Bringelly Road Upgrade
Ecological Assessment

June 2011

NSW Roads and Traffic Authority

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Executive summary

This ecological assessment describes the potential impact of the Bringelly Road Upgrade (the Proposal) on the ecological values of the locality with an emphasis on Threatened 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 proposal involves the upgrade of Bringelly Road, from two lanes to four lanes, to accommodate planned development within the South West Growth Centre in which the site is located.

The report describes the nature of the proposal and its potential impact on the existing ecological values of the locality as identified through desktop and field-based study. Ameliorative measures have been designed to avoid, mitigate and offset these impacts and form part of the proposal assessed.

Assessments of impact significance were conducted in accordance with state and Commonwealth legislation to determine whether ecological values would be significantly affected by the proposal.

Habitats of ecological significance recorded in the study area include Cumberland Plain Woodland and River-Flat Eucalypt Forest Threatened ecological communities. Cumberland Plain Woodland along the existing Bringelly Road exists as mature remnant trees with introduced understorey and groundcover and is generally in poor condition. Several patches of Cumberland Plain Woodland in moderate to good condition are also found within the study area, however these areas appear to have been subject to previous clearing and lack mature and hollow-bearing trees. The River-Flat Eucalypt Forest of the study area is generally in poor condition with little native understorey and a highly disturbed groundcover dominated by introduced species.

These communities provide habitat for Threatened species of animals and potential habitat for Threatened species of plant. Approximately 32.3 hectares of this habitat would be cleared or modified for the proposal however approximately 29.8 hectares of this habitat is moderately to highly degraded.

The proposal is unlikely to significantly affect the TSC Act listed River-Flat Eucalypt Forest however a significant impact on Cumberland Plain Woodland, listed under the TSC Act and under the EPBC Act (as Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest) is likely to occur. The areas of Cumberland Plain Woodland which would be significantly impacted are located within certified areas and hence the preparation of a Species Impact Statement (SIS) would not be required for this community.

Threatened species of animal listed under the TSC Act and recorded within the study area include the Cumberland Land Snail and six species of bat. The Cumberland Land Snail was recorded in several locations under woody debris and rubbish in moderate to poor condition Cumberland Plain Woodland and is likely to be significantly affected by the proposal. The Cumberland Land Snail habitat which would be significantly impacted is located within certified areas and hence the preparation of a Species Impact Statement (SIS) would not be required for this species.

Tree hollows, a key habitat feature for hollow-roosting bats, were almost entirely restricted to the avenues of trees found along the existing Bringelly Road. The Threatened hollow-dependent microbats listed under the TSC Act which are likely to use these trees (Eastern Freetail-bat Bat, Greater Broad-nosed Bat, Eastern False Pipistrelle and Yellow-bellied Sheathtail Bat) are likely to be significantly affected by the proposal. The habitat for these bats which would be significantly impacted is located within certified areas and hence the preparation of a Species Impact Statement (SIS) would not be required for these species.

The study area provides potential habitat for a variety of other Threatened species of plant and animal. Significance assessments were conducted for these species through which it was concluded that none of these species are likely to be significantly affected by the proposal. This conclusion was reached on the basis of the poor condition of most of the study area as habitat for these species and the low likelihood of

an ecologically significant proportion of any local population of these species occurring within the subject site.

In order to streamline assessment and approval in the Growth Centres, an order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 was issued in 2007 by the Minister for Climate Change Environment and Water (Minister for Climate Change Environment and Water 2007). Biodiversity certification may be conferred on an Environmental Planning Instrument if the Minister is satisfied that the instrument, in addition to any other relevant measures to be taken will lead to the overall improvement or maintenance of biodiversity values.

The *Threatened Species Conservation Amendment (Biodiversity Certification) Act 2010* also made an amendment to the application of the Growth Centres biodiversity certification (refer Section 2.1.2). The effect of the amendment is that biodiversity certification now applies to development and activities carried out under any environmental planning instruments that apply to the subject land. This would include road works under the *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP).

Biodiversity certification switches off the need to assess the significance of impacts for Threatened species in certified areas subject to the conditions detailed in the order to confer biodiversity certification (Minister for Climate Change Environment and Water 2007). In certified areas, it is taken that development is not likely to significantly affect any Threatened species, population or ecological community, or its habitat. In non-certified areas, there is no change to the approval process however offsetting of impacts on these areas is required under the conditions of certification.

The non-certified areas of the study area are all located within riparian zones and adjacent flood-prone land. The remainder of the study area including cleared lands and most of the roadside vegetation and substantial woodland patches in good condition is within certified areas.

RTA best practice however suggests an assessment of significance (7 part test) for threatened biodiversity should be completed as part of the environmental assessment process to determine initially whether the proposed activity is likely to have an impact irrespective of the applicability of biodiversity certification. Biodiversity certification would then be applied where relevant to remove the need to progress to the preparation of a Species Impact Statement, to seek concurrence or offset impacts in 'certified areas'.

Biodiversity certification does not cover Commonwealth legislation. The Department of Planning (Strategic Lands) in consultation with SEWPAC is currently undertaking a Strategic Assessment under the EPBC Act of the Growth Centres (North-west and South-west) development program. The purpose of the strategic assessment is to review and potentially approve the Growth Centres State Environmental Planning Policy (SEPP) development program. The strategic assessment will address potential impacts on matters of national environmental significance associated with the program of development of the growth centres as outlined in the Growth Centres SEPP. If as part of the assessment the Minister agrees to endorse the program this does not automatically constitute approval under the EPBC Act for the taking of an action (e.g. the upgrade of Bringelly Rd). However the Minister may then decide to approve an action or class of action in accordance with the program which would mean that no further approval is required (Department of Environment Water Heritage and the Arts 2009).

Referral of the proposal to the Commonwealth would be required due to the potential impact on EPBC Act listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (located within certified lands) unless this requirement is removed as a result of the Strategic Assessment process. The requirement for approval by the Commonwealth and any additional conditions would be dependent on the outcome of the referral and any Commonwealth approval requirements for endorsement of the SEPP.

Significant impacts are likely within 'certified' areas however the impacts of the proposal on 'non-certified' areas are not likely to be significant. The preparation of a Species Impact Statement is not required for the proposal however impacts within 'non-certified' areas would need to be offset.

Glossary and definitions

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity – the variety of genes (or units of heredity) in any population ▪ species diversity – the variety of species ▪ ecosystem diversity – the variety of communities or ecosystems.
Biodiversity Certification	Biodiversity certification under Section 126G of the *Threatened Species Conservation Act 1995* identifies areas within the growth centres as either certified or non-certified. Certified areas are those that are likely to be of lower conservation value. Non-certified areas generally correspond with areas of higher conservation value (such as known locations of Threatened species habitat), and flood prone and transitional land. Biodiversity certification switches off the need to undertake further significance assessments for Threatened species (under Section 5A of the EP&A Act, the Seven Part Test). In these areas, it is considered that development is not likely to significantly affect any threatened species, population or ecological community, or the habitat of any of these. In non-certified areas, there is no change to the approval process and Threatened species assessments are required as normal under Section 5A of the EP&A Act. See Section 3.6.2 for more detail.
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* and both the State (OEH) and Federal (SEWPAC) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant State and Commonwealth legislation.
Department of Environment, Climate Change and Water (DECCW)	The most recent former name for the NSW Office of Environment and Heritage (OEH).
Department of Sustainability, Environment, Water, Population and Communities (SEWPAC)	The Commonwealth Department of Sustainability, Environment, Water, Population and Communities changed name in 2010 from the Department of Department of the Environment, Water, Heritage and the Arts (DEWHA) to the current name. The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the *Environment Protection and Biodiversity Conservation Act 1999*.
Department of the Environment, Water, Heritage and the Arts (DEWHA)	The most recent former name of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC).
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
EP&A Act	Abbreviates the NSW *Environmental Planning and Assessment Act 1979*.
EPBC Act	Abbreviates the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
FM Act	Abbreviates the NSW *Fisheries Management Act 1994*.

Growth centre	Growth Centres are declared under *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*. This SEPP provides for the coordinated release of land for residential, employment and other urban development in the North West and South West growth centres of the Sydney Region (in conjunction with the Environmental Planning and Assessment Regulation relating to precinct planning).
Habitat	An area or areas occupied, or periodically or occasionally occupied by a species, population or ecological community, including any biotic or abiotic components.
Investigation area	The entire area investigated during field surveys encompassing the subject site, study area and additional investigation areas at the Camden Valley Way/Bringelly Road/Cowpasture Road intersection, Byron Road extension, Masterfield Road/Barry Avenue connection and Cowpasture Road (south). The investigation area for the proposal was identified by the RTA and is shown in Appendix A.
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key Threatening Processes are listed under the *Threatened Species Conservation Act 1995,* the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant State and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004) .
Locality	The area within 10 km of the subject site.
Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (Department of Environment and Climate Change 2007b).
Migratory species	Species protected as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*. Listed migratory species are those listed in the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA). Listed migratory species also include any native species identified in an international agreement approved by the Minister (Department of the Environment Water Heritage and the Arts 2010c). Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*.
Office of Environment and Heritage (OEH)	Following the 2010 NSW elections the NSW Department of Environment Climate Change and Water (DECCW) was abolished, is now known as the Office of Environment and Heritage and has been incorporated into the Department of Premier and Cabinet. Broadly, the Office of Environment and Heritage works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land and waters: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making.

Priorities action statements	In November 2004, the NSW State Government reformed the State's threatened species legislation (*Fisheries Management Act 1994* and the *Threatened Species Conservation Act 1995*). One element of the reforms included a requirement for the Director-Generals of the NSW Department of Primary Industries (DPI) and Department of Environment and Climate Change (DECC) to prepare and adopt a Priorities Action Statement (PAS). A separate PAS has been prepared by each agency (Department of Industry and Investment 2010a). Each PAS outlines the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threatened species, populations and ecological communities and manage key threatening processes (Department of Environment Climate Change and Water 2010c) (Department of Industry and Investment 2010a).
Proposal	The proposed construction and operation of the road upgrade and associated infrastructure as described in Section 2.3.
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, and all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999* to assist the recovery of a Threatened species, population, or ecological community.
REF	Abbreviates Review of Environmental Factors.
Region	A bioregion defined in a national system of bioregionalisation. For this study, this is the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Significant	Important, weighty, or more than ordinary (as defined by the Department of Environment and Climate Change 2007b).
Study area	The subject site and additional areas that could potentially be affected by the proposal either directly or indirectly, including vegetation immediately adjacent to the subject site and adjacent highly disturbed areas in poor ecological condition that are possible locations of construction access tracks and compound areas. Examination of this are allowed the subject site to be examined in the context of the surrounding areas.
Subject site	The specific area that would be affected by the upgrade, namely the design footprint of the road upgrade and an area of 5 metres around the footprint to account for construction access.
Threatened biodiversity	Threatened species, populations or ecological communities, or their habitats as listed under the *Threatened Species Conservation Act 1995 Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the terms 'Threatened' in this report refers to listing under the relevant State and/or Commonwealth legislation.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant State and/or Commonwealth legislation.
TSC Act	Abbreviates the NSW *Threatened Species Conservation Act 1995*.
Viable local population	A population that has the capacity to live, develop, and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007b).
Weeds of National Significance	In 1998, Australian governments endorsed a framework to identify which weed species could be considered (WONS) within an agricultural, forestry and environmental context. Twenty WONS were identified through this process (Australian Government 2010).

1. Introduction

The NSW Roads and Traffic Authority (RTA) is proposing to upgrade Bringelly Road. The Bringelly Road upgrade (the proposal) involves widening Bringelly Road from a two lane road to a four lane divided road, between the Camden Valley Way intersection at Leppington and The Northern Road intersection at Bringelly as well as the upgrading of a number of intersections (refer Figure 1.1 and Appendix A).

The RTA is preparing a Review of Environmental Factors (REF) for the proposal and has commissioned Parson Brinckerhoff Pty Ltd to prepare an ecological assessment as part of the REF process.

1.1 Study aims and objectives

The ecological assessment involved flora and fauna surveys and a review of existing information regarding the ecological characteristics of the locality. In order to further inform the study, input has been sought from a number of community groups with a special interest in wildlife.

The main objective of this study is to assess the impacts of the proposal on the ecological values of the site. Specifically, the assessment aimed to:

- Determine and describe the characteristics and condition of the vegetation communities and the flora and fauna habitats within the study area.
- Determine the presence, or likelihood of occurrence, of Threatened biodiversity listed (including preliminary listings) under the *Threatened Species Conservation Act 1995* (TSC Act) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) occurring within the study area.
- Describe and assess likely impacts of the proposal on biodiversity values.
- Undertake significance assessments for Threatened biodiversity listed under the EPBC Act and TSC Act that occur or have potential habitat within the study area.
- Propose amelioration measures to mitigate or minimise impacts on the ecological values of the study area.

The following areas were investigated for feasibility of construction to accommodate the proposed South West Growth Centre road network strategy, but will not be constructed as part of the Bringelly Road Upgrade proposal. Ecological assessment of these areas (refer Section 4.10) was limited to an assessment of whether there are any issues or constraints in these areas of sufficient magnitude to prevent road construction and no impact assessment was undertaken:

- Camden Valley Way/Bringelly Road/Cowpasture Road intersection.
- Byron Road extension.
- Masterfield Road/Barry Avenue connection.
- Cowpasture Road (south) upgrade.

