, P 1985, *The Birdlife of Rottnest Island*, The Authors, Perth.

Swift Parrot Recovery Team 2001, *Swift Parrot Recovery Plan*, Department of Primary Industries, Water and Environment, Hobart.

Threatened Species Scientific Committee 2010, *Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) - Pseudomys novaehollandiae*, Threatened Species Scientific Committee, Canberra.

Turner, V & Ward, SJ 1995, 'Eastern Pygmy-possum', in R Strahan (ed.), *The Mammals of Australia*, Reed New Holland, Sydney, pp. 217-8.

Webb, JK & Shine, R 1994, *Habitat use by the broad-headed snake, Hoplocephalus bungaroides*, Environment Australia, Canberra.

Webb, JK & Shine, R 1998, 'Ecological characteristic of an endangered snake species *Hoplocephalus bungaroides* (Serpentes: Elapidae)', *Animal Conservation*, vol. 1, pp. 185-93.

Appendix C

Plant species recorded

Plant species recorded

Family name	Scientific name	Common name	Native	Wons[1]
Alliaceae	*Agapanthus praecox*	Agapanthus	False	
Anthericaceae	*Laxmannia gracilis*	Slender Wire-lily	True	
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	False	
Apiaceae	*Trachymene incisa*		True	
Apocynaceae	*Nerium oleander*	Oleander	False	
Asclepiadaceae	*Araujia sericifera*	Moth Vine	False	
Asclepiadaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	False	
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	False	Yes
Asparagaceae	*Asparagus asparagoides*	Bridal Creeper	False	Yes
Asparagaceae	*Asparagus officinalis*	Asparagus	False	Yes
Asteraceae	*Ageratina adenophora*	Crofton Weed	False	Yes
Asteraceae	*Bidens pilosa*	Cobblers Pegs	False	
Asteraceae	*Cirsium vulgare*	Spear Thistle	False	
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	False	
Asteraceae	*Gamochaeta calviceps*	Silky Cudweed	False	
Asteraceae	*Hypochaeris radicata*	Catsear	False	
Asteraceae	*Taraxacum officinale*	Dandelion	False	
Bignoniaceae	*Jacaranda mimosifolia*	Jacaranda	False	
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	True	
Casuarinaceae	*Allocasuarina littoralis*	Black Sheoak	True	
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	True	
Commelinaceae	*Tradescantia albiflora*	Wandering Jew	False	
Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	False	
Convolvulaceae	*Ipomoea indica*	Blue Morning Glory	False	
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	True	
Epacridaceae	*Leucopogon juniperinus*	Long-flower Beard-heath	True	
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart, Native Poplar	True	
Euphorbiaceae	*Triadica sebifera*	Chinese Tallowood	False	
Fabaceae (Caesalpinioideae)	*Senna pendula*	Easter Cassia	False	
Fabaceae (Faboideae)	*Dipogon lignosus*	Dolichos Pea	False	
Fabaceae (Faboideae)	*Genista monspessulana*	Montpellier Broom	False	
Fabaceae (Faboideae)	*Glycine clandestina*	Twining Glycine	True	
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla	True	
Fabaceae (Faboideae)	*Indigofera australis*	Austral Indigo	True	
Fabaceae (Faboideae)	*Kennedia rubicunda*	Red Kennedy Pea	True	
Fabaceae (Faboideae)	*Lotus sp.*		True	
Fabaceae (Faboideae)	*Medicago lupulina*	Black Medic	False	
Fabaceae (Faboideae)	*Vicia sativa*	Common Vetch	False	
Fabaceae (Mimosoideae)	*Acacia falcata*		True	
Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally	True	
Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle	True	
Fabaceae (Mimosoideae)	*Acacia longifolia*	Sydney Golden Wattle	True	

Family name	Scientific name	Common name	Native	Wons[1]
Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle	True	
Fabaceae (Mimosoideae)	*Acacia salicina*	Cooba	True	
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	False	
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	True	
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	True	
Malaceae	*Cotoneaster pannosus*	Velvet Cotoneaster	False	
Malvaceae	*Modiola caroliniana*	Red-flowered Mallow	False	
Malvaceae	*Sida rhombifolia*	Paddys Lucerne	False	
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	True	
Myrtaceae	*Callistemon rigidus*	Stiff Bottlebrush	True	
Myrtaceae	*Eucalyptus haemastoma*	Broad-leaved Scribbly Gum	True	
Myrtaceae	*Eucalyptus resinifera subsp. resinifera*		True	
Myrtaceae	*Eucalyptus saligna x botryoides*		True	
Myrtaceae	*Kunzea ambigua*	Tick Bush	True	
Myrtaceae	*Leptospermum juniperinum*		True	
Myrtaceae	*Lophostemon confertus*	Brush Box	True	
Myrtaceae	*Melaleuca hypericifolia*		True	
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	False	
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	False	
Oleaceae	*Ligustrum sinense*	Small-leaved Privet	False	
Oleaceae	*Olea europaea subsp. cuspidata*		False	
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	True	
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	True	
Plantaginaceae	*Plantago lanceolata*	Lambs Tongues	False	
Poaceae	*Aristida ramosa*	Cane Wire-grass	True	
Poaceae	*Briza maxima*	Quaking Grass	False	
Poaceae	*Bromus catharticus*	Prairie Grass	False	
Poaceae	*Chloris divaricata*		True	
Poaceae	*Chloris gayana*	Rhodes Grass	False	
Poaceae	*Cynodon dactylon*	Common Couch	True	
Poaceae	*Ehrharta erecta*	Panic Veldtgrass	False	
Poaceae	*Entolasia marginata*	Bordered Panic	True	
Poaceae	*Eragrostis curvula*	African Lovegrass	False	
Poaceae	*Imperata cylindrica*	Bladey Grass	True	
Poaceae	*Microlaena stipoides*		True	
Poaceae	*Nassella neesiana*	Chilean Needle Grass	False	Yes
Poaceae	*Oplismenus aemulus*		True	
Poaceae	*Paspalum dilatatum*	Paspalum	False	
Poaceae	*Paspalum urvillei*	Vasey Grass	False	
Poaceae	*Pennisetum clandestinum*	Kikuyu Grass	False	
Poaceae	*Phyllostachys sp.*		False	
Poaceae	*Setaria gracilis*	Slender Pigeon Grass	False	
Poaceae	*Sporobolus africanus*	Parramatta Grass	False	

Family name	Scientific name	Common name	Native	Wons[1]
Poaceae	*Themeda australis*	Kangaroo Grass	True	
Primulaceae	*Anagallis arvensis*	Scarlet/Blue Pimpernel	False	
Proteaceae	*Banksia ericifolia*	Heath Banksia	True	
Proteaceae	*Banksia oblongifolia*		True	
Proteaceae	*Grevillea robusta*	Silky Oak	True	
Proteaceae	*Lomatia silaifolia*	Crinkle Bush	True	
Proteaceae	*Persoonia levis*	Broad-leaved Geebung	True	
Ranunculaceae	*Clematis glycinoides*	Headache Vine	True	
Rosaceae	*Rubus fruiticosus*	Blackberry complex	False	Yes
Rosaceae	*Rubus rosifolius*	Rose-leaf Bramble	True	
Santalaceae	*Exocarpos cupressiformis*	Native Cherry	True	
Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	False	
Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	True	
Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla	True	
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush	False	
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	False	
Ulmaceae	*Celtis sinensis*	Chinese Nettle Tree	False	
Verbenaceae	*Lantana camara*	Lantana	False	Yes
Verbenaceae	*Verbena bonariensis*	Purpletop	False	