1.2 Report structure

The report is structured as set out in Table 1.1 below.

Table 1.1 Report structure

Section	Description
1. Introduction	Sets the scene of the study describing the nature of the study, the environmental conditions and land-use history of the study area.
2. Legislative requirements	Outline of the legislative requirements of relevance to the study.
3. Methodology	A description and justification of the methods used for the study.
4. Results	A description of the study area and subject site including tabulated data, maps, photos: a description of the potential impacts of the proposal.
5. Amelioration measures	A discussion of the proposed measures to avoid, mitigate and offset the impacts of the proposal.
6. Assessment of impacts	An assessment of whether the proposal would be likely to have a significant impact on biodiversity addressing the factors of s5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the significant impact guidelines under the EPBC Act.
7. Conclusions	Summary of the major findings of the study.
8. References	A list of all information sources used.
Appendices	Additional detailed information.

1.3 Proposal description

The development of the South West Growth Centre means that Bringelly Road will require upgrading. The NSW Roads and Traffic Authority (RTA) have commenced planning for this future upgrade.

Bringelly Road is approximately 10 km long. In its current condition the road provides for one eastbound and one westbound lane as a two lane undivided carriageway. It acts as an integral component of the metropolitan road and transport network (Roads and Traffic Authority 2009) and will form one of the arterial transport corridors within the South West Growth Centre.

The proposed upgrade to Bringelly Road involves widening from a two lane road to a four lane divided road, between the Camden Valley Way intersection at Leppington and The Northern Road intersection at Bringelly, as well as the upgrading of a number of intersections (refer Figure 1.1 and Appendix A).

The proposed activity also involves the construction and operation of the following:

- new bridges over the Sydney Water Supply Channel and South Creek
- upgraded culverts beneath the road carriageway
- shared pedestrian and bicycle paths
- bus facilities
- temporary construction access compounds and materials storage areas.

As part of the planning process the RTA has commissioned a number of environmental studies including this ecological assessment.

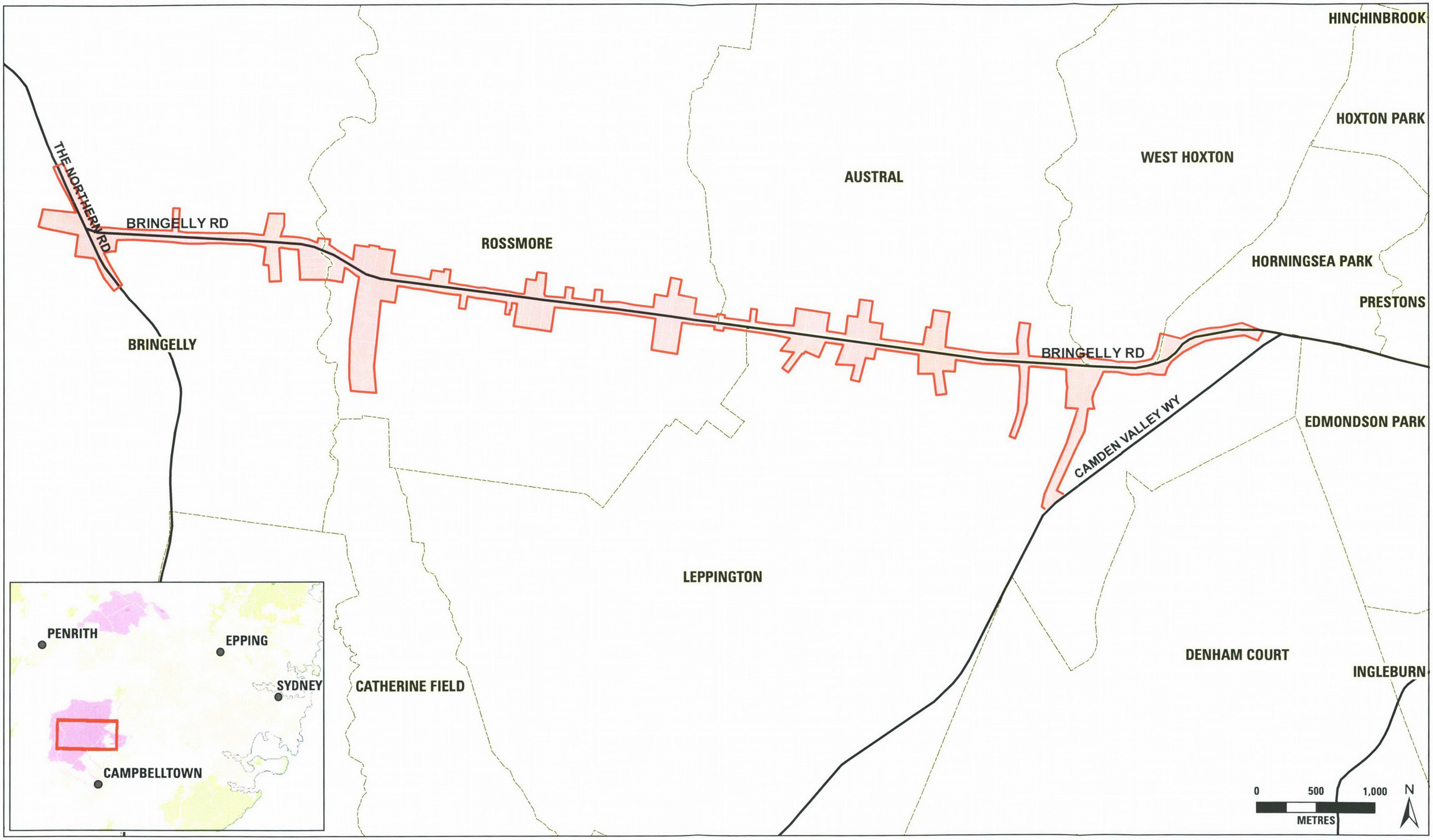


Figure 1.1 Location map

1.4 Context of study area

1.4.1 Regional context

The study area is located within the Sydney Basin Bioregion. The Sydney Basin Bioregion extends from just north of Batemans Bay to Nelson Bay on the NSW central coast, and almost as far west as Mudgee covering an area of approximately 3,632,890 hectares (Department of the Environment Water Heritage and the Arts 2010a).

Within the Sydney Basin Bioregion, the study area is located in the Cumberland subregion. Prior to European settlement, the natural vegetation of this area was dominated by grassy eucalypt woodlands, interspersed with taller eucalypt forests in regularly inundated floodplain areas.

The Cumberland Plain is one of the most heavily disturbed areas within the bioregion being highly altered with severe pressure from the growth of the greater Sydney Metropolitan area (Department of the Environment Water Heritage and the Arts 2010a). Extensive vegetation clearing, initially for agriculture and subsequently for residential and infrastructure development has since resulted in the loss of the vast majority of this native vegetation. Native vegetation on the Cumberland Plain has been reduced to a patchwork of small isolated forest and woodland fragments. Much of this vegetation is in poor condition due to previous and ongoing agricultural activity and weed invasion.

Larger patches of forest and woodland are chiefly located within conservation reserves and other public lands however less than 1.5% of the Cumberland Plain is reserved for conservation and little opportunity exists for additions to the current reserve scheme with many ecosystems within the subregion not found anywhere else in the bioregion.

1.4.2 Soils, Geology and Landscape

1.4.2.1 Topography

The study area is relatively flat with few undulating rises and falls. The study area is relatively low lying with ground elevations along the proposed length of works varying from approximately 70 metres above sea level (ASL) to 100 metres ASL (2009).

1.4.2.2 Geology

The study area is located on Bringelly Shale, which forms part of the Wianamatta group, being a series of fine grained sedimentary rocks. Bringelly shale is characterised as a coastal alluvial plain sequence (RTA 2009).

1.4.2.3 Soils

Three soil landscapes occur throughout the study area, these being the South Creek soil landscape, Luddenham soil landscape and Blacktown soil landscape (RTA 2009).

The soils of the study area consist of clays derived from the weathering of Bringelly shales with gravel inclusions.

1.4.2.4 Mitchell landscapes

Mitchell landscape mapping (NSW National Parks and Wildlife Service 2002c) uses a mapping methodology based upon common soil, vegetation or combined parameters to produce a regional overview of geology, geomorphology, topography, soils and vegetation.

The study area is located within the Cumberland Plain landscape. This landscape is characterised by low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast on horizontal Triassic shales. Lithic sandstones form a down-warped block on the coastal side of the Lapstone monocline. The shale-dominated plain is intruded by a small number of volcanic vents and partly covered by Tertiary river gravels and sands (Hawkesbury-Nepean Terrace Gravels landscape). Quaternary alluvium occurs along the mains streams. The general elevation of the landscape is 30-120 metres with local relief to 50 metres (Department of Environment and Climate Change 2008).

Soils are uniform red to brown clays on volcanic hills, red and brown texture-contrast soils on crests grading to yellow harsh texture-contrast soils in valleys (Department of Environment and Climate Change 2008).

Woodlands and open forest of Grey Box (*Eucalyptus moluccana*), Forest Red Gum (*Eucalyptus tereticornis*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Thin-leaved Stringybark (*Eucalyptus eugenioides*), Cabbage Gum (*Eucalyptus amplifolia*) and Broad-leaved Apple (*Angophora subvelutina*) form the dominant vegetation. These woodlands have grassy to shrubby understorey often dominated by Australian Boxthorn (*Bursaria spinosa*). Poorly drained valley floors are often salt affected and dominated by Swamp Oak (*Casuarina glauca*) and paperbarks (*Melaleuca* spp.)(Department of Environment and Climate Change 2008).

1.4.3 Waterways

The majority of the study area is located in the South Creek sub-catchment of the Hawkesbury-Nepean catchment region with the eastern most section of the study area located within the Sydney metropolitan catchment. Waterways that intersect the study area include South/Wianamatta Creek, Kemps Creek and Bonds Creek. South/Wianamatta Creek is given the dual name with Wianamatta being the Indigenous name and South being the European name given to the creek (Roads and Traffic Authority (RTA) of NSW 2009).

For the purposes of this study South/Wianamatta Creek will be referred to as South Creek.

The waterways of the study area are likely to exhibit elevated nutrient and turbidity levels due to surrounding land uses.

1.4.4 Disturbance history

The study area is located in the south west region of Sydney with general land use in the area being small rural holdings, light industrial, commercial premises, educational facilities, local road networks and Western Sydney Parklands. The study area has semi-rural characteristics with the majority of land occupied by medium sized holdings with scattered residential houses and small commercial dwellings. The lack of mature trees through much of the study area suggests that it has been cleared of trees in the past and the vegetation patches currently present represent regrowth.

Mature trees are restricted to the road reserves of existing roads. The dominance of introduced species of plant throughout much of the study area is indicative of soil disturbance associated with previous road construction, horticultural and agricultural activities.

2. Legislative requirements

2.1 State legislation and assessment process

NSW legislation and planning policies relevant to the protection of biodiversity are provided below. These statutory instruments provide conditions, matters for consideration and requirements to seek authorisation (licences and approvals) to undertake various actions and activities. In addition, recent legislation that confers biodiversity certification on certain areas of land is applicable to the proposal, as it lies within the South West Growth Centre.

2.1.1 Environmental Planning and Assessment Act 1979

The Bringelly Road Upgrade is being assessed and approved by the RTA under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). As such, a Review of Environmental Factors (REF) is required for the development.

Under Part 5 of the EP&A Act (s.111 and s.112), all proposals must include an assessment of Threatened biodiversity and their habitats that are likely to occur within the area of the development or that may be indirectly affected by the construction and operation of a proposal. If Threatened biodiversity or their habitats are found on site, an assessment of whether the proposal is 'likely to have a significant effect on the environment' must be made, and a decision made on whether an Environmental Impact Statement (EIS) or Species Impact Statement (SIS) is required. In order to make this decision, a determining authority must consider the effect of an activity on:

- Critical habitat (listed under the TSC Act or *Fisheries Management Act 1994* (FM Act)).
- In the case of Threatened species, populations and ecological communities, and their habitats (listed under the TSC Act or FM Act) whether there is likely to be a significant effect on those species, populations or ecological communities (as determined in Section 5A of the EP&A Act), or those habitats.
- Any other protected fauna or protected native plants within the meaning of the *National Parks and Wildlife Act 1974* (NPW Act).

Section 5A of the EP&A Act outlines the seven factors that must be taken into account when deciding whether a proposal is likely to have a significant impact on Threatened biodiversity or their habitats (significance assessments).

RTA best practice suggests an assessment of significance (7 part test) for threatened biodiversity should be completed as part of the environmental assessment process to determine initially whether the proposed activity is likely to have an impact. Biodiversity certification would then be applied where relevant to remove the need to progress to the preparation of an SIS or to seek concurrence (refer Section 2.1.2).

2.1.2 Threatened Species Conservation Act 1995

The Office of Environment and Heritage administers the TSC Act. The TSC Act seeks to protect certain classes of threatened wildlife including Threatened species, Threatened populations and Threatened ecological communities.

In order to streamline assessment and approval in the Growth Centres, an order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (refer Section 2.2) was issued on the 11 December 2007 by the Minister for Climate Change Environment and Water. Biodiversity certification (under Section 126G of the TSC Act) may be conferred on an Environmental Planning Instrument if the Minister is satisfied that the instrument, in addition to any other relevant measures to be taken will lead to the overall improvement or maintenance of biodiversity values.

The Threatened Species Conservation Amendment (Special Provisions) Act 2008 was passed on 25 June and amends the TSC Act by inserting a new part to Schedule 7 (Savings, transitional and other provisions) of the Act. The new Part 7, Schedule 7 of the Act confers biodiversity certification on the Growth Centres State Environmental Planning Policy. The amendment largely replicates the order to confer biodiversity certification on the Growth Centres State Environmental Planning Policy that was issued by the Minister for the Environment on 11 December 2007 and resolves any uncertainty about the certification granted on the Growth Centres State Environmental Planning Policy in accordance with Section 126G.

In order to demonstrate how biodiversity certification of the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 would lead to the overall improvement or maintenance of biodiversity values, a draft conservation plan (Eco Logical Australia 2007) was prepared. The draft conservation plan identified biodiversity values within the Growth Centres and proposed mechanisms to achieve positive conservation outcomes through the development assessment process. In addition to the mechanisms outlined in the draft conservation plan, the Minister's order (Minister for Climate Change Environment and Water 2007) outlines the conditions of the biodiversity certification.

On 15 June 2010 the *Threatened Species Conservation Amendment (Biodiversity Certification) Act 2010* (Biodiversity Certification Act) amended the TSC Act, Part 7AA, and note section 111 of the EP&A Act with the following regarding assessment impacts for activities undertaken within certified land:

- *An activity to which Part 5 of the Planning Act applies which is carried out or proposed to be carried out on biodiversity certified land is taken, for the purposes of Part 5 of the Planning Act, to be an activity that is not likely to significantly affect any threatened species, population or ecological community under this Act, or its habitat.*

- *A determining authority under Part 5 of the Planning Act is not required under that Part to consider the effect on biodiversity values of an activity carried out on biodiversity certified land (despite section 111 of the Planning Act).*

The Biodiversity Certification Act also made an amendment to the application of the Growth Centres biodiversity certification. Specifically, Clause 18(2) of Part 7 of Schedule 7 of the TSC Act was amended as follows:
(2) The biodiversity certification conferred by this Part applies:
(a) only to the subject land, and
(b) to all development and activities that may be carried out under the Growth centres SEPP (including development and activities that may be carried out under another EPI that applies

to the subject land) and
(c) to all threatened species population and ecological communities (underlined text indicates amendments made to the clause).

The effect of these amendments is that biodiversity certification now applies to development and activities carried out under any environmental planning instruments that apply to the subject land (which may include the Growth Centres SEPP, any Local Environment Plans or other State Environmental Planning Policies). This would include road works under the State Environmental Planning Policy (Infrastructure) 2007 (ISEPP).

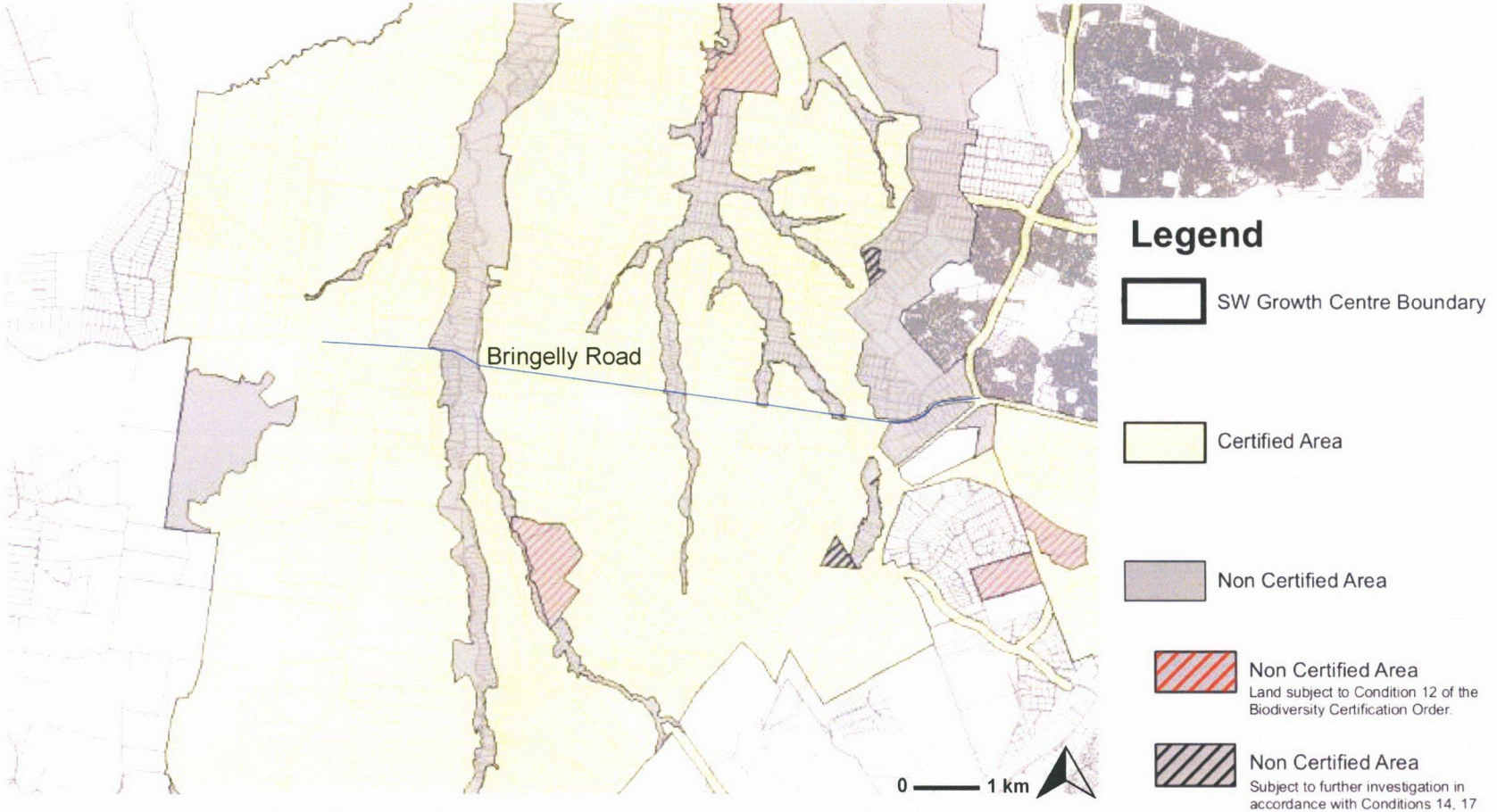
For the purposes of this report the above State legislation is to be taken and applied. Seven part tests of significance, whilst not required under relevant legislation, have been undertaken and are provided in Appendix D. As stated above biodiversity certification switches of the requirement to assess impacts on state listed threatened species.

To lead to the overall improvement or maintenance of biodiversity values, the biodiversity certification order outlines the requirement to offset impacts to biodiversity. In certified areas, biodiversity offsets will be contributed to as part of the Special Infrastructure Contribution. The value of the contribution will be determined in a precinct plan at a flat value per hectare. However, as the Special Infrastructure Contribution applies only to actions requiring development approval under Part 4 of the EP&A Act, the RTA is not required to contribute to offsets for impacts to biodiversity in the certified areas resulting from the Bringelly Road upgrade (Growth Centres Commission 2008).

Offsets are however required for impacts to biodiversity resulting from the proposal in non-certified areas under condition 11 of the order to confer biodiversity certification on the Growth Centres SEPP (Minister for Climate Change Environment and Water 2007). Biodiversity offsets for the proposal are discussed further in Section 5.4.

It should be noted that Biodiversity certification does not cover Commonwealth legislation.

An excerpt from the South West Growth Centre Biodiversity Certification map contained in the *Order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (Minister for Climate Change Environment and Water 2007) is provided in Figure 2.1 showing the location of Bringelly Road.



Source: South West Growth Centre Biodiversity Certification map contained in the *Order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (Minister for Climate Change Environment and Water 2007)

Figure 2.1 South West Growth Centre – Biodiversity Certification map

2.1.3 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 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 2010b).

The Minister for Fisheries would need to be notified of any proposed dredging (Part 7 Division 3 of the FM Act) or reclamation works associated with the proposed upgrade in accordance with Section 199 of the Act. It is unlikely at this stage that any dredging or reclamation works would be required for this proposal but this would be confirmed upon finalisation of the concept design.

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 Primary Industries under the Act.

2.1.4 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* (NW Act) 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 NW Act, the Minister for Primary Industries 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.

2.1.5 National Parks and Wildlife Act 1973

The *National Parks and Wildlife Act 1974* (NPW Act) is administered by the Office of Environment and Heritage It contains provisions that relate to the protection of native terrestrial fauna and some flora and Endangered ecological communities. Under the NPW Act it is an offence to harm an Endangered Ecological Community 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 Part 5 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 Director General of the Office of Environment and Heritage 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 a project that has received development consent under the EP& A Act.

2.2 State Environmental Planning Policies

2.2.1 State Environmental Planning Policy (Sydney Region Growth Centres) 2006

The study area is within the South West Growth Centre identified in the State Environmental Planning Policy (Sydney Region Growth Centres) 2006. The South West Growth Centre covers approximately 17,000 hectares of land and includes suburbs in three council areas: Liverpool, Camden and Campbelltown. The aims of the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 are to:

- Co-ordinate the release of land for residential, employment and other urban development in the North West and South West growth centres of the Sydney Region.
- Provide for comprehensive planning for those growth centres.
- Provide controls for the sustainability of land in those growth centres that has conservation value.
- Provide for the orderly and economic provision of infrastructure in and to those growth centres.
- Provide development controls in order to protect the health of the waterways in those growth centres.
- Protect and enhance land with natural and cultural heritage value.
- Provide land use and development controls that will contribute to the conservation of biodiversity.

2.3 Commonwealth legislation

2.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any action which has, would have, or is likely to have a significant impact on a Matter of National Environmental Significance (NES) or on Commonwealth land, triggers the Act and may require Commonwealth assessment and approval from the Commonwealth Minister for the Environment. NES matters are addressed in Section 6 and Appendix D of this assessment.

The eight matters of national environmental significance protected under the EPBC Act are:

- 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) (Department of the Environment Water Heritage and the Arts 2010c).

2.3.2 Commonwealth assessment process

Approval of an action under the EP&A Act does not negate the requirement to consider the provisions of the EPBC Act. The EPBC Act is triggered by actions that are likely to have a significant effect on NES matters.

Under the EPBC Act, actions that are likely to have a significant impact on NES matters require approval from the Commonwealth Environment Minister and should be referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for consideration. Actions deemed by the SEWPAC to require Commonwealth approval are deemed 'controlled actions' and an environmental assessment must be carried out.

Department of Planning (Strategic Lands) in consultation with SEWPAC is currently undertaking a Strategic Assessment under the EPBC Act of the Growth Centres (North-west and South-west) development program. The purpose of the strategic assessment is to review and potentially approve the growth centres program. The exhibition period for the Draft Terms of Reference for the Strategic Assessment closed in December 2009.
Once signed off by the Federal Environment Minister, a Strategic Assessment will be prepared addressing the Terms of Reference. The strategic assessment will address potential impacts associated with the development of the growth centres as outlined in the Growth Centres SEPP. If as part of the assessment the Minister agrees to endorse the SEPP development program, it does not automatically constitute approval under the Act for the taking of action in accordance with the program for which approval is required. However the Minister may then decide to approve an action or class of action in accordance with the program which would mean that no further approval is required. If the Minister as part of the strategic assessment does not approve an action, the proponent still has the option of submitting a proposal under the normal approval pathway.

3. Methodology

The biodiversity assessment for the proposal included desk-based searches of databases and historical records, as well as field inspections of the study area. This Section outlines the specific methods used to survey and assess biodiversity within and surrounding the study area.

3.1 Nomenclature

Names of vegetation communities used in this report are based on the dominant species and structure of the community. The names follow those used in Tozer (2003) and the most current vegetation mapping for the study area, which in this case is *Final Native Vegetation Mapping of the Cumberland Plain, Western Sydney* (NSW National Parks and Wildlife Service 2002d) . These names are cross-referenced with those of the OEH vegetation types database (Department of Environment Climate Change and Water 2008b) used in BioMetric 2.0 (Gibbons *et al.* 2008) and where applicable, names of Threatened ecological communities listed under the TSC Act and/or the EPBC Act.

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with reference to PlantNet (Royal Botanic Gardens 2010)or recent taxonomic changes. Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in plant lists in Appendix B. The names of introduced species are denoted with an asterisk (*).

Names of vertebrate fauna follow the Census of Australian Vertebrates (CAVS) database maintained by the (Department of the Environment Water Heritage and the Arts 2010b). Common names are used in the 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 (Department of Environment Climate Change and Water 2010c) and the BioBanking Threatened Species Profile Database (Department of Environment Climate Change and Water 2008a) are also provided in the tabulated data in Appendix B where these differ from the names used by Harden, the Plantnet database and the CAVS database.