1. Weed of National Significance

Appendix D

Animal species recorded

Animal species recorded

Scientific name	Common name	Native	Observation type	Threatened
Birds				
Acridotheres tristis	Australian Brush-turkey	Yes	O	
Gymnorhina tibicen	Australian Magpie	Yes	O	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Yes	O	
Accipiter fasciatus	Brown Goshawk	Yes	O	
Gymnorhina tibicen	Australian Magpie	Yes	O	
Acridotheres tristis	Common Myna	No	O	
Dacelo novaeguineae	Laughing Kookaburra	Yes	O	
Grallina cyanoleuca	Magpie-lark	Yes	O	
Manorina melanocephala	Noisy Miner	Yes	O	
Strepera graculina	Pied Currawong	Yes	O	
Trichoglossus haematodus	Rainbow Lorikeet	Yes	O	
Cacatua galerita	Sulphur-crested Cockatoo	Yes	O	
Mammals				
Felis catus	Cat (feral)	No	O	
Trichosurus vulpecula	Common Brushtail Possum	Yes	O	
Pteropus poliocephalus	Grey-headed Flying-fox	Yes	O	Vulnerable under the TSC Act and EPBC Act
Reptiles				
Lampropholis guichenoti	Garden Skink	Yes	O	

Appendix E

Significant assessments

Significance assessments

The proposed works will be assessed under Part 5 of the *Environmental Planning & Assessment Act* 1979 (EP&A Act). Section 5A of the EP&A Act requires that a 7 part test is undertaken to assess the likelihood of significant impact upon Threatened species, populations or ecological communities under the *Threatened Species Conservation Act 1995* .

For Threatened biodiversity under the *Environment Protection and Biodiversity Conservation Act 1999* significance assessments have been completed in accordance with the *Matters of National Environmental Significance, Significant Impact Guidelines 1.1* (Department of the Environment, 2013 #4194). Species listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* have been assessed using both assessment guidelines separately.

The following assessments were undertaken for the Threatened ecological communities recorded and the species with a moderate or higher likelihood of occurrence within the study area. The definitions used in determining the likelihood of occurrence are outlined in section 4 of the main report.

Contents

Page number

1. Blue Gum High Forest

1.1 Status

Blue Gum High Forest is listed as an Endangered Ecological Community under the *Threatened Species Conservation Act 1995*.

1.2 Description

Tall open forest, with dominant canopy trees, including Blue Gum (*Eucalyptus saligna*), Blackbutt (*Eucalyptus pilularis*) and/or Smooth-barked Apple (*Angophora costata*) and infrequently Rough-barked Apple (*Angophora floribunda*) and Grey Ironbark (*Eucalyptus paniculata*) on deep shale soils. The shrub stratum is usually mesophyllus and may contain species such as Sweet Pittosporum (*Pittosporum undulatum*), Forest Oak (*Allocasuarina torulosa*), Large Mock-olive (*Notalaea longifolia*), Coffee Bush (*Breynia oblongifolia*) and Narrow-leaved Orange Bark (*Maytenus sylvestri*) .

1.3 Habitat and ecology

Blue Gum Ironbark Forest in the Sydney region where it generally associated with altitudes higher than 100 m above sea level, on the Hornsby Plateau in the North Shore and northern suburbs of Sydney. There are five largest high-quality remnants of the Blue Gum High Forest of the Sydney Basin Bioregion ecological community that remain within Dalrymple-Hay Nature Reserve, Sheldon Forest, occurrences near Fox Valley Road and Burns Road in the Local Government Area of Ku-ring-gai, and an occurrence that is part of the Cumberland State Forest in Baulkham Hills.

This community is predominantly restricted to deep soils derived from Wianamatta Shale in high rainfall areas that receive more than 1100 mm per year. In lower rainfall areas this community grades into Turpentine Ironbark Forest.

It is predominantly restricted to deep soils derived from Wianamatta Shale in high-rainfall areas that receive more than 1100 mm per year. Some remnants also occur on Hawkesbury Sandstone and the Mittagong formation. In lower rainfall zones, it grades into Turpentine Ironbark Forest with which it shares some characteristic species .

1.4 Distribution

Blue Gum High Forest was originally restricted to the ridgelines in Sydney's north from Crow's Nest to Hornsby and expanding along the ridges between Castle Hill and Eastwood. In 2000 there was less than 200 hectares remaining (about 4.5% of its original extent). It only occurs in small remnants of which the largest is less than 20 hectares. The remnants mainly occur in the Lane Cove, Willoughby, Ku-ring-gai, Hornsby, Baulkham Hills, Ryde and Parramatta local government areas. An example of Blue Gum High Forest can be seen at the Dalrymple-Hay Nature Reserve, St Ives .

1.5 Threats

Recognised threats to this species include:

- The main threat is further clearing for urban development, and the subsequent impacts from fragmentation.
- Habitat degradation from inappropriate access and distrubance from people, horses, trail bikes and other vehicles.
- Urban run-off, which leads to increased nutrients and sedimentation.
- Weed invasion, including listed weeds such as Lantana, exotic vines and scramblers, and exotic perennial grasses.
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.
- Loss of community structure particularly understorey species from underscrubbing, landscaping and continual mowing.

1.6 Recovery actions

The Office of Environment and Heritage have identified the following recovery actions for the species:

- Coordinate detailed review and assessment (tenure/zoning/ownership/threats) of mapped BGHF remnants, incorporating new remnants.
- (Guidelines) Develop criteria and targets for protection of BGHF remnants.
- (Habitat assessment) Identify and map priority sites for protection of BGHF remnants.
- Liaise and support landholders to secure protection and active management of priority BGHF sites.
- (Guidelines) Develop criteria and targets for threat management actions.
- (Habitat assessment) Prioritise threat management actions.
- Liaise with landholders to prepare site specific Plans of Management.
- Undertake priority weed control works.
- Implement appropriate fire management practices.
- Undertake rehabilitation/restoration and/or regeneration actions at identified priority sites.
- Undertake priority stormwater and erosion control works.
- Control and regulate access and land use via fencing and signage.

- Notify land owners/managers of presence of BGHF and discuss implications for use and management.
- Investigate planning and incentives programs to promote and encourage protection and management of BGHF, particularly on private land.
- Development and implementation of EIA guidelines.
- Development and implementation of best practice management guidelines for BGHF remnants.
- Develop and implement a BGHF community education, awareness and involvement campaign.
- Encourage or conduct research to determine ecological processes within BGHF, including fire ecology, soil seedbank and response to disturbance.
- Undertake and facilitate research into best practice guidelines for threat management and conservation of BGHF remnants.
- Develop and implement a threat management monitoring program.
- Provide map of known occurrences to Rural Fire Service and seek inclusion of mitigative measures on Bush Fire Risk Management Plan(s), risk register and/or operation map(s).
- Assess and manage the impacts of mountain bike activities .

1.7 Specific impacts

The low condition Blue Gum High Forest vegetation described within the study area is consistent with the Critically Endangered ecological community, Blue Gum High Forest as listed under the *Threatened Species Conservation Act 1995*.

This vegetation community was recorded within the “Additional aerial earth (overhead) wires only” section of the study area. Within this area overhead wires will be installed, vegetation surrounding each power pole will be disturbed for access only. Vegetation clearing within this area will only be required if a power pole(s) need to be replaced for safety reasons (i.e. existing power pole(s) too fragile to support overhead wires etc). Where the replacement of power pole(s) is required vegetation to remove will include only a small area of groundcover surrounding the pole(s) (approximately 2 X 2 m). The proposal will remove approximately 0.36 ha of Blue Gum High Forest that is dominated by introduced species.

1.8 TSC Act significance assessment

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

Not applicable.

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

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

The proposal could reduce the extent of the Blue Gum High Forest by 0.36 ha. The local occurrence of this community is already at risk of extinction due to factors such as weed invasion and vegetation clearance. The potential removal of 0.36 ha of this critically endangered ecological community will not have an adverse effect on the local extent of the community such that it is placed at significantly heightened risk of extinction as the area of this community to be removed is very small (0.36 ha) and other larger better quality remnants remain in the locality. The magnitude of this vegetation removal is not significant enough to result in the local or regional extinction of this community.

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

No the removal of this vegetation is not likely to place the community at risk of extinction within the locality due to the small area and the low condition of vegetation to be removed. Existing edge effects would not be significantly increased as the vegetation already has a high edge to area ratio. The vegetation is also heavily infested with weed species, if the appropriate weed management are applied this is unlikely to increase. These impacts are likely to be minor and are unlikely to significantly modify the composition of the ecological community such that its local occurrence is likely to be placed at further risk of extinction.

In relation to the habitat of a threatened species, population or ecological community:

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

The proposal could potentially 0.36 ha of Blue Gum High Forest. The vegetation is likely only to be disturbed as a result of accessing the power poles. Removal of vegetation (groundcover dominated by introduced species) is only likely to occur if power poles need to be replaced.

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

The vegetation within the study area is already heavily disturbed, isolated and fragments as a result of past land clearance. No increase in fragmentation or isolation is expected from the proposal as the 'breaking apart' of single areas of habitat into smaller areas of habitat would not occur.

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

The importance of the habitat to be removed by the proposal in terms of the long-term survival of Blue Gum High Forest in the locality is likely to be low. Blue Gum High Forest largely exists as tall open forest with a high density of native species not like the highly degraded understory like the vegetation in the study area. The area to be disturbed is likely to be small and only remove highly degraded vegetation along the edge of this community. The larger remnants are undoubtedly the most important for the long-term survival of this community. Smaller disturbed regrowth remnants like the one being assessed here are unlikely to be important for the long-term survival of the community in the locality.

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

No critical habitat has been declared for Blue Gum High Forest under the TSC Act. The habitat within the study area is unlikely to be critical due to its small size and highly degraded condition.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for the Blue Gum High Forest listed under the TSC Act. The Office of Environment and Heritage has identified recovery actions (listed above) to assist the recovery of this community through their Saving Our Species program. The proposal is not consistent with any of these recovery actions.

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

The proposal has the potential to contribute to two Key Threatening Processes (KTP) under the EPBC Act and six under the TSC Act (see section 5.7 of the main report).

The proposal has the potential to contribute to the following threatening processes:

- *Threatened Species Conservation act* 1995 *Key Threatening Processes*:
  - Invasion of native plant communities by exotic perennial grasses.
  - Clearing of native vegetation.
  - Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
  - Invasion, establishment and spread of Lantana camara (refer section 5.5)
  - Invasion of native plant communities by African Olive Olea europaea L. subsp. cuspidata (refer section 5.5)
  - Invasion and establishment of exotic vines and scramblers (refer section 5.5)

- *Environmental Protection and Biodiversity Conservation Act* 1999 *Key Threatening Processes.*

  - Land clearance.

  - Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Due to the small amount of clearing required, the additional impact of the proposal on these key threatening processes is not likely to significantly affect this community.

Conclusion

While the proposal will have a small impact (0.36 ha) to some heavily modified Blue Gum High Forest, the proposal is unlikely to place the local occurrence of this community at significantly increased risk of extinction. No increase in fragmentation or isolation is expected from the proposal. Vegetation clearing will only occur in areas if power poles require replacement (to ensure safety) otherwise the vegetation of this community will only be disturbed as a result of accessing the power poles to install the overhead earthing wires. The very small area if to be removed which is unlikely to affect pollination or animal movements. The importance of the area of Blue Gum High Forest to be removed by the proposal in terms of the long-term survival of this community in the locality is likely to be low. Consequently, a significant impact to Blue Gum High Forest is considered unlikely to occur from the proposal.

2. Sydney Turpentine-Ironbark Forest

2.1 Status

Sydney Turpentine-Ironbark Forest is listed as an Endangered Ecological Community under the *Threatened Species Conservation Act 1995*.

2.2 Description

Open forest, with dominant canopy trees, including Turpentine *Syncarpia glomulifera*, Grey Gum *Eucalyptus punctata*, Grey Ironbark *Eucalyptus paniculata* and thin-leaved Stringybark *E. eugenioides*. In areas of high rainfall (over 1050 mm per annum), Sydney Blue Gum *E. saligna* is more dominant. The shrub stratum is usually sparse and may contain mesic species such as Sweet Pittosporum *Pittosporum undulatum* and Elderberry Panax *Polyscias sambucifolia*.

2.3 Habitat and ecology

Turpentine-Ironbark Forest occurs mainly on the Cumberland Plain of the Sydney region with patches extending onto the adjoining plateaux. This community is heavily fragmented, with only 0.5% of its original extent remaining intact. Remnants mostly occur in the Baulkham Hills, Hawkesbury, Hornsby, Ku-ring-gai, Parramatta, Ryde, Sutherland, Wollongong and Wollondilly local government areas. Examples can be seen in small reserves such as Wallumatta Nature Reserve and Newington Nature Reserve.

Turpentine-Ironbark Forest is associated with the Cumberland Lowlands although remnants do occur to the west on shale-capped ridges. The community occurs at elevations from 2-308 m above sea level in the lowland plains and to altitudes up to 750 m above sea level in the west.

This community occurs in association with clay soils derived from Wianamatta Shale, or shale layers within Hawkesbury Sandstone on Plateaus and hillsides often along the margins of shale caps over sandstone. Within the Cumberland plains Turpentine-Ironbark Forest occurs in areas with rainfall of up to 1200 mm per annum, with maximum temperatures of 27 degrees Celsius .

2.4 Distribution

Turpentine-Ironbark Forest occurs mainly on the Cumberland Plain of the Sydney region with patches extending onto the adjoining plateaux. This community is heavily fragmented, with only 0.5% of its original extent remaining intact. Remnants mostly occur in the Baulkham Hills, Hawkesbury, Hornsby, Ku-ring-gai, Parramatta, Ryde, Sutherland, Wollongong and Wollondilly local government areas. Examples can be seen in small reserves such as Wallumatta Nature Reserve and Newington Nature Reserve.

2.5 Threats

Recognised threats to this species include:

- The main threat is further clearing for urban development, and the subsequent impacts form fragmentation.
- Mowing, which stops regrowth.
- Urban run-off, which leads to increased nutrients and sedimentation.
- Weed invasion.
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

2.6 Recovery actions

The Office of Environment and Heritage have identified the following recovery actions for the species:

- Incorporate consideration of EEC protection in regional open space planning.
- Investigate the preparation of a recommendation for the declaration of critical habitat.
- Promote best practice management guidelines.
- Manage, to best practice standards, areas of EECs which have conservation as a primary objective, or where conservation is compatible. Priorities are to be based on DEC conservation significance assessment.
- Encourage and promote best-practice management of EECs on private land.
- Local Government prepare plans of management in accordance with the Local Government Act for reserves containing EECs, which have conservation as a primary objective, or where conservation is compatible.
- Ensure the consideration of impacts on EECs when enforcing noxious weed or pest species control in EECs.
- Prepare and implement community awareness, education and involvement strategy.
- Develop and implement Cumberland Plain Reservation Strategy and create a protected bushland network through targeted land acquisition as land becomes available.
- Management of EECs to be included in the conditions for Crown land trusts, lease and licence holders.
- Management of EECs is to be included in school environmental management plans where the school land contains EECs.
- Support community conservation by providing nursery or other facilities, for regeneration activities.

- Liaise with institutions to facilitate research relevant to the recovery of Cumberland Plain EECs.
- Investigate the development of a regular monitoring program to assess the change in extent of vegetation across the Cumberland Plain.
- Public authorities will promote management agreements to landholders through their ongoing land use planning activities.
- Encourage planning authorities to address EECs in development of environmental planning instruments and, where possible, seek biodiversity certification.

2.7 Specific impacts

The low condition Sydney Turpentine-Ironbark Forest vegetation described within the study area is consistent with the Endangered ecological community, Sydney Turpentine-Ironbark Forest as listed under the *Threatened Species Conservation Act 1995*.

The proposal will remove/and modify approximately 0.58 ha of Sydney Turpentine-Ironbark Forest which occurs as degraded regrowth vegetation along Lindfield Avenue in Lindfield, NSW.