3.2 Study team and licenses

The contributors to the preparation of this paper, their qualifications and roles are listed in Table 3.1.

Table 3.1 Study team

Name	Qualification	Role
Dr. Martin Predavec	BSc (Hons), PhD	Technical Executive - Ecology– report review
Lukas Clews	BSc, GradCertAppSci	Botanist – field surveys, report preparation
Paul Rossington	BSc, GradDipWldMgt	Ecologist – field surveys, report preparation

All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the *National Parks and Wildlife Regulations 2002*, Section 132C

of the *National Parks and Wildlife Act 1974* as well as animal research authorities issued by the Department of Trade and Investment, Regional Infrastructure and Services (Primary Industries) (refer Appendix C).

3.3 Background research

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

This allowed the known habitat characteristics to be compared with those of the study area to make a preliminary determination of the likelihood of occurrence of each species, populations and ecological community. These results informed the identification of appropriate field survey effort focussed on the groups most likely to be affected by the proposal.

This assessment included a review of:

- Aerial photographs.
- Cumberland Plain vegetation community mapping (NSW National Parks and Wildlife Service 2002d)
- Database searches (refer Table 3.2 and Appendix B).

Table 3.2 Database searches

Database	Date of search	Search area	Reference
Atlas of NSW Wildlife	05 January 2010	10 km locality search from eastern and western extents of study area	(Department of Environment Climate Change and Water 2010a)
PlantNet Database	05 January 2010	10 km locality search from eastern and western extents of study area	(Royal Botanic Gardens 2010)
Bionet	05 January 2010	10 km locality search from eastern and western extents of study area	(Department of Environment Climate Change and Water 2010b)
Threatened species, populations, and communities database	05 January 2010	Sydney Metropolitan Catchment Management Area (Cumberland sub-region)	(Department of Environment Climate Change and Water 2010c)
Protected Matters Search Tool	05 January 2010	10 km locality search from eastern and western extents of study area	(Department of the Environment Water Heritage and the Arts 2010d)

3.4 Field survey methods

The study area was inspected during daylight hours by a team of two ecologists on 11, 12 and 15 February 2010. Night surveys were conducted on 11 and 15 February. The weather conditions on all days were sunny, and warm with an afternoon thunderstorm and evening rainfall on 12 February 2010.

This survey sought primarily to assess the extent and condition of vegetation and fauna habitat, especially for the Threatened species and ecological communities.

3.4.1 Species of plant and vegetation communities

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. Four vegetation survey quadrats were conducted in the locations shown in Figure 3.1.

Random meander transects were completed in accordance with the technique described by Cropper (1993) whereby the recorder walks in a haphazard manner 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 undertaken in nine locations throughout the study 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.

3.4.2 Vegetation condition

The quality of vegetation was assessed using parameters such as intactness, diversity, history of disturbance, weed invasion and 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.
- **Poor:** 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.

For the Critically Endangered ecological community Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest the condition thresholds outlined in the Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest Listing Advice (Threatened Species Scientific Committee 2009) were utilised.

BELLFIELD AV
NORTH AV
ROSSMORE AV WEST
ROSSMORE AV EAST
KING ST
Q3
Q4
Q1
Q2
Q5
SOUTH CREEK
MASTERFIELD ST
ALLENBY RD
MCCANN RD
POLO RD
0
500
METRES
N

Investigation area
Project footprint
Design
Waterways

Field survey
Anabat
Flora quadrat
Spotlight transect

Figure 3.1 Field survey locations

\\APSYDNAS02\proj\R\Roads_and_Traffic_Auth\2117110A_ECO_Bringelly_Road\10_GIS\Projects\ESRI\FieldSurveyLocationsMap_A3.mxd// black // 24/05/2011 //

3.4.3 Fauna habitat assessment

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

- 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.

A general fauna features traverse was undertaken throughout the study area during the survey covering all major native vegetation occurrences. The time spent in each area of potential habitat was generally proportional to the size of the area and the diversity of habitat features observed. The objective of this traverse was to identify additional species and their habitats. During the traverse, opportunistic recordings of species were made through incidental sightings, aural recognition of calls, and observing indirect evidence of species' presence, such as scats, feathers, hair, tracks, diggings, and burrows.

The following criteria were used to evaluate habitat values:

- **Good:** A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate:** Some fauna habitat components are missing 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 past clearing.

3.4.4 Fauna survey methodology

The following field survey methods were used in an attempt to detect any Threatened species of animals that may be utilising the study area. The locations of all Threatened fauna species detected were recorded using a GPS unit with a positional accuracy of five to ten metres.

3.4.4.1 Bird surveys

Bird surveys were point surveys whereby all birds observed from a single point are noted for a set period of time (minimum 30 minutes). Survey points were located in each vegetation community.

3.4.4.2 Call playback

Nocturnal animals were surveyed using call playback, whereby recordings of the vocalisations of target species were broadcast in order to elicit a response, either vocal or behavioural. At each site there was an initial 10 minute listening period followed by a five minute call broadcast and then a five minute listening and spotlighting period for each target species. A final listening period of 10 minutes and final spotlight of the survey site was conducted after call broadcasting was concluded. Calls were broadcast using a portable MP3 player and amplified through a megaphone.

3.4.4.3 Spotlighting

Spotlighting was undertaken along two transects in the study area on foot using a handheld 100 Watt spotlight.

3.4.4.4 Anabat Bat Detection

Anabat Bat detection (Z-CAIM) was used to record and identify the echolocation calls of microchiropteran bats. Bat detection included hand-held use during spotlighting, then stationary recording for the rest of the survey. A minimum of four hours of recording was undertaken on each of two nights.

The results were analysed by Paul Rossington with reference to (Pennay *et al.* 2004) and the associated bat call library for the Sydney region. The results of the analysis and representative bat call sonograms are found in Appendix D.

3.4.4.5 Habitat searches

Diurnal herpetological and invertebrate searches were carried out opportunistically random meander surveys conducted for habitat assessment. Species were surveyed by actively searching area of suitable habitat. Rocks, bark and ground debris that provide potential shelter were hand-turned and replaced during searches.

3.4.4.6 Tracks, scats and signs search

Searches were conducted during habitat assessment for indirect evidence of the presence of animals such as scratches, feeding scars, bones and scats.

3.4.4.7 Incidental observations

Incidental observations of animal species were recorded throughout the field surveys.

3.4.4.8 Survey effort

In addition to the habitat and vegetation condition assessment, the following survey effort (refer Table 3.3) was expended in search of Threatened species and identification of Threatened ecological communities.

Table 3.3 Field survey effort

Survey technique	Targeted threatened species/population and communities	Effort expended
Flora		
Random Meander	Threatened plants, Noxious weeds	8 hours (11 locations)
Transects/ Quadrats	Threatened plants, noxious weeds, Threatened ecological communities.	14 hours (5 locations)
Fauna		
Diurnal Bird Surveys	Threatened species of birds.	4 hours (2 sessions in each of 4 locations)
Call playback	**Nocturnal Birds** Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), **Nocturnal Mammals** Squirrel Glider (*Petaurus norfolcensis*), Koala (*Phascolarctos cinereus*), **Frogs** Green and Golden Bell Frog (*Litoria aurea*)	4 hours (Two sessions in each of two locations on separate nights)
Spotlighting	Squirrel Glider (*Petaurus norfolcensis*), Koala (*Phascolarctos cinereus*), Eastern Pygmy-possum *Cercartetus nanus* Grey-headed Flying-fox (*Pteropus poliocephalus*)	4 hours (Two sessions in each of two locations on separate nights)
Anabat Bat Detection	Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*), Large-footed Myotis (*Myotis macropus*) and other threatened microbat species	8 hours (Two sessions in two locations on separate nights)
Habitat searches	Green and Golden Bell Frog (*Litoria aurea*), Cumberland Land Snail (*Meridolum corneovirens*)	12 hours (opportunistically throughout study area)
Incidental observations or evidence of fauna	Various	opportunistically throughout the field study

3.5 Likelihood-of-occurrence assessment

The likelihood of Threatened and Migratory species and Threatened populations occurring within the study area are assessed against the criteria outlined in Table 3.4.

Species subject to likelihood-of-occurrence assessments were those identified during the desktop and field-based investigations and/or the professional opinion of contributors to this assessment.

Table 3.4 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.
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.
Known	▪ Recorded in the study area during current field study.

3.6 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 (10 km from the subject site) and that had a moderate to high likelihood of occurring within the subject site based on suitable habitat or observation in the field (or else was recorded during the current surveys).

For species or communities listed under the TSC Act, significance assessments were completed by addressing the factors of s5A of the EP&A Act following the *Threatened species assessment guidelines The assessment of significance* (Department of Environment and Climate Change 2007b). For species or communities listed under the EPBC Act, significance assessments were completed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment Water Heritage and the Arts 2009).

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

Threatened species were assessed as a group if they share similar lifestyle and habitat requirements and are affected by many of the same threatening processes (e.g. hollow dependant microbats, large forest owls). The potential impact of the proposal on each species within a group is expected to be similar in most cases however sufficient information regarding each species in a group is provided to enable differentiation of impacts on specific species where appropriate. This approach enabled all species that are likely to be affected by the proposal to be assessed while keeping the impact assessment concise.

The extent of potential habitat affected and conclusions with regard to the significance of impacts on Threatened biodiversity was separated into certified and non-certified areas in each assessment. A conclusion with regard to impact significance is also reached for the combined impacts of the proposal.

3.7 Constraints and limitations

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

Where surveys were conducted outside the optimal time for detecting a particular species (e.g. orchids) a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.

4. Results

4.1 Ecological context of the study area

The study area is located within the Liverpool and Camden local government areas, and the surrounding landscape is part of the broader Cumberland Plain, within the Sydney Basin Bioregion. The Cumberland Plain overlies Wianamatta shales, has gentle slopes and fertile soils - creating an ideal landscape for agriculture. Since the middle of the nineteenth century, the Cumberland Plain has undergone extensive clearing, grazing and disturbance for agriculture, urban and industrial development. Currently, the study area exists in a highly fragmented landscape, surrounded by roads, rural residential properties, industrial estates urban towns and new housing developments. However, remnant vegetation exists as linear strips in road reserves and as fragmented stands on private property.

4.2 Identified vegetation communities

The field surveys and desktop assessments identified that the vegetation within the study area was dominated by four communities, the distribution of which was specifically related to geological, topographical, and geomorphological characteristics and previous land use (refer Figure 4.1, Figure 4.2). The vegetation communities in the study area (refer Table 4.1) were:

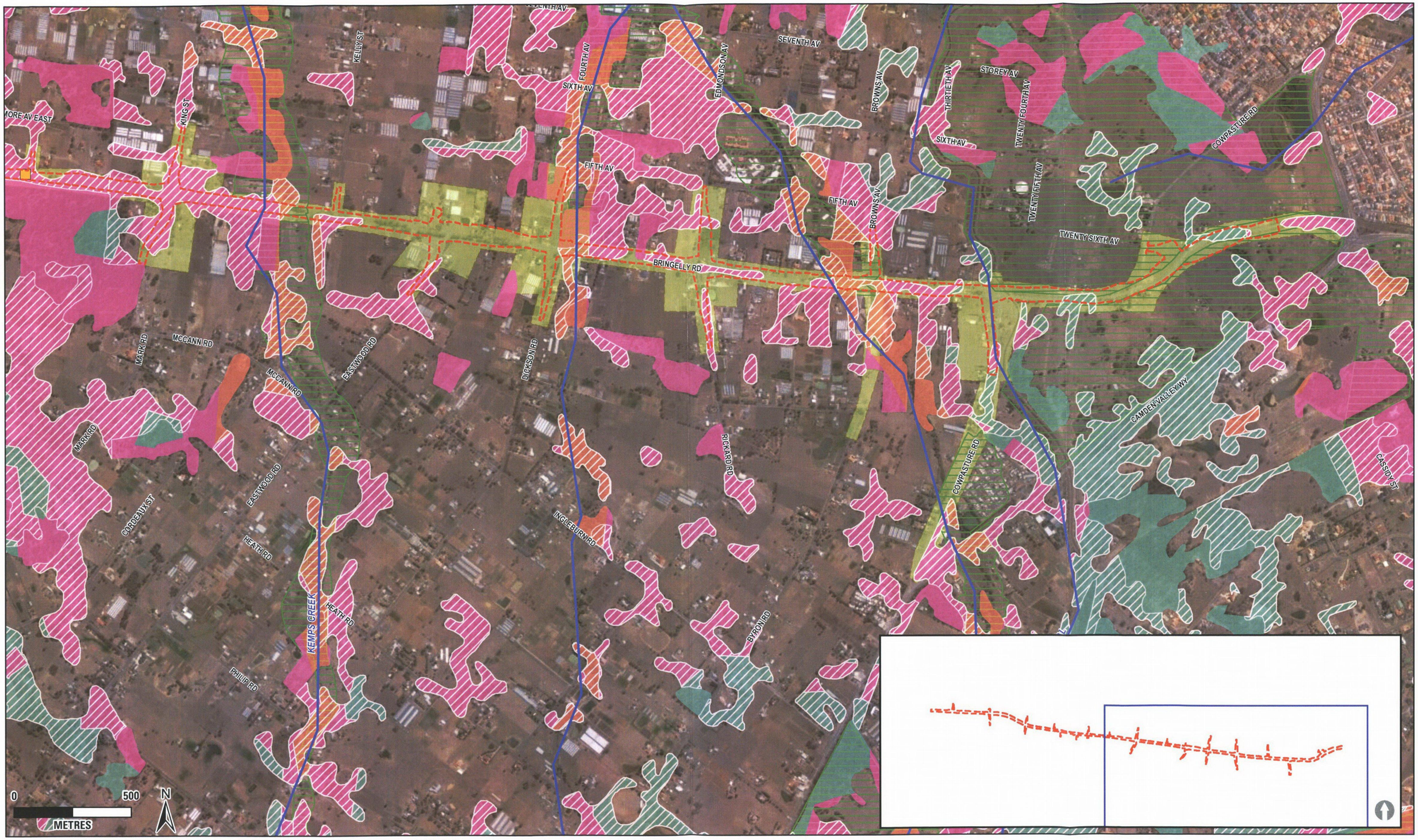
- Shale Plains Woodland (forms part of the Critically Endangered Cumberland Plain Woodland).
- Shale Hills Woodland (forms part of the Critically Endangered Cumberland Plain Woodland).
- Alluvial Woodland (forms part of the Endangered River-Flat Eucalypt Forest on Coastal Floodplains).
- Cleared and disturbed land with scattered trees.