Within the “Additional aerial earth (overhead) wires only” area of the proposed works the Sydney Turpentine Ironbark Forest” is only likely to be modified unless power poles are required to be removed. Vegetation to be removed in this circumstance is likely to be only groundcover vegetation immediately surrounding the existing poles.

2.8 TSC Act significance assessment

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

Not applicable.

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

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

The proposal would reduce the extent of the Sydney Turpentine-Ironbark Forest by 0.58 ha. The local occurrence of this community is already at risk of extinction due to factors such as weed invasion and vegetation clearance. The removal of 0.58 ha of this endangered ecological community will not have an adverse effect on the local extent of the community

such that it is placed at significantly heightened risk of extinction as the area of this community to be removed is very small (0.58 ha) and other larger better quality remnants remain in the locality. The magnitude of this vegetation removal is not significant enough to result in the local or regional extinction of this community.

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

No the removal of this vegetation is not likely to place the community at risk of extinction within the locality due to the small area and the low condition of vegetation to be removed. Existing edge effects would not be significantly increased as the vegetation already has a high edge to area ratio. The vegetation is also heavily infested with weed species, if the appropriate weed management are applied this is unlikely to increase. These impacts are likely to be minor and are unlikely to significantly modify the composition of the ecological community such that its local occurrence is likely to be placed at further risk of extinction.

In relation to the habitat of a threatened species, population or ecological community:

vi) the extent to which habitat is likely to be removed or modified as a result of the action proposed

The proposal will remove approximately 0.58 ha of Sydney Turpentine-Ironbark Forest.

Within the “Additional aerial earth (overhead) wires only” area of the proposed works the Sydney Turpentine Ironbark Forest” is only likely to be modified unless power poles are required to be removed. Vegetation to be removed in this circumstance is likely to be only groundcover vegetation immediately surrounding the existing poles.

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

The vegetation within the study area is already heavily disturbed, isolated and fragments as a result of past land clearance. No increase in fragmentation is expected from the proposal as the ‘breaking apart’ of single areas of habitat into smaller areas of habitat would not occur. Some small increase to isolation of patches will occur but the magnitude of this impact is considered insufficient to significantly affect processes such as pollination and seed dispersal.

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

The importance of the habitat to be removed by the proposal in terms of the long-term survival of Sydney Turpentine-Ironbark Forest in the locality is likely to be low. Sydney Turpentine-Ironbark Forest largely exists as open/dense forest and not as the shrubby regrowth like the vegetation in the study area. The larger remnants are undoubtedly the most important for the long-term survival of this community. Smaller disturbed regrowth remnants like the one being assessed here are unlikely to be important for the long-term survival of the community in the locality.

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

No critical habitat has been declared for Sydney Turpentine-Ironbark Forest under the TSC Act. The habitat within the study area is unlikely to be critical due to its small size and degraded condition.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for the Sydney Turpentine-Ironbark Forest community. The Office of Environment and Heritage has identified recovery actions (listed above) to assist the recovery of this community. The proposal is not consistent with any of these recovery actions.

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

The proposal has the potential to contribute to two Key Threatening Processes (KTP) under the EPBC Act and six under the TSC Act (see section 5.7 of the main report).

The proposal has the potential to contribute to the following threatening processes:

- *Threatened Species Conservation act* 1995 *Key Threatening Processes*:
  - Invasion of native plant communities by exotic perennial grasses.
  - Clearing of native vegetation.
  - Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
  - Invasion, establishment and spread of Lantana camara (refer section 5.5)
  - Invasion of native plant communities by African Olive Olea europaea L. subsp. cuspidata (refer section 5.5)
  - Invasion and establishment of exotic vines and scramblers (refer section 5.5)
- *Environmental Protection and Biodiversity Conservation Act* 1999 *Key Threatening Processes.*
  - Land clearance.
  - Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Due to the small amount of clearing required, the additional impact of the proposal on these key threatening processes is not likely to significantly affect this community.

Conclusion

While the proposal will have a small impact (0.58 ha) to some heavily degraded Sydney Turpentine-Ironbark Forest, the proposal is unlikely to place the local occurrence of this community at significantly increased risk of extinction. No increase in fragmentation is expected from the proposal and only a very small area if to be removed which is unlikely to affect pollination or animal movements. The importance of the area of Sydney Turpentine-Ironbark Forest to be removed by the proposal in terms of the long-term survival of this

community in the locality is likely to be low. Consequently, a significant impact to Sydney Turpentine-Ironbark Forest is considered unlikely to occur from the proposal.

3. Powerful Owl

3.1 Status

The Powerful owl is listed as Vulnerable under the *Threatened Species Conservation Act 1995.*

3.2 Species and habitat description

The Powerful Owl inhabits a range and mosaic of vegetation types, from woodland and open sclerophyll forest (on productive sites) to tall open wet forest and rainforest, with mesic gullies and permanent streams . The owl requires large tracts of forest or woodland habitat but can also occur in fragmented landscapes. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species .

Powerful Owls nest in large tree hollows (at least 0.5 metres deep), in large eucalypts (diameter at breast height of 80–240 centimetres) that are at least 150 years old. . During the breeding season, the male Powerful Owl roosts in a 'grove' of up to 20–30 trees, situated within 100–200 metres of the nest tree where the female shelters .

The main prey items are medium-sized arboreal marsupials, particularly the slow-moving Greater Glider, as well as Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls .

Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400–1450 hectares .

3.3 Threats

Recognised threats to this species include:

- Historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. This loss also affects the populations of arboreal prey species, particularly the Greater Glider which reduces food availability for the Powerful Owl.
- Inappropriate forest harvesting practices that have changed forest structure and removed old growth hollow-bearing trees. Loss of hollow-bearing trees reduces the availability of suitable nest sites and prey habitat.
- Can be extremely sensitive to disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Disturbance during the breeding period may affect breeding success.
- High frequency hazard reduction burning may also reduce the longevity of individuals by affecting prey availability.

- Road kills.
- Secondary poisoning.
- Predation of fledglings by foxes, dogs and cats .

3.4 Recovery actions

The Office of Environment and Heritage have identified the following recovery actions for the species:

- Encourage CMAs to invest in actions that actively manage and/or conserve large forest owl habitat as part of their Catchment Action Plans.
- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat.
- Prepare environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess impacts of developments on the Powerful Owl.
- Monitor and report on effectiveness of concurrence and licence conditions previously applied to reduce impacts of development on Powerful Owls and their habitats, by recording conditions, picking case studies and checking owl presence post development.
- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the Powerful Owl outside conservation reserves and State forests.
- Update and refine existing Powerful Owl habitat models using the best available information and map the amount of modelled habitat across forested land in NSW.
- Design a sampling strategy to test the modelled habitat for the presence of Powerful Owls and undertake field validation.
- Estimate amount of mapped modelled habitat for Powerful Owls that is occupied (based on proportion of sample sites with owls in them). Use this to further estimate number of owl territories within different land tenures (based on home range data).
- Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.
- Investigate and pursue the cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.
- Implement a regional monitoring program. This will be undertaken once owl habitat models have been refined, validated and sampling strategy developed.
    - Investigate the implementation of the forestry threatened species licence owl prescriptions by carrying out proactive audits targeting these prescriptions and through IFOA monitoring and reporting.

- Carry out post harvest surveys in locations where Powerful Owls were detected prior to logging to determine if they are continuing to occupy the habitat.
- Encourage student radio tracking projects examining the use of logged and unlogged forest by the Powerful Owl species.
- Make an assessment of the implementation and effectiveness of forestry owl prescriptions and if necessary refine the prescriptions and negotiate changes to the forestry threatened species licences.
- Promote awareness of the research needs of the Powerful owl among the scientific and academic community.
- Seek an ARC Linkage Grant or other joint funding opportunity to initiate research into identified key areas of the biology and ecology of the three large forest owls.
- Seek scholarship funds for an identified aboriginal student to investigate the cultural and historic significance of the Powerful Owl.
- Current information on owl and habitat identification must be maintained on the threatened species website.
- Convene a threatened owl workshop with relevant experts and stakeholders to reassess the state conservation status of the Powerful owl.
- Finalise the large forest owl Multi species plan for Sooty, Masked and Powerful Owl by 2006.
- Provide up to date and accurate large forest owl and habitat information in the PVP Developer - Threatened Species Tool'.
- Provide up to date information and data for the Biobanking assessment methodology.
- Prepare information package containing: a species profile for each species; habitat protection and management guidelines; and survey and assessment guidelines.
- Make information packages available from DEC offices and internet website, and distribute to key groups such as local councils, Catchment Management Boards, community landcare groups and interested individuals.
- Encourage Catchment Management Authorities and other groups such as Landcare to protect existing habitat (particularly known nest sites) and establish new habitat (particularly linking existing fragments of habitat or around nest sites).
- Actively source and publicise funds to be used for owl conservation on private land as a management incentive and for specific protective or rehabilitative projects.
- Seek to secure sympathetic management of owl habitat (particularly nest sites) on private land through liaison with private landholders to discuss management options (property management plans, voluntary conservation agreements and management incentives)

- Prepare environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess impacts of developments on the large forest owls.
- Monitor and report on effectiveness of concurrence and licence conditions previously applied to reduce impacts of development on owls and their habitats, by recording conditions, picking case studies and checking owl presence post development.
- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the 3 large forest owls outside conservation reserves and State forests.
- Update and refine existing owl habitat models using the best available information.
- Map the amount of modelled habitat across forested land in NSW.
- Design a sampling strategy to test the modelled habitat for the presence of owls and locate identified sites.
- Field validation of modelled habitat for the presence of owls.
- Estimate amount of mapped modelled habitat for each species that is occupied (based on proportion of sample sites with owls in them). Use this to further estimate number of owl territories within different land tenures (based on home range data).
- Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.
- Investigate and pursue the cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.
- Implement a regional monitoring program.
- Investigate the implementation by DPI of the forestry threatened species licence owl prescriptions by carrying out proactive audits targeting these prescriptions (DEC) and through IFOA monitoring and reporting (DPI).
- Carry out post harvest surveys in locations where owls were detected prior to logging to determine if they are continuing to occupy the habitat.
- Encourage student radio tracking projects examining the use of logged and unlogged forest by the three owl species.
- Make an assessment of the implementation and effectiveness of forestry owl prescriptions using data collected in this action.
- If necessary, refine the prescriptions and negotiate changes to the forestry threatened species licences.
- Promote awareness of the research needs of the three large forest owls among the scientific and academic community.

- Encourage involvement of researchers and students in the recovery efforts for the three large forest owls, particularly in habitat survey, and population monitoring.
- Seek avenues to raise additional funds through sponsorship and public appeals to support research projects that are not funded.
- Provide scholarship funds for an identified aboriginal student to investigate the cultural and historic significance of the three species.
- Encourage and coordinate the involvement of community-based groups (e.g.. Australian Bird and Bat Study Association) and animal care groups (e.g.. WIRES) in the implementation of recovery actions.
- Set up website linked to DEC website, targeting the community, providing information on owl identification, habitat identification/protection current activities they can be involved in, & how & where to report sightings. Site linked to other websites.
- Coordination of implementation of actions.
- Seek to integrate recovery actions with other recovery plan actions and conservation initiatives.
- Review of plan and rewrite in final year.
- Convene a threatened owl workshop with relevant experts and stakeholders to reassess the state conservation status of the 3 large forest owls. This action will be undertaken upon conclusion of the implementation of all of the above actions .

3.5 Specific impacts

The vegetation within the study area is considered to be marginal foraging habitat for the Powerful Owl, due to its small patch size, isolation and weed invasion. The proposal will remove approximately 2.31 ha of potential foraging habitat.

3.6 TSC Act significance assessment

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

The subject site provides marginal foraging habitat for the Powerful Owl. Although the study area extends approximately 2.4 km, it is linear in nature, with vegetation clearing resulting in an incremental loss of approximately 2.31 ha of potential foraging habitat. Foraging and breeding habitats are abundant in the locality and as such it is considered that the proposal is unlikely to have an adverse effect upon the lifecycle of these species such that a viable local population is likely to be placed at risk of extinction.

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

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable

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

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

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

It is estimated that 2.31 ha of suitable foraging habitat will be affected by the proposal. Local populations of these species would not be restricted to habitat resources within the subject site, as they would likely use similar and potentially more significant habitat resources within the locality.

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

Habitat connectivity is not likely to be affected by the proposal. Approximately 2.31 ha of vegetation is likely to be affected within the study area and vegetation removal will be largely limited to linear widening of existing railway line and road corridor within the main works area. Vegetation removal modification is likely to be low within the additional aerial earth (overhead) wires only areas. Given the mobility of this species and that similar and more significant habitat occurs widely in the locality, it is considered unlikely that habitat would become further isolated or fragmented significantly beyond that currently existing in the study area.

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

Areas of potential habitat to be removed are predominately located adjacent to the existing road corridor, and as such are subject to edge effects and not considered significant habitat for this species. Due to the mobility of this species and the linear nature of the proposal, potential habitat occurring in the subject site would likely be used as part of a larger home range. Although, it is recognised that vegetation likely to be affected will add incrementally to the loss of habitat for this species.

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

No critical habitat has been listed for the assessed species to date. It is estimated that approximately 2.31 ha of degraded and isolated foraging habitat would be affected by the proposal. Suitable habitat occurring in the subject site is not considered critical to the survival of this species due to the large abundance of higher quality habitat in the broader locality.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan or priority action statements have been prepared for the assessed species under the TSC Act. The proposal is not likely to affect any recovery measures proposed for this species by the Office of Environment and Heritage.

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

The proposal has the potential to contribute to two Key Threatening Processes (KTP) under the EPBC Act and six under the TSC Act (see section 5.7 of the main report).

The proposal has the potential to contribute to the following threatening processes:

- *Threatened Species Conservation act* 1995 *Key Threatening Processes*:
  - Invasion of native plant communities by exotic perennial grasses.
  - Clearing of native vegetation.
  - Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
  - Invasion, establishment and spread of Lantana camara (refer section 5.5)
  - Invasion of native plant communities by African Olive Olea europaea L. subsp. cuspidata (refer section 5.5)
  - Invasion and establishment of exotic vines and scramblers (refer section 5.5)
- *Environmental Protection and Biodiversity Conservation Act* 1999 *Key Threatening Processes.*
  - Land clearance.
  - Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Due to the small amount of clearing required, the additional impact of the proposal on these key threatening processes is not likely to significantly affect this community.

Conclusion

Vegetation removal associated with the proposal will be linear in nature, predominately clearing areas of degraded regrowth vegetation adjacent to and isolated by the existing rail corridor and roads. This area lacks breeding habitat and provides only marginal foraging

habitat which is relatively small in terms of the extent of similar or greater quality habitat available in the study area and surrounding landscape. As such, the proposal is unlikely to have a significant impact on the Powerful Owl.

4. Little Lorikeet

4.1 Status

The Little Lorikeet is listed as Vulnerable under the *Threatened Species Conservation Act 1995.*

4.2 Species and habitat description

In NSW Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range . Little Lorikeets are generally considered to be nomadic with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts .

The breeding biology of Little Lorikeets is little known with most breeding records from the western slopes. The major threats to Little Lorikeets are loss of breeding sites and food resources from ongoing land clearing .

4.3 Threats

- Extensive clearing of woodlands for agriculture has significantly decreased food for the lorikeet, thus reducing survival and reproduction. Small scale clearing, such as during roadworks and fence construction, continues to destroy habitat and it will be decades before revegetated areas supply adequate forage sites.
- The loss of old hollow bearing trees has reduced nest sites, and increased competition with other native and exotic species that need large hollows with small entrances to avoid predation. Felling of hollow trees for firewood collection or other human demands increases this competition.
- Competition with the introduced Honeybee for both nectar and hollows exacerbates these resource limitations .