Table 4.1 Identified vegetation communities

Vegetation community name (Tozer 2003), (NSW National Parks and Wildlife Service 2002d)	OEH vegetation types database/Biometric vegetation type (Keith 2004)	TSC Act name/status(Department of Environment Climate Change and Water 2010c)	EPBC Act name/status (Department of the Environment Water Heritage and the Arts 2010e)
Shale Plains Woodland	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	Cumberland Plain Woodland (critically endangered)	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (critically endangered)
Shale Hills Woodland	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	Cumberland Plain Woodland (critically endangered)	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (critically endangered)
Alluvial Woodland	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains, Sydney Basin and South East Corner	River-Flat Eucalypt Forest on Coastal Floodplains (endangered)	n/a
Cleared and disturbed land with scattered trees	Highly disturbed areas with no or limited native vegetation	n/a	n/a

The observed distribution of these communities generally corresponds with the existing broad scale (1:100,000) vegetation mapping (NSW National Parks and Wildlife Service 2002a) of the study area.

Detailed summaries of the dominant species recorded in each vegetation community and the vegetation habitat assessments are provided below.



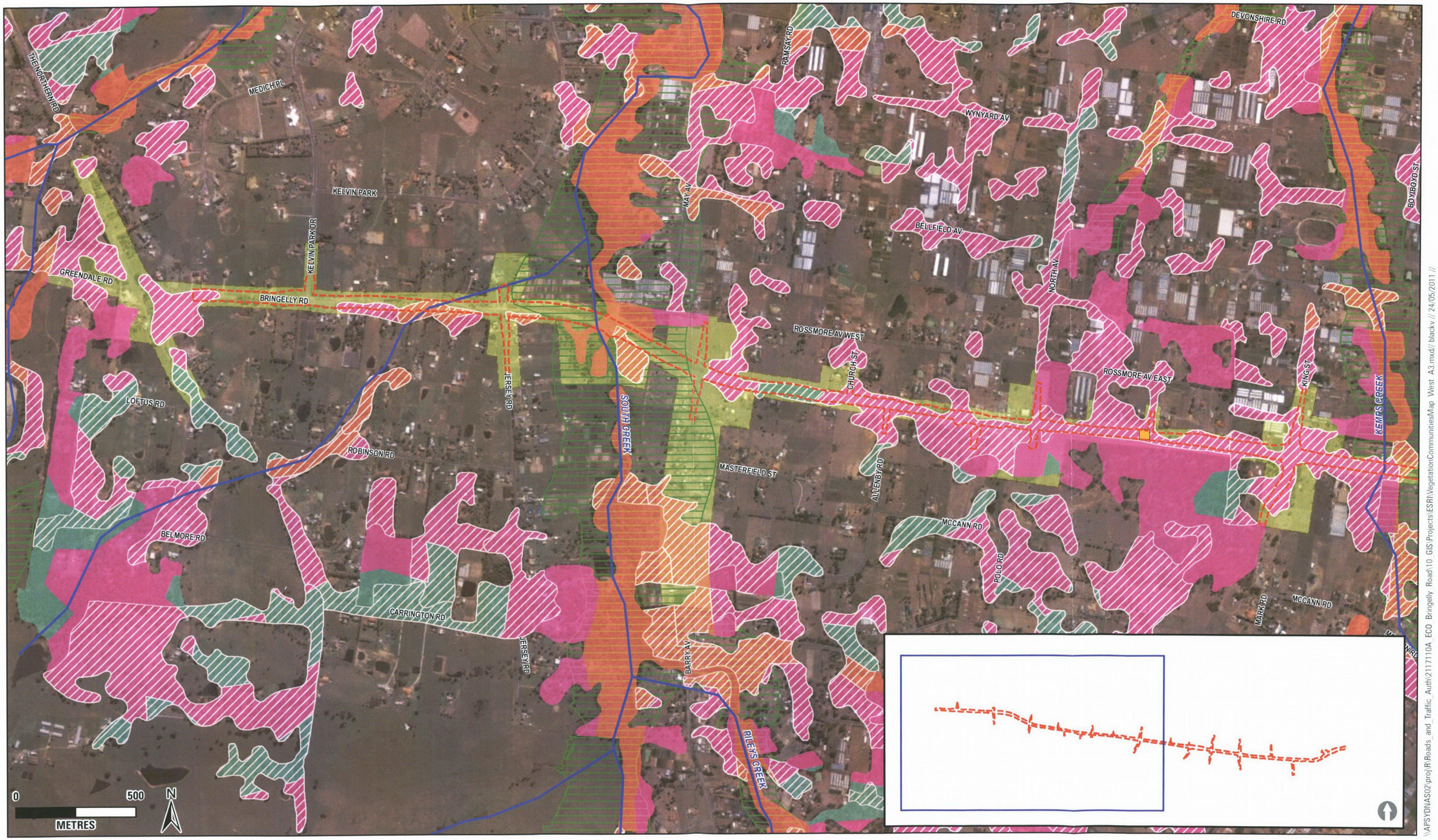
Investigation area
Project footprint
South West Non-certified area
Waterways

Vegetation with canopy cover greater than 10%
10 - Shale Plains Woodland
11 - Alluvial Woodland
9 - Shale Hills Woodland

Vegetation with canopy cover less than 10%
10 - Shale Plains Woodland
11 - Alluvial Woodland
9 - Shale Hills Woodland

Marsdenia viridiflora ssp. viridiflora

Figure 4.1 Vegetation map east



Investigation area

Project footprint

South West Non-certified area

Waterways

Vegetation with canopy cover greater than 10%

10 - Shale Plains Woodland

11 - Alluvial Woodland

9 - Shale Hills Woodland

Vegetation with canopy cover less than 10%

10 - Shale Plains Woodland

11 - Alluvial Woodland

9 - Shale Hills Woodland

Marsdenia viridiflora ssp. viridiflora

Figure 4.2 Vegetation map west

4.2.1 Cumberland Plain Woodland

Cumberland Plain Woodland in the Sydney Basin Bioregion (Cumberland Plain Woodland) is restricted to drier areas of the Sydney Basin with soils derived from Wianamatta Shale. Cumberland Plain Woodland is typically a grassy woodland community dominated by species including *Eucalyptus moluccana* and *E. tereticornis* with *E. crebra*, *E. fibrosa*, and *Corymbia maculata* occurring less frequently (NSW National Parks and Wildlife Service 2004). Cumberland Plain Woodland was once wide spread across the western suburbs of the Sydney region, however only 9 per cent of the original extent of this community currently exists (NSW National Parks and Wildlife Service 2004). Cumberland Plain Woodland is listed as a Critically Endangered ecological community under both the TSC Act and the EPBC Act. Cumberland Plain Woodland is included within the Critically Endangered ecological community listed under the EPBC Act as Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest. However, the EPBC Act listing excludes some patches that are regarded as Cumberland Plain Woodland under the TSC Act on the basis of condition thresholds (NSW Scientific Committee 2009).

Two distinct structural and floristic variations of Cumberland Plain Woodland, as described by Tozer (Tozer 2003) have been mapped within the study area (refer Figure 4.1, Figure 4.2), which are recognised as:

- Shale Hills Woodland.
- Shale Plains Woodland.

Shale Hills Woodland

Several small patches of this variant have been mapped within the eastern Section of the study area along Bringelly Road (NSW National Parks and Wildlife Service 2002d). These patches occur adjacent to and intergrade with Shale Plains Woodland. The distinction between these variations was not apparent within the study area due to disturbance and weed invasion in the understorey and ground layers and they are treated as a single unit referred to as Shale Plains Woodland.

Shale Plains Woodland

The Shale Plains Woodland variation of Cumberland Plain Woodland is the most abundant native vegetation community within the study area. This community occurs chiefly as patches with sparse (less than 10%) canopy cover many of which extend into adjacent properties beyond the study area. Several patches of this community however retain a more intact canopy cover particularly in the area between North Avenue and King Street. This community covered a total of approximately 68 hectares within the study area with approximately 9.8 hectares in good condition (refer Figure 4.2).

Within the study area, the composition of this community varied considerably due primarily to variation in disturbance history and natural drainage patterns with two broad condition types recognised. These condition types are described in Table 4.2 and Table 4.3 below.

Table 4.2 Poor Condition Cumberland Plain Woodland

Remnant trees (less than 10 per cent cover) over disturbed understorey

Extent in investigation area (approx) and location	64.3 hectares throughout existing road reserves and adjacent properties of the investigation area, particularly along Bringelly Road. Mapped Shale Hills Woodland and Shale Plains Woodland with canopy cover less that 10 per cent in Figures 4.1 and 4.2.
Extent within subject site (approx)	27.3 hectares (25.9 hectares in certified areas, 1.4 hectares in non-certified areas)
Description	Canopy: A sparse cover of large mature trees present: chiefly *Eucalyptus moluccana* and *Eucalyptus tereticornis* with occasional *Eucalyptus longifolia*. Little evidence of canopy regeneration. Understorey: absent or dominated by exotic species including *Olea europaea* subsp. *cuspidata**, *Sida rhombifolia** and *Lycium ferocissimum** with occasional native species including *Bursaria spinosa*, *Acacia decurrens*, *Dillwynia sieberi*, *Indigofera australis*. Groundcover: a mosaic of areas dominated by exotic grasses and herbaceous weeds (e.g. *Paspalum dilatatum**, *Eragrostis curvula**, *Bromus catharticus**, *Plantago lanceolata**, and *Crassula spp**) and patches with a substantial native component (e.g. *Einadia hastata, Microlaena stipoides*, *Solanum prinophyllum*).
Condition	Poor. This condition type was dominated by weeds with a low cover of native species in the understorey and groundcover layers. Low to moderate recovery potential: would require intensive management.
Threatened species of plant?	None recorded. This community contains some marginal quality habitat for several Threatened species of plant.
Threatened community?	Small patches with a substantial component of native species in the understorey and groundcover layers are consistent with TSC Act listed CPW but not with the EPBC Act listed Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CPSW&SGTF) due to their small size. Other areas with minimal native cover in these strata do not conform to any Threatened community.

Table 4.3 Good condition Cumberland Plain Woodland

Dense regrowth woodland	
Extent in investigation area (approx) and location	10.4 hectares in properties adjoining Bringelly Road and the intersection of North Avenue and King Street. Mapped Shale Plains Woodland with canopy cover greater than 10 per cent in Figure 4.1, Figure 4.2.
Extent within subject site (approx)	0.9 hectares (entirely within certified areas)
Description	Canopy: dense cover of immature and semi-mature trees *Eucalyptus moluccana* and *Eucalyptus tereticornis* and *Melaleuca decora* present with occasional *Eucalyptus crebra*. Mature trees very infrequent. Canopy recruitment evident. Understorey: sparse to dense cover of shrubs. Native species dominant including *Bursaria spinosa*, *Dillwynia sieberi*, *Ozothamnus diosmifolius* and *Dodonaea viscosa* ssp. *cuneata*. Groundcover: native grasses and herbs dominant including *Brunoniella australis, Cheilanthes sieberi, Dichondra repens, Themeda australis, Microlaena stipoides, Einadia hastata*) with patches of introduced species (e.g. *Setaria* spp*, *Bidens pilosa**, *Solanum nigrum**, *Asparagus asparagoides**).
Condition	Good. The understorey of this vegetation is largely intact and the ground layer is dominated by native species. Some weed growth, particularly in moist areas and at edges. High recovery potential.
Threatened species of plant?	None recorded. This community provides suitable habitat for a number of Threatened species of plant. As indicated in Section 4.7.
Threatened community?	Consistent with the TSC Act listing for CPW. Consistent with the EPBC Act listed CPSW&SGTF.

4.2.2 Alluvial Woodland

Alluvial Woodland occurs exclusively in association with drainage lines (NSW National Parks and Wildlife Service 2002d) and was restricted to the streams and associated floodplains of the study area, with the most substantial occurrence found in association with South Creek. This community occurs within the subject site in certified (2.0 hectares) and in non-certified areas (3.1 hectares) of the subject site.