4.4 Recovery actions

- Encourage retention of old-growth Eucalyptus trees through PVPs and EIA.
- Encourage retention of hollow bearing trees through PVPs and EIA .

4.5 Specific impacts

The approximately 0.94 ha of native vegetation affected may be used as a marginal foraging habitat by this species on a seasonal basis when the exotic plant species are in fruit or flowering heavily.

4.6 TSC Significance assessment

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

The study area traverses fragmented pockets of vegetation that provide potential marginal foraging resources for this species. The subject site is linear in nature, with vegetation clearing which will incur an incremental loss of approximately 0.94 ha of potential habitat. Potential habitats are relatively abundant in the locality and therefore it is considered unlikely that the proposed removal of habitat would adversely impact the viability of populations in the locality.

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

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable.

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

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

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

The removal of approximately 0.94 ha of vegetation would result in a small decrease in habitats favoured by this species however more extensive and suitable habitat would continue to exist within nearby bushland areas.

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

The proposed vegetation removal would be largely limited to linear areas of potential marginal foraging habitat along the edges of fragmented patches of native vegetation. As a consequence, the proposal is unlikely to represent significant increases to habitat isolation and/or fragmentation.

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

A limited linear area of potential foraging habitat (approximately 0.94 ha) would be affected. Foraging opportunities occurring within the study area would continue to exist and an

abundance of similar and more extensive foraging opportunities would be retained within the immediate areas surrounding the study area. Therefore, habitat to be removed is not considered to be important to these species.

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

No critical habitat has been listed for the assessed species to date. It is estimated that approximately 0.94 ha of suitable habitat would be affected by the proposal. Suitable habitat occurring in the subject site is not considered critical to the survival of this species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan or priority action statements have been prepared for these species under the *Threatened Species Conservation Act 1995*.

The proposal is not likely to significantly affect any recovery measures proposed for these species by the Office of Environment and Heritage.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

One key threatening processes (KTP) associated within the proposal has the potential to affect the foraging habitat of these species, being, loss of native vegetation. A threat abatement plan has not been prepared for this process. Due to the marginal habitat recorded within the study area and the higher quality foraging habitat within the broader locality this KTP is not likely to significantly affect this species in the locality.

Conclusion

The subject site provides marginal foraging opportunities for these species, due to the occurrence of vegetation patches intersected by open areas. Vegetation clearance will include the removal of approximately 0.94 ha of vegetation that is considered marginal foraging habitat for the species. In addition, native vegetation to be removed will be largely represented by the removal of a linear strip to construct a substation over a distance of approximately 160 m.

The area of potential foraging habitat to be removed is relatively small in terms of the extent of similar or greater quality habitat available in the study area and surrounding landscape. As such, the proposal is unlikely to have a significant impact on the Little Lorikeet.

5. Microchiropteran bats

5.1 Status, species and habitat description

The following microchiropteran bats (microbats) are each listed as Vulnerable under the *Threatened Species Conservation Act 1995* and have been grouped for assessment owing to similarities in ecology and habitat preference:

- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)
- Eastern Free-tail Bat (*Mormopterus norfolkensis*)
- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)

These species have been assessed together as they generally share similar habitat requirements: threats that affect their recovery: and potential impacts as a result of the proposal. These details have been provided in Table 3.1.

Table 3.1 Details of threat-listed microchiropteran bats

Species name	TSC Act Status	EPBC Act Status	Habitat
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 .
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 .
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 .

5.2 Threats

Recognised threats to this species include:

- Disturbance to roosting and summer breeding sites.
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions.
- Loss of hollow-bearing trees; clearing and fragmentation of forest and woodland habitat.
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.
- Disturbance by recreational cave climbers and general public accessing the cave and adjacent areas particularly during winter or breeding.
- Loss of foraging habitat.
- Predation by feral cats and foxes.
- Introduction of exotic pathogens, specifically known White-nosed fungus.
- Threat of cave entrances being blocked for human safety reasons. Also, vegetation encroaching and blocking cave entrances.
- Potential for large scale wildfire to impact on resource availability in surrounding habitat. Direct threats at caves from fire.
- Weeds (blackberry) encroaching over cave entrances restrict access; need to ensure sympathetic control techniques for blackberry.

5.3 Recovery actions

The Office of Environment and Heritage have identified the following recovery actions for the species:

- Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools.
- Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes, such as revegetating and installing bat boxes.
- Research to quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops.
- Ensure the Code of Practice for private native forestry includes adequate measures to protect large, hollow-bearing trees and viable numbers of recruit trees.
- Research the roosting ecology of tree-roosting bats. For example identifying the attributes of key roosts.

- Research the degree of long-term fidelity to roost trees and roosting areas in order to assess their importance and the effects of their removal.
- Use radio-tracking to identify important foraging range and help interpret density of records.
- Raise awareness of the effects of pesticides.
- Study the species biology such as reproductive capacity, longevity, mortality rate and life history, or thermal and energy requirements to better determine capacity to respond to changes in climate or recover from losses in the population.
- Study the susceptibility of this species to pesticide accumulation.
- Establish a community program to encourage the reporting of roost trees.
- Prepare EIA guidelines which address the retention of hollow bearing trees maintaining diversity of age groups, species diversity, structural diversity. Give priority to largest hollow bearing trees.
- Research the potential for long distance/seasonal movement.
- Research the effect of different burning regimes.
- Investigate the effectiveness of logging prescriptions.
- Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes.
- Identify the effects of fragmentation on the species in a range of fragmented landscapes.
- Study the ecology, habitat requirements and susceptibility to logging and other forestry practices of this little-known species.
- Identify areas of private land that contain high densities of large, hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs.
- Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means.
- Develop and promote State-wide bat awareness programs for schools, CMAs, landholders and industry groups etc.
- Quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops.
- Identify important foraging range and key habitat components for this species.
- Investigate the effectiveness of logging prescriptions.
- Promote bats throughout the rural community as ecologically interesting and important, but sensitive to disturbance at caves/disused mine tunnels.

- Undertake non-chemical removal of weeds (e.g. lantana, blackberry) to prevent obstruction of cave entrances.
- Restrict access where possible to known maternity sites. (e.g. signs; bat-friendly, preferably external gates at caves).
- Restrict caving activity during critical times of year in important roosts used by species, particularly maternity and hibernation roosts.
- Establish a gating design for disused mines across species range that will not adversely impact species. Consultation with cave bat specialist prior to any gating operations.
- Monitor the breeding success of a representative sample of maternity colonies in cave roosts over a number of years to determine the viability of regional populations.
- Regular censuses of maternity colonies (Wee Jasper, Bungonia, Willi-Willi, Riverton) and other key roosts in network, especially where there are population estimates from banding in the 1960s.
- For roost caves vulnerable to human disturbance, monitor their visitation by people, particularly during winter and spring/summer maternity season and in school holidays.
- Measure genetic population structure among cave roosts of maternity colonies to estimate dispersal and genetic isolation, and vulnerability to regional population extinction.
- Confirm species taxonomy of NSW populations, relative to other Australian populations.
- Search for significant roost sites and restrict access where possible. Significant includes maternity, hibernation and transient sites including in artificial structures.
- Compile register of all known roost sites in natural and artificial structures including current and historical data and identify significance of roost, e.g. maternity, hibernation, transient roost.
- Promote the conservation of these key roost areas using measures such as incentive funding to landholders, offsetting and biobanking, acquisition for reserve establishment or other means.
- Prepare fire management plans for significant roost caves, disused mines, culverts, especially maternity and winter roosts.
- Restrict caving activities at significant roosts during important stages of the annual bat life cycle (e.g. winter hibernation, summer maternity season).

5.4 Specific impacts

The air spaces within and around all native vegetation within the study area provide foraging opportunities for these bat species.

There were no tree species (with tree hollows) recorded during the field survey and no caves or artificial structures potentially suitable as habitat for cave-dwelling bats would be affected.

The proposal would include the clearing of vegetation from approximately 2.31 ha of potential foraging habitat for these species.

5.5 TSC Significance assessment

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

The study area provides foraging habitat for the species. No breeding habitat (such as hollow-bearing trees, caves or existing structures) will be impacted upon by the proposed construction. As no breeding habitat will be removed and foraging habitat is likely to remain in the surrounding area after the completion of the project it is considered unlikely that the proposal will place any of these species in risk of extinction.

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

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable

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

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

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

The proposal would include the clearing of up to 2.31 ha of potential foraging habitat for microbat species.

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

An area of habitat is not considered likely to become fragmented or isolated from another area of habitat as the study area is already isolated from potential habitat in the broader locality.

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

Potential foraging habitat for these species is considered to be relatively abundant in the locality. The foraging habitat for the species which would be removed is likely to be of only low importance to local populations of these species due to its poor condition and abundance of similar or more extensive habitat present in the locality (such as in bushland reserves). This habitat is also likely to remain suitable for foraging after the proposal is complete.

As these species are highly mobile they are considered unlikely to be significantly affected by the removal of 2.31 ha of native vegetation that would occur as a result of the proposal.

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

No critical habitat has been listed for these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plans have been developed for these species however priority actions have been identified for their recovery. Most of these actions relate to research, education and policy development and are of limited relevance to the proposal. The proposal is not considered likely to interfere with the implementation of any recovery actions of relevance to these species.

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

The proposal would contribute to one key threatening process that may affect these species, namely clearing of native vegetation.

The native vegetation within the study area provides marginal foraging habitat for the species. Due to the poor condition of vegetation and presence of higher quality foraging resources in the broader locality it is considered unlikely that the removal of remnant native vegetation will be significant.

Conclusion

Habitat modification as a result of the proposal is unlikely to have a significant impact on local populations of Threatened bat species due to the loss only a small proportion of potential roosting and foraging habitat in the locality.

6. Grey-headed Flying-fox

6.1 Status

The Grey-headed Flying-fox is listed as Vulnerable under the *Threatened Species Conservation Act 1995 and Environment Protection and Biodiversity Conservation Act 1999.*

6.2 Species and habitat description

The Grey-headed Flying-fox is found in a variety of habitats including subtropical and temperate rainforest, mangroves, paper bark swamps, heathland, sclerophyll forests, urban gardens and cultivated areas. It forages on blossoms and fruits of over 80 species of plants . The major foraging resource for Grey-headed Flying-fox includes the nectar and pollen of a variety of native plants including *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines, and native figs (*Ficus* spp.). They have also been found to chew leaves and appear to eat the salt glands from mangroves .

Grey-headed Flying-foxes congregate in camps of up to 200,000 individuals with camp size influenced by the availability of the local blossom, with the camps being located close to water, in vegetation within a dense canopy. These bats have nightly feeding ranges of up to 20 to 50 km from their daytime camp .

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. For the first three weeks females carry their young when they forage, after this, the young are left together in the camp when they forage .

Site fidelity to camps is high with some camps being used for over a century. Individuals are highly mobile and regularly move between camp sites in response to local food availability.

6.3 Threats

Recognised threats to this species include:

- Loss of foraging habitat.
- Loss and disturbance of roosting sites.
- Unregulated shooting.
- Electrocution on powerlines, entanglement in netting and on barbed-wire.
- Competition with Black Flying-foxes.
- Negative public attitudes and conflict with humans.
- Impacts from climate change.
- Disease.

6.4 Recovery actions

The Office of Environment and Heritage have identified the following recovery actions for the species:

- Set priorities for protecting foraging habitat critical to the survival of Grey-headed Flying-foxes and generate maps of priority foraging habitat.
- Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.
- Grey-headed Flying-fox National Recovery Team to undertake an annual review of the national recovery plan's implementation.
- Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage), including habitat restoration/rehabilitation works.
- Establish & maintain a range-wide database of Grey-headed Flying-fox camps, including information on location, tenure, zoning & history of use, for distribution to land management/planning authorities, researchers & interested public.
- Improve knowledge of Grey-headed Flying-fox camp locations, targeting regional areas and seasons where information is notably incomplete, such as inland areas during spring and summer.
- Protect roosting habitat critical to the survival of Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.
- Determine characteristics of roosting habitat for Grey-headed Flying-foxes, exploring the roles of floristic composition, vegetation structure, microclimate and landscape features, and assess the status of camps.
- Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.
- Develop and promote incentives to reduce killing of flying-foxes in commercial fruit crops.
- Identify the commercial fruit industries that are impacted by Grey-headed Flying-foxes, to provide an information base for use by the various stakeholders.
- Systematically document the levels of flying-fox damage to the horticulture industry within the range of the Grey-headed Flying-fox.
- Develop methods for rapid estimates of flying-fox damage on commercial crops, allowing the long-term monitoring of industry-wide levels and patterns of flying-fox damage.
- Develop and implement a grower-based program to monitor trends in damage to commercial fruit crops by flying-foxes, and use the results to monitor the performance of actions to reduce crop damage.

- Develop methods to monitor landscape scale nectar availability trends, to explain/potentially predict crop damage trends where crop protection is absent, & promote importance of foraging habitat productive in seasons critical to the horticulture industry.
- Describe the species, age structure & demographics of flying-foxes killed in fruit crops to improve the understanding of the impact by assessing trends in the species, sex, age & reproductive status of animals killed on crops.
- Review & evaluate camp site management activities, summarising outcomes of past experiences at controversial camps. Noise impacts on neighbours of camps to be considered. For use in managing future conflicts with humans at flying-fox camps.
- Develop guidelines to assist land managers dealing with controversial flying-fox camps.
- Develop materials for public education & provide them to land managers & local community groups working with controversial flying-fox camps, highlighting species status, reasons for being in urban areas, reasons for decline etc.
- Assess the impacts Grey-headed Flying-fox camps have on water quality, and publish results in a peer-reviewed journal.
- Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.
- Monitor public attitudes towards flying-foxes.
- Review and improve methods used to assess population size of Grey-headed Flying-foxes.
- Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.
- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts.
- Investigate the differences in genetic relatedness, sex, age etc. between sedentary and transient Grey-headed Flying-foxes.
- Investigate between-year fidelity of Grey-headed Flying-fox individuals to seasonal camps.
- Investigate the genetic structure within Grey-headed Flying-fox camps, including levels of relatedness within and between members of adult groups, occupants of individual trees etc.
- Investigate the patterns of juvenile Grey-headed Flying-fox dispersal and mortality, allowing identification of the specific habitat requirements of juveniles.
- Investigate the age structure and longevity of Grey-headed Flying-foxes.
- Complete national recovery plan.

6.5 Specific impacts

Approximately 2.31 ha of native vegetation affected are likely to be used as foraging habitat by this species. This vegetation is likely only to be used by the Grey-headed Flying-fox on a seasonal basis when the exotic plant species and Eucalypts are in fruit or flowering heavily.

6.6 TSC Significance assessment

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

No camp sites (roosting and breeding habitat) for the Grey-headed Flying-fox are located within or adjacent to the study area and winter-flowering eucalypts, an important foraging resource, are scarce in the study area. The life cycle of the species is hence unlikely to be significantly affected.

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

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

Not applicable

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

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

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

Approximately 2.31 ha of highly degraded native vegetation would be cleared which is likely to be used as marginal foraging habitat by this species on a seasonal basis when the dominant flowering and fruit bearing trees are in season.

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

An area of habitat is not considered likely to become fragmented or isolated from another area of habitat as the study area is already isolated from potential habitat in the broader locality.

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

As this species is highly mobile it is considered unlikely to be significantly affected by the proposal. Potential foraging habitat for this species is considered to be relatively abundant in the locality. The foraging habitat in the study area is considered to be of only low importance to the local occurrence of this species as it is highly degraded, isolated and only a small area of this habitat would be lost.