Alluvial Woodland is a diverse vegetation community that can be dominated by a range of different species depending on the adjacent vegetation community (NSW National Parks and Wildlife Service 2002d). Within the study area, the Alluvial Woodland canopy and sub-canopy were dominated by *Eucalyptus amplifolia, E. tereticornis* and *Angophora floribunda* as occasional emergent trees over patches of *Casuarina glauca* and *Melaleuca* spp. Exotic tree species including *Salix nigra** and *Olea europaea* ssp. *cuspidata** were also found here. This community generally lacked a shrub layer and the ground cover was dominated by introduced species such as *Tradescantia fluminensis** with occasional patches of native species, chiefly *Commelina cyanea* and *Microlaena stipoides*.

The condition of this community varies from poor to moderate within the study area. In poor condition areas introduced species are dominant in the understorey and groundcover layers with the canopy intact to partially cleared. In moderate condition areas, the native canopy and/or understorey layer are of reduced cover and the groundcover layer is a mixture of native and introduced species. Under-scrubbing of shrubbery and horse grazing appear to be the cause of this degradation and appear to have resulted in a reduction in native shrub, herb and grass diversity and abundance as a result of grazing pressure and trampling.

The condition of this community within the subject site was uniformly poor due to weed dominance in the groundcover layer however patches exhibiting relatively intact canopy layers and landscape scale connectivity occur along South Creek and Kemps Creek. Small fragmented patches with sparse canopy layers and extensive weed invasion occur elsewhere within the subject site and broader study area.

The Alluvial Woodland of the study area is consistent with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Department of Environment and Climate Change 2007a). This community is listed as Endangered under the TSC Act.

Photo 4.1 Alluvial woodland

4.2.3 Cleared and disturbed land with scattered trees

This vegetation type occupies areas in the study area that have been historically subject to substantial anthropogenic disturbance including clearing for farming and road construction. Consequently, this community is not mapped as native vegetation in the existing broad scale (1:100,000) vegetation mapping of the study area by (refer Photo 4.1, Figure 4.1, Figure 4.2). Cleared and disturbed land with scattered trees occurs throughout the study area and is the dominant form of vegetation.

This community consisted of a dense ground cover consisting of a diverse array of exotic grasses and herbaceous species (up to 0.5 metres tall and 95% cover) with occasional emergent scattered *Eucalyptus moluccana* and *E. tereticornis* (to 20 metres tall) and patches of exotic shrubs and small trees including *Olea europaea* ssp. *cuspidata** and *Ligustrum spp.** Dominant groundcover species include, *Chloris gayana**, *Pennisetum clandestinum**, *Paspalum dilatatum**, *Eragrostis curvula**, *Crassula spp**., and *Bidens pilosa**. The Cleared and disturbed land with scattered trees contains a wide variety of grass and herbaceous weed species. Very few native species were recorded in this community.

The cleared and disturbed land with scattered trees community was in poor ecological condition. This vegetation community has been extensively modified by past land use including farming and road construction and as a consequence has lost most of its native species and is significantly structurally modified with minimal canopy cover. Exotic species are dominant and have replaced much of the indigenous canopy, shrub layer, and groundcover.

The cleared and disturbed land with scattered trees community is unlikely to contain suitable habitat for any Threatened plant species and none were located in this community during the field surveys.

Photo 4-2 Cleared and disturbed land with scattered trees

4.3 Species of plant

One hundred and thirty four species of plant were recorded within the study area of which 59 (44 per cent) were introduced (refer Appendix B). Fourteen species of plant recorded within the study area are listed as Noxious Weeds in the control areas of Camden and Liverpool under the NW Act (refer Table 4.4). The main occurrences of noxious weeds are shown in the map in Appendix E.

Woody weeds (*Cestrum parqui*, Ligustrum lucidum*, Salix nigra*, Lycium ferocissimum** and *Ricinus communis**) were largely restricted to riparian areas and road reserves. The aquatic weeds *Alternanthera philoxeroides** and *Salvinia molesta ** were found in South Creek. *Salvinia molesta** was also found in a small farm dam to the south-east of the intersection of Bringelly Road and the Northern Road.

The main Noxious weed infestations are shown in the map in Appendix E. *Olea europaea* subspecies *cuspidata is* ubiquitous in the study area with particularly dense infestations found along streams and the road reserve in the eastern half of Bringelly Road. Noxious weeds, in particular *Asparagus asparagoides** and *Lycium ferocissimum** were also found as scattered individuals within road reservations and disturbed vegetation on private properties throughout the study area.

Six of these are Weeds of National Significance (WONS) (Thorp & Lynch 2000) which are species which have been identified as posing a particularly high risk to socio-economic and environmental values.

Table 4.4 Noxious weeds recorded in the study area listed under the *Noxious Weeds Act 1993* for the Camden and Liverpool control areas

Scientific Name	Common name	Control class[1]	WONS[2]
Alternanthera philoxeroides	Alligator weed	3	yes
Asparagus asparagoides	Bridal creeper	5	yes
Cestrum parqui	Green cestrum	3	no
Lantana camara	Lantana	4	yes
Ligustrum lucidum	Privet (Broad-leaf)	4	no
Lycium ferocissimum	African boxthorn	4	no
Olea europaea subspecies *cuspidata*	African olive	4 (Liverpool only)	no
Opuntia stricta	Common Prickly Pear	4	no
Oxalis spp.	exotic Oxalis species and varieties]	5	no
Parietaria judaica	Pellitory , Asthma weed	4 (Liverpool only)	no
Ricinus communis	Castor oil plant	4 (Liverpool only)	no
Rubus fruticosus aggregate species	Blackberry	4	yes
Salix nigra	Black willow	5	yes
Salvinia molesta	Salvinia	3	yes
Xanthium occidentale	Noogoora Burr, Cockle Burr	4	no

Notes: [1] Noxious weed control categories (pursuant to the *NSW Noxious Weeds Act 1993*):Class 3: The plant must be fully and continuously suppressed and destroyed. 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. Class 5: The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.[2] Weeds of National Significance (Thorp & Lynch 2000).

4.4 Habitat

The suitability, size, and configuration of vertebrate fauna habitats are typically correlated with the structure, floristics, connectivity, and quality of the vegetation communities present at a given site. Therefore, the fauna habitats present in the study area were highly restricted and degraded as a result of past land use, most notably land clearing for agriculture, construction of roads, and associated urban development.

4.4.1 Terrestrial habitats

Three broad types of terrestrial fauna habitat were found within the study area referred to here as:

- highly disturbed woodland
- diverse regrowth woodland
- cleared land with scattered trees.

These habitats are described below.

4.4.1.1 Highly disturbed woodland

This habitat type includes the highly disturbed Shale Plains and Shale Hills woodland with less than 10% canopy cover which is chiefly found within the road reserves of the study area. These areas contain very little native understorey or groundcover vegetation. All occurrences of Alluvial Woodland are also included in this category due to the almost total dominance of introduced plant species in the groundcover layer and the paucity of understorey vegetation observed (refer Table 4.5, Figure 4.3 and Figure 4.4).

These areas generally lacked a variety of microhabitat features, such as a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna species. The groundcover in these disturbed areas still provides shelter for some species of reptile, amphibians and invertebrates, particularly where shelter in the form of large woody debris or rubbish is present.

This habitat type does however contain many mature and semi-mature eucalypts. Twenty-eight mature eucalypts located within this habitat type contained, or were considered likely to contain, hollows with small to medium-sized (2-10 cm entrance diameter) - hollows suitable for birds such as small parrots, small arboreal mammals and tree roosting microchiropteran bat species. Furthermore, the loose bark of *E. tereticornis* and *E. moluccana* may also provide habitat for microchiropteran bats.

These canopy trees also provide nectar, pollen, seeds and insect prey for migratory, nomadic and highly mobile canopy-foraging birds and flying-foxes. Air space within and surrounding the canopy is foraging habitat for bat species.

Overall, this fauna habitat type is in moderate condition providing suitable habitat for species of animal that permanently occupy disturbed environments and species that are highly capable of moving within fragmented landscapes to utilise seasonably variable food sources

such as nectar. This was reflected by the paucity of records of sedentary and disturbance sensitive birds made during the field surveys.

4.4.1.2 Diverse regrowth woodland

This habitat type includes Shale Plains and Shale Hills woodland with greater than 10 per cent canopy cover which is chiefly found within parcel of land surrounding and between North Avenue and King Street (refer Table 4.6, Figure 4.3 and Figure 4.4). This patch is in a certified area.

These areas contain relative intact native understorey and/or groundcover vegetation. Patches of dense understorey and diverse groundcover in this habitat type (refer Table 4.6) provide potential foraging and nesting habitat for small insectivorous birds and a variety of terrestrial reptiles and invertebrates including the Endangered Cumberland Land Snail.

The canopy of this habitat type consists of a dense cover of immature and semi-mature trees which provide foraging habitat for birds. The relatively immature trees may not yet provide a substantial foraging resource for nectar-feeding or seed-eating animals and are unlikely to provide a substantial supply of hollows for hollow-dependent species.

The small size of the patches of this vegetation however limit their value to many small woodland birds which are sensitive to habitat fragmentation and are only likely to persist in relatively large remnants (NSW National Parks and Wildlife Service 2002b). The paucity of potentially hollow-bearing trees also limits the potential of this vegetation as roosting or breeding habitat for many hollow-dependent species.

Overall, this fauna habitat type is in moderate condition providing potential habitat for species of animal that required diverse native understorey vegetation.

4.4.1.3 Cleared land with scattered trees

This habitat type occurs in areas that have been subject to substantial anthropogenic disturbance including clearing for farming and road construction. This habitat type does not correspond to any native vegetation community and includes both certified and non-certified areas.

Native vegetation in this habitat type is restricted to occasional trees and shrubs within the otherwise exotic vegetation of rural and residential properties.

This habitat is only likely to provide habitat for native and introduced fauna species that are adapted to open environments and tolerant of human disturbance. Many such native species (e.g. Noisy Miner, Sulphur-crested Cockatoo) have increased in abundance in response to human disturbance to the extent that they are now considered to be a threat to less adaptable species.

This habitat type is in poor condition and of very limited value to Threatened fauna species.

Table 4.5 Highly disturbed woodland

Extent in investigation area (approx) and location	81.4 hectares throughout existing road reserves and within adjacent properties. Mapped as 'Other remnant vegetation' and 'Support to core habitat' (NSW National Parks and Wildlife Service 2002b) (refer Figures 4.3 and 4.4).
Extent within subject site (approx)	32.3 hectares (29.2 hectares within certified areas and 3.1 hectares in non-certified areas)
Description	Canopy: Patchy cover of mature and semi-mature trees - likely to flower heavily and provide a food source for nectar-feeding bird and mammal species such as lorikeets, honeyeaters, sugar gliders and flying-foxes. Seeds provide food source for large parrots. Hollows provide potential roosting and breeding habitat for mobile fauna species. Understorey: absent, sparse or dominated by exotic species – habitat for habitat generalists such as Noisy Miners and Superb Fairy Wren – understorey unlikely to be used by any Threatened species. Groundcover: chiefly exotic groundcover likely to be utilised by birds of open environments such as Magpie Larks, Australian Magpies, Red-rumped Parrots.
Condition	Moderate. This habitat is highly fragmented and weed-infested yet contains hollow-bearing tree which may be important to local populations of birds and mammals including Threatened species of microbats. Mature trees may also be important to local populations of nectar-feeding birds. The Threatened Grey-headed Flying-fox may utilise this resource.
Threatened species of animal?	Threatened microbats, Grey-headed Flying-fox, Cumberland Land Snail. This community contains some marginal quality habitat for several other Threatened species of birds (Refer to bird species with moderate likelihood of occurrence in Appendix B).
Conservation priority	Moderate

Table 4.6	Diverse regrowth woodland
Extent in investigation area (approx) and location	9.2 hectares of Cumberland Plain Woodland and River-Flat Eucalypt Forest in properties adjoining Bringelly Road and the intersections of North Avenue and King Street. Mapped as 'Core habitat' in Figures 5.3 and 5.4.
Extent within subject site (approx)	1.3 hectares entirely located within certified areas
Description	Canopy: dense cover of immature and semi-mature trees provides foraging habitat for birds. Relatively immature trees may not yet provide substantial foraging resource for nectar-feeding or seed-eating animals and unlikely to contain a substantial supply of hollows for hollow-dependent species. Understorey: sparse to dense cover of shrubs provides cover, foraging and nesting habitat for small nest-building birds. Groundcover: native grasses and herbs provide foraging habitat for small seed-eating and insectivorous birds, reptiles and invertebrates.
Condition	Moderate. Provides foraging and nesting resources for a variety of animal species however the lack of mature and hollow-bearing trees limits its present value. Riparian areas, although degraded have the greatest potential as fauna movement corridors. High recovery potential however riparian areas require intensive management.
Threatened species of animal?	Threatened microbats, Grey-headed Flying-fox, Cumberland Land Snail. This community contains some marginal quality habitat for several other Threatened species of bird (Refer to bird species with moderate likelihood of occurrence in Appendix B).
Conservation priority	High.