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

No critical habitat has been listed for this species. The study area is not considered to be critical habitat for the species as the vegetation present is likely only to provide marginal foraging habitat for the species. Furthermore, more extensive foraging habitat is present within the locality (such as in nearby bushland reserves).

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The proposal is not considered likely to substantially contribute to or interfere with the implementation of recovery strategies for this species due to the small area to be removed, low condition of the foraging habitat and the abundance of higher quality habitat in the locality.

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

The proposal would contribute slightly (2.31 ha of clearing) to the clearing of native vegetation key threatening process (KTP). Due to the low condition of the vegetation present and the abundance of high quality foraging habitat in the locality (such as in bushland reserves) the increased impact of this KTP as a result of the proposal is not however considered likely to significantly impact the local population of this species.

Conclusion

Approximately 2.31 ha of marginal foraging habitat will be removed by the proposal. The Grey-headed Flying-fox is unlikely to be significantly impacted by the proposal due to the low condition of the vegetation to be removed and the abundance of higher quality foraging habitat in the locality.

6.7 EPBC Act significance assessment – Vulnerable species

The Grey-headed Flying-fox is listed as vulnerable under the *Environmental Protection and biodiversity Conservation Act 1999.*

Will the action lead to a long-term decrease in the size of an important population?

Grey-headed Flying-foxes occur within a variety of habitats foraging mainly within flowering Eucalypts and other blossom producing plant species. It is unlikely that the marginal habitat that occurred within the study area (which contains no Eucalypt species) would be important habitat for the species. The study area does not contain any winter flowering species that would be utilised by the Grey-headed Flying-fox during which food resources are more limited. The proposal may lead to a decrease in suitable habitat however, any such decrease is likely to be minor, and unlikely to decrease the size of an important population.

Will the action reduce the area of occupancy the species?

This species is highly mobile and is more likely to occur throughout the broader locality within more suitable habitat. The proposal will remove 2.31 ha of marginal foraging habitat for the species.

Will the action fragment an existing population into two or more populations?

No increase in fragmentation is expected from the proposal as the 'breaking apart' of single areas of habitat into many smaller areas of habitat will not occur. Some small increase to isolation of habitat patches will occur.

Will the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for the species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

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

The habitat that would be affected as a result of the proposal is unlikely to be important for the long-term maintenance of these species, important for genetic diversity, or important for re-introductions as it is located connected only to street plantings and is affected by barrier effects from the railway line and arterial roads.

Will the action disrupt the breeding cycle of a population?

Grey-headed Flying-fox breed within large exposed branches of canopy trees within large camps. There are no Grey-headed Flying-fox camps within the study area or adjacent areas. The proposal will remove 2.31 ha of potential foraging habitat for this species. It is unlikely to interfere with the lifecycle of any local population as it is unlikely to result in the loss of breeding habitat in the locality.

Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposal will impact 2.31ha of potential foraging habitat for the species via the direct removal of suitable habitat. The proposal may also increase indirect disturbances such as weed incursions and sediment and erosion impacts into adjacent areas of habitat. Whilst the proposal will decrease the potential habitat available for this species it is unlikely to lead to the decline of the species as a whole as the habitat affected is unlikely to be important habitat due to its isolation and moderate to high degree of degradation.

Will the action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

The study area and surround vegetation (street plantings) are already heavily disturbed from past vegetation clearing and the establishment of exotic species as such it is considered that the proposal is unlikely to significantly alter the current disturbance regimes that are already in place. Construction has the potential to spread weeds but the implementation of weed management measures will minimise these impacts. The proposal is unlikely to result in the introduction of any invasive species that would be harmful to the Grey-headed Flying-fox becoming established in the species' habitat.

Will the action introduce disease that may cause the species to decline?

No, the proposal is unlikely to introduce or spread any diseases likely to cause the species to decline.

Will the action interfere with the recovery of the species?

A draft national recovery plan has been prepared for the Grey-headed Flying-fox. The proposal will not interfere significantly with any of the identified recovery actions.

Conclusion

The proposal will require the removal of 2.31 ha of potential foraging habitat for the Grey-headed Flying-fox. Based on the small area of degraded habitat to be impacted, this species is unlikely to be significantly affected by the proposal. Overall, the potential impact from the proposal on the species is not considered significant with regard to its context and intensity.

References

Churchill, S. *Australian Bats*. 2nd ed. Sydney: Allen & Unwin, 2008.

Debus, S.J.S. "Surveys of Large Forest Owls in Northern New South Wales: Methodology, Calling Behaviour and Owls Responses." *Corella* 19, no. 2 (1995): 38-50.

Debus, S.J.S., and C.J. Chafer. "The Powerful Owl *Ninox Strenua* in Nsw." *Australian Birds* 28, (1994): 41-57.

Department of Environment and Climate Change. *Threatened Species Assessment Guidelines. The Assessment of Significance*. Hurstville: Department of Environment and Climate Change, 2007.

Department of Sustainability Environment Water Populations and Communities, "Turpentine-Ironbark Forest in the Sydney Basin Bioregion - Sprat Profile" http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=38.

Department of the Environment, "Blue Gum High Forest of the Sydney Basin Bioregion" http://www.environment.gov.au/node/14558 (accessed 26 June 2014).

Eby, P. "Seasonal Movements of Grey-Headed Flying-Foxes, *Pteropus Poliocephalus* (Chiroptera: Pteropodidae), from Two Maternity Camps in Northern New South Wales." *Wildlife Research* 18, no. 5 (1991): 547 - 559.

Higgins, P.J., ed. *Handbook of Australian, New Zealand and Antarctic Birds Volume 4: Parrots to Dollarbirds*. Edited by P.J Higgins, Volume 4: Parrots to Dollarbird. Melbourne: Oxford University Press, 1999.

Kavanagh, R.P., S. Debus, T. Tweedie, and R. Webster. "Distribution of Nocturnal Forest Birds and Mammals in North-Eastern New South Wales: Relationships with Environmental Variables and Management History." *Wildlife Research* 22, no. 1 (1995): 359-377.

Kavanagh, R.P., and S.J.S. Debus. "The Powerful Owl *Ninox Strenua* in New South Wales." *Australian Birds* 28, supplement 21-38, (1994).

NSW National Parks and Wildlife Service. *Large Forest Owls Northern Regional Recovery Plan.* Coffs Harbour, 1998.

NSW Scientific Committee. *Little Lorikeet Glossopsitta Pusilla - Vulnerable Species Listing Nsw Scientific Committee - Final Determination*. Department of Environment, Climate Change and Water, 2009.

Office of Environment and Heritage, "Little Lorikeet - Profile" http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20111 (accessed 04/12/2013 2013).

Office of Environment and Heritage, "Powerful Owl - Profile" http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10562 (accessed 25 June 2013).

Office of Environment and Heritage, "Blue Gum High Forest in the Sydney Basin Bioregion - Profile" http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10094 (accessed 20 June 2014).

Parry-Jones, K. A., and M. L Augee. "Movements of Grey-Headed Flying-Foxes (*Pteropus Poliocephalus*) to and from Colony Site on the Central Coast of New South Wales." *Wildlife Research* 19, no. 3 (1992): 331 - 339

Parry-Jones, K. A., and M. L. Augee. "Food Selection by Grey-Headed Flying Foxes (*Pteropus Poliocephalus*) Occupying a Summer Colony Site near Gosford, New South Wales." *Wildlife Research* 18, no. 1 (1991): 111 - 124

Royal Australian Ornithologists Union. *The New Atlas of Australian Birds*: Royal Australian Ornithologists Union, Hawthorn East, Victoria, 2003.

Spencer, H.J, C. Palmer, AD Carol, K Parry, and B Tones. "Movements of Fruit-Bats in Eastern Australia Determined by Using Radio-Tracking." *Wildlife Research* 18, no. 1 (1991): 463-8.