4.4.2 Habitat conservation value

The value of habitat for the conservation of plants and animals is affected by a variety of factors including:

- vegetation condition (e.g. floristic diversity, structural complexity, weed cover)
- vegetation composition (e.g. the presence or otherwise of key feed species for fauna)
- vegetation status (e.g. vegetation/habitat types which have undergone major declines in their distribution and are threatened with extinction)
- patch size (e.g. for fauna species with limited dispersal ability)
- connectivity (e.g. for maintaining genetic viability of populations and allowing re-colonisation of habitat after local loss of species).

A conservation significance assessment (NSW National Parks and Wildlife Service 2002b) has been prepared for the vegetation communities and associated habitat values of the Cumberland Plain.

Fragmentation is recognised as a key factor in the conservation ecological processes and species persistence is well recognised. The most effective way to conserve ecological values is to manage all the remnants as a network across the landscape, with connectivity being maintained or created between remnants to increase the network's viability (NSW National Parks and Wildlife Service 2002b).

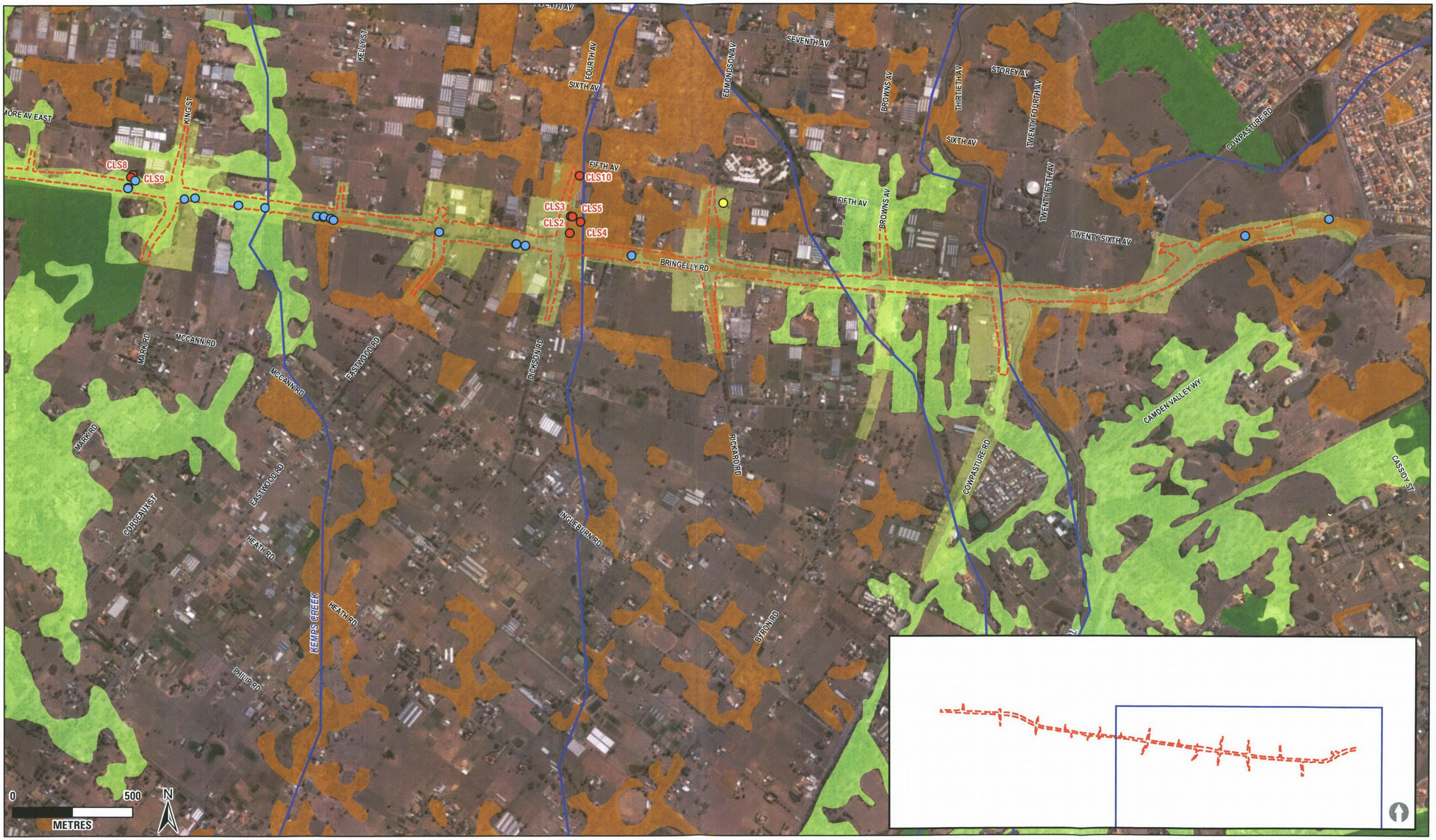
The conservation significance assessment identifies the potential of remnants to contribute to such a network.

The conservation significance categories identified in the plan and found in the Study Area are described in Table 4.7.

Table 4.7 Habitat conservation significance categories

Significance category	Description
Core Habitat	Comprises areas that constitute the backbone of a viable conservation network across the landscape (core areas), or areas where the endangered ecological communities are at imminent risk of extinction.
Support for Core Habitat	These are areas that provide a range of support values to the Core Habitat, including increasing remnant size, buffering from edge effects, and providing corridor connections. Priority areas for conservation and restoration in order to enhance the biodiversity values in the region.
Other Remnant Vegetation	This category contains all native vegetation that does not fall within the above significance categories.

Source: (NSW National Parks and Wildlife Service 2002b).



Investigation area
Project footprint
Waterways

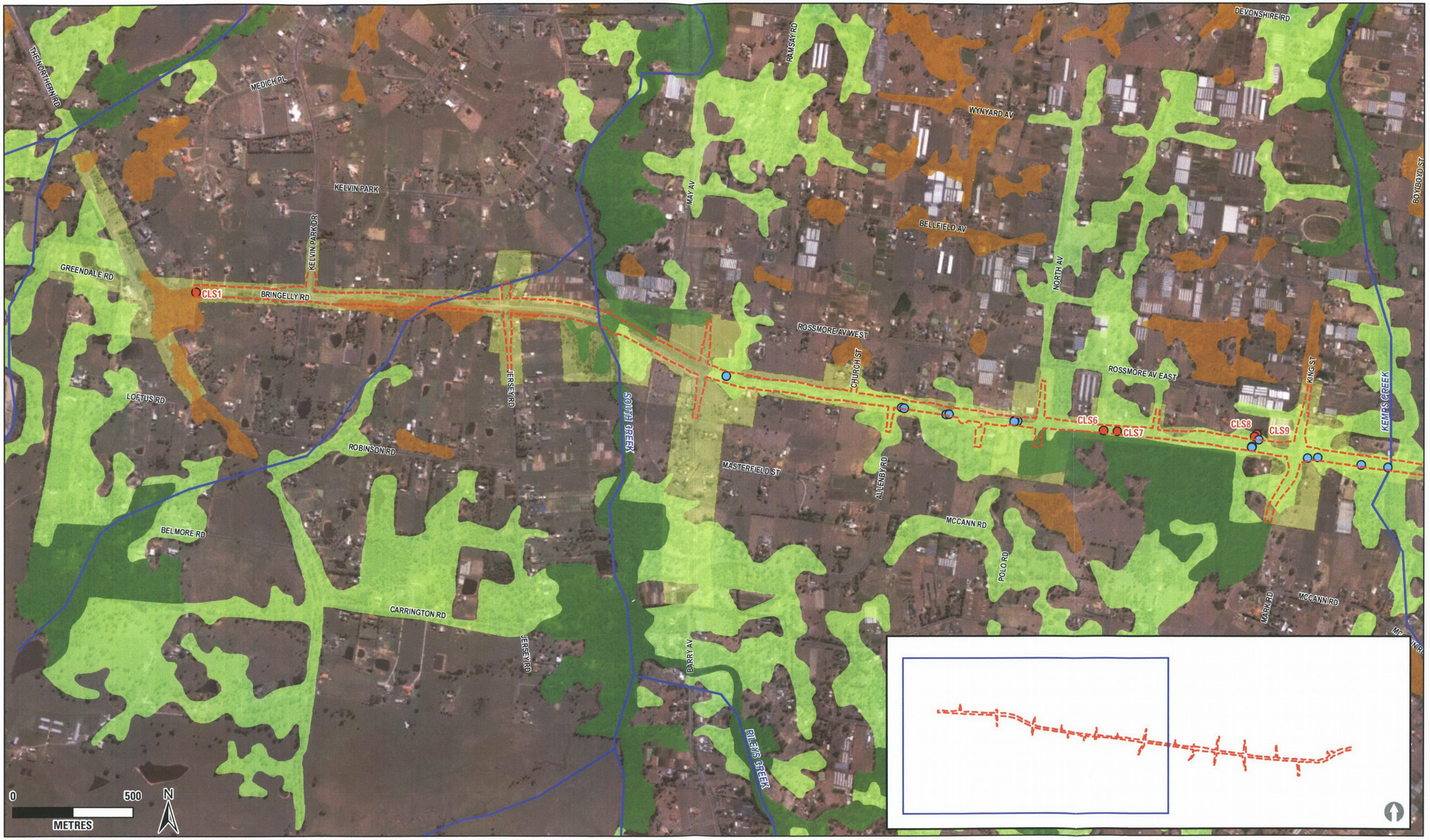
Habitat conservation significance

Core Habitat
Support to Core Habitat
Other Remnant Vegetation

Threatened fauna and habitat locations

Hollow-bearing Trees
Cumberland Land Snail
Varied Sittella

Figure 4.3 Habitat map east



Investigation area
Project footprint
Waterways

Habitat conservation significance

Core Habitat
Support to Core Habitat
Other Remnant Vegetation

Threatened fauna and habitat locations

Hollow-bearing Trees
Cumberland Land Snail

Figure 4.4 Habitat map west

4.5 Species of animal

Sixty-nine vertebrate species were recorded within the study area during the field survey (refer Appendix B), of which 62 are native species as summarised below and in Table 4.8.

The most abundant fauna group in the subject site was birds with 39 species recorded (of which four are introduced). Most of these birds are generalist species that are tolerant to disturbance and are relatively common in urban and fragmented landscapes. One migratory bird species, Latham's Snipe, was recorded in the study area (refer section 4.7.5).

Eight species of frog were heard calling from farm dams and moist depressions within and adjacent to the study area. All were common species that readily inhabit disturbed areas and are widespread throughout western Sydney and the Sydney Basin Bioregion.

Nine species of reptile were recorded. These lizard and snake species are all commonly found throughout Sydney Basin Bioregion.

Twelve mammal species were recorded including nine species of bat, Feral Rabbit, European Red Fox, Domestic Goat and Sugar Glider. Six of these are Threatened species of bat (refer Table 4.11).

The relatively low diversity of fauna recorded is attributed to the paucity of foraging and sheltering habitat within the study area for species which require large patches of structurally diverse vegetation or an abundance of moderate to large entrance diameter tree hollows. The land-use history of study area, particularly previous clearing, and impacts from introduced predators are likely to have led to local extinctions of less resilient species of fauna.

Seven introduced species of birds and mammals were recorded comprising approximately 13% of the total vertebrate species. The Feral Rabbit, European Red Fox and the introduced bird species are all common vertebrate pests. Invertebrate surveys were not conducted during the study with the exception of a targeted search of potential habitat for the Threatened Cumberland Land Snail. Three live snails and six dead shells of this species were recorded within the study area as shown in Figure 4.3 and Figure 4.4.

Table 4.8 Summary of fauna recorded during field survey

Group	Total species	Native species	Introduced species	Threatened species	Migratory species
Amphibians	8	8	0	0	0
Reptiles	9	9	0	0	0
Birds	39	34	4	0	1
Mammals	13	10	3	6	0
Invertebrates	1	1	0	1	0
TOTAL	**70**	**62**	**7**	**7**	**1**

Note: refer to Appendix B for details

4.5.1 Aquatic habitat

The streams within the study area are located within the South Creek subcatchment of the Hawkesbury Nepean catchment. The South Creek subcatchment is perhaps the most degraded subcatchment in the Hawkesbury Nepean. Hydrological and sediment regimes have been dramatically altered due to vegetation clearance and increasing urbanisation causing changes to the geomorphology and ecology of the watercourses. A number of major Sewerage Treatment Plants discharge into South Creek and these, along with stormwater from urban areas and agricultural runoff, contribute to the poor water quality of the streams The recovery potential of the catchment's streams is very low however the watercourses form extremely important habitat corridors despite heavy weed invasion in the riparian zones (Hawkesbury-Nepean Catchment Management Authority 2010).

Field observation of these streams revealed that they were in poor condition with high turbidity, low flow and the presence of introduced species of plant and animal. The introduced Plague Minnow *Gambusia holbrooki* was recorded in all streams and no native fish species were observed. In-stream aquatic habitat is likely to provide habitat for native animal species that are tolerant of reduced water quality such as species of eel, Eastern Snake-necked Tortoise and common frogs such as the Striped Marsh Frog.

South Creek and Kemps Creek and Bonds Creek are Class 3 streams containing minimal fish habitat and requiring only a culvert or ford to maintain adequate fish passage.

Farm dams that are separate from the creeks of the study area are less likely to be infested with exotic fish and are likely to contain fewer pollutants due to their smaller catchment areas. Based on the listening surveys conducted for frogs, these dams appear to provide the main breeding habitat for the eight frog species recorded during the study.

The aquatic habitats of the study area are not likely to be inhabited by any Threatened species.

4.6 Corridors and connectivity

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, which in turn may help reduce the risk of population extinction (Wilson & Lindenmayer 1995).

Vegetation and associated fauna habitat within the study area was fragmented by Bringelly Road, other local roads, and surrounding semi-rural and urban development. In this type of modified landscape, riparian corridors, linear strips of trees within roadside reserves, small patches of regrowth, and isolated trees all play an important role in maintaining local connectivity between the remaining patches of habitat. These linkages may be used by species 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 riparian vegetation remnants associated with South Creek and Kemps Creek have the most potential as wildlife movement corridors due to their connectivity with other vegetation remnants in the locality such as Kemps Creek Nature Reserve. This vegetation has high value as a wildlife corridor connecting habitat both in the immediate locality and in the broader region. Vegetation constituting these corridors within the subject site is located almost entirely within the non-certified areas.

The provision of fauna passage in these areas for terrestrial and arboreal fauna, such as possums, gliders and reptiles should be considered. This passage would facilitate safe movement of animals between habitats on either side of the road thereby assisting in the maintenance of viable populations by reducing inbreeding, reducing the incidence of road kills and allowing for habitat re-colonisation after localised species loss. Whilst the species which would benefit directly from these measures are not Threatened, they are important food items for several Threatened fauna species that are likely to inhabit the study area, such as the Powerful Owl and Little Eagle.

The fragmented patches of vegetation within the remainder of the subject site have low connectivity with vegetation in the broader locality and are of limited contribution to regional wildlife corridors.

4.7 Species, populations and communities of conservation concern

4.7.1 Threatened ecological communities

4.7.1.1 Commonwealth listed communities

Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest is listed as a Critically Endangered ecological community under the EPBC Act. Unlike the TSC Act listing of Cumberland Plain Woodland, the EPBC Act listing of Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest excludes very small patches of vegetation (<0.5 hectares in size) and vegetation patches that do not meet other condition thresholds outlined by the Threatened Species Scientific Committee (2009) and presented in Table 4.9 below.

Table 4.9 Condition thresholds for vegetation patches to meet the description of the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Category	Description	Thresholds
Category A	Core thresholds that apply under most circumstances: patches with an understorey dominated by natives and a minimum size that is functional and consistent with the minimum mapping unit size applied in NSW.	Minimum patch size is ≥0.5 ha AND ≥50 per cent of the perennial understorey vegetation cover is made up of native species
Category B	Larger patches which are inherently valuable due to their rarity.	Minimum patch size is ≥ 5 ha AND ≥30 per cent of the perennial understorey vegetation cover is made up of native species
Category C	Patches with connectivity to other large native vegetation remnants in the landscape.	The patch size is ≥0.5 ha AND ≥30 per cent of the perennial understorey vegetation cover is made up of native species AND The patch is contiguous with a native vegetation remnant that is ≥5 hectares in area.
Category D	Patches that have large mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain.	The patch size is ≥0.5 ha AND ≥30 per cent of the perennial understorey vegetation cover is made up of native species AND The patch has at least one tree with hollows per hectare or at least one large tree (≥80cm diameter at breast height) per hectare from the upper tree layer

Some patches of vegetation within the study area meet the condition thresholds of Category A and C and consequently form part of the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest Critically Endangered ecological community as listed under the EPBC Act. Field verification of the distribution of the EPBC listed community within the study area revealed that it corresponds closely with the area of Shale Plains Woodland mapped with a canopy cover greater than 10% (refer Figure 4.1 Figure 4.2).

A total of 10.4 hectares of EPBC Act listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest was recorded in the study area of which 0.9 hectares was located in the subject site.

A summary of the impact assessment conducted under the EPBC Act for the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest Critically Endangered ecological community is provided in Section 6.1 and is provided in full in Appendix D.

4.7.1.2 State listed communities

Two state-listed Threatened ecological communities, Cumberland Plain Woodland (Shale Plains and Shale Hills Woodland) and River-Flat Eucalypt Forest (Alluvial Woodland) were recorded. The occurrence of these communities in the study area is described in Section 4.2 and displayed in Figure 4.1, Figure 4.2).

4.7.2 Endangered populations

Endangered populations are listed under Schedule 1, Part 2 of the TSC Act.
Four Endangered Populations are known to occur within Sydney Metropolitan Catchment Management Area, Cumberland Subregion. Of these four populations only one occurs in the locality—*Marsdenia viridiflora* subsp. *viridiflora*. in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas.

Marsdenia viridiflora subsp. *viridiflora* was recorded in a single location in the study area (refer Figure 4.2). Approximately ten stems of *Marsdenia viridiflora ssp. viridiflora* were found within an area of approximately three square metres within certified lands near the southern verge of Bringelly Road approximately 20 metres west of the intersection with Glen Allan Road. These stems may represent a single mature plant and multiple seedlings or vegetative growth from smaller number of individuals. This location is within the subject site and would be affected by the proposal.

A single Endangered animal population: the Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai LGAs is located within this subregion. This population is of no relevance to the proposal.

4.7.3 Threatened species of plant

Sixty-three species of Threatened plant (including fungi) listed under the TSC Act and/or the EPBC Act are known to occur or predicted to occur in the Cumberland sub-catchment of the Sydney Metropolitan Catchment Management Authority (CMA) region and the Cumberland sub-catchment of the Hawkesbury/Nepean CMA region which the study area traverses (refer Appendix B).

Of those species, only six have a moderate likelihood of occurring in the study area (Table 4.10) based on the existence of local records for these species and the habitat characteristics observed on the site. No Threatened species of plant has a high likelihood of occurrence.

Table 4.10 Threatened species of plant with potential to occur in habitat affected by the proposal

Threatened species	Conservation significance		
Species Name	**TSC Act***	**EPBC Act***	**Likelihood of occurrence**
Acacia pubescens	V	V	Moderate
Cynanchum elegans	E	E	Moderate
Grevillea juniperina	V	-	Moderate
Pimelea spicata	E	E	Moderate
Pultenaea pedunculata	E	-	Moderate

* Key: V = Vulnerable, E = Endangered
Note: excludes Threatened species planted outside of natural range.

Consequently, searches for these species were undertaken throughout the study area with a focus on higher condition areas of potential habitat. The surveys were conducted at the appropriate time of year to detect these species (i.e. the surveys were conducted during the flowering period for these species). A reference site for *P. spicata* near the Lower Prospect Canal was checked and it was found that this species was flowering heavily during March 2010.

These surveys did not detect these species. It is thus unlikely that a large population of any of these species is present in the study area. There is a moderate chance however that a small population may have been missed or represented as a soil seed-bank and an assessment of impact significance was conducted in accordance with the precautionary principle.

4.7.4 Threatened species of animal

Fifty-two Threatened species of animal listed under the TSC Act and/or the EPBC Act have been recorded or are predicted to occur in the Cumberland sub-catchment of the Sydney Metropolitan Catchment Management Authority (CMA) region and the Cumberland sub-catchment of the Hawkesbury/Nepean CMA region which the study area traverses (refer Appendix B).

Eight Threatened species of animal were recorded in the study area during the field surveys (Table 4.11).

Table 4.11 Threatened species of animal recorded during the field surveys

Threatened species	Conservation significance		Location/Comment
Species Name	**TSC Act***	**EPBC Act***	
Cumberland Land Snail	E	-	3 live animals, 6 empty shells (9 locations shown in Figure 4.3 and Figure 4.4)
Eastern Bentwing-bat	V	-	possible Anabat record
Eastern False Pipistrelle	V	-	probable Anabat record
Greater Broad-nosed Bat	V	-	probable Anabat record
Grey-headed Flying-fox	V	V	flying over study area

Threatened species	Conservation significance		Location/Comment
Species Name	**TSC Act***	**EPBC Act***	
Large-footed Myotis	V	-	under bridge over South Creek
Varied Sittella	V	-	Approximately 4 individuals recorded foraging near the intersection of Browns Rd and Sixth Avenue
Yellow-bellied Sheathtail-bat	V	-	probable Anabat record

* Key: V = Vulnerable, E = Endangered, CE = Critically Endangered

An additional eight Threatened species of animal which have been recorded previously in the proposal locality are moderately likely to use habitat affected by the proposal (Table 4.12).

Table 4.12 Additional Threatened species of animal likely to use habitat affected by the proposal

Threatened species	Conservation significance	
Species Name	**TSC Act***	**EPBC Act***
Eastern Freetail-bat	V	-
Little Eagle	V	-
Little Lorikeet	V	-
Powerful Owl	V	-
Regent Honeyeater	CE	E
Scarlet Robin	V	-
Spotted Harrier	V	-
Swift Parrot	E	E

* Key: V = Vulnerable, E = Endangered, CE = Critically Endangered

The Cumberland Plain region in which the study area is located has been subject to extensive clearing. Outside of the scattered national parks and nature reserves remnant vegetation is largely restricted to small patches on private lands and narrow strips along roadsides and watercourses much of which is regrowth from previous clearing activities. Much of the understorey and ground layer of this vegetation is highly disturbed, exhibiting low floristic and structural diversity and extensive weed invasion. This habitat degradation in conjunction with other disturbances such as predation by feral animals and collision with vehicles is likely to have led to the local extinction of many vertebrate animal species which forage or otherwise traverse habitats at ground level.

The only Threatened species of vertebrate likely to utilise the habitat of the study area are birds and bats. All of the bird species likely to use habitat affected by the proposal have been infrequently recorded in the locality and have a moderate likelihood of occurring within the study area due to the habitat fragmentation, the paucity of mature trees and modification to the structure and composition of vegetation communities.

The Threatened microbat species (refer Table 4.11 and Table 4.12) that are known or likely to occur in the study area are highly mobile and adapted to aerial foraging in relatively open habitat. Of these, the following five species are hollow-dependent:

- Eastern Freetail-bat.
- Eastern False Pipistrelle.
- Greater Broad-nosed Bat.
- Large-footed Myotis.
- Yellow-bellied Sheathtail-bat.

The smaller size of these microbats in comparison to many hollow-dependent animals allows these species to use hollows with smaller entrances which are more abundant than those required by larger animals such as owls, possums and large parrots. Microbats thus appear to be less susceptible to disturbance to native understorey and groundcover vegetation and fragmentation of habitat and have a high likelihood of occurrence in the study area.

One threatened invertebrate, the Cumberland Land Snail was recorded and has potential to occur elsewhere within the study area where woody debris and native groundcover plants remain. The identity of this species was confirmed by Dr Michael Shea, a Malacologist with expertise in land snail identification, from the Australian Museum based on photographs and dead shell samples.

It is unlikely that any of the remaining Threatened fauna species would be affected by development within the study area (refer Appendix B), for one or more of the following reasons:

- No habitat was recorded in the study area.
- The area is outside the normal range of the species and records are likely to be of vagrants or invalid.
- The species is considered locally extinct.

Habitat descriptions for each of the species are provided in Appendix B.

4.7.5 Migratory species

Twelve migratory species have been predicted to occur within the proposal locality, based on the SEWPAC Protected Matters Search Tool (refer Appendix B). One Migratory species, Latham's Snipe, was detected near the edge of a small farm dam in the south-east corner of 993 Bringelly Road (Lot: 10 DP 812153) during the surveys.

Migratory species are protected under international agreements to which Australia is 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 comprise 'Matters of National Environmental Significance' and are protected under the EPBC Act.

One migratory species that is also listed as Critically Endangered under the EPBC Act (Regent Honeyeater) has potential to occur in the Study Area. Impacts on this species are considered in Section 6.1 and Appendix D.

Other migratory species of bird may also use the area (refer Appendix B). The site would not be classed as an 'important habitat' for any migratory species as defined under the EPBC Act Policy Statement 1.1 Principal Significant Impact Guidelines (Department of the Environment and Heritage 2006) in that the site is unlikely to 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 unlikely that the proposed development within the study area would significantly affect Latham's Snipe or any other migratory species and this group is not considered further in this report.

4.8 Critical habitat

Critical habitat is listed under both the TSC Act and EPBC Act. Both the State and Federal Directors-General maintain a register of this habitat. Critical habitat is the whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, a Critically Endangered species, an Endangered population, an Endangered Ecological Community or a Critically Endangered Ecological Community that is critical to the survival of the species, population or ecological community.

There is no listed critical habitat within the study area so no critical habitat is likely to be affected by the proposal.

4.9 Potential impacts

4.9.1 Key Threatening Processes

Threatening processes are those that threaten, or have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities.

Key threatening processes are listed under the TSC Act and EPBC Act. A process can be listed as a key threatening process if it could:

- Cause a native species or ecological community to become eligible for inclusion in a threatened list (other than the conservation dependent category).
- Cause an already listed Threatened species or Threatened ecological community to become more endangered.
- Adversely affect two or more listed Threatened species or Threatened ecological communities.

Presently there are 35 key threatening processes listed under the TSC Act, and 19 listed under the EPBC Act.

The potential impacts of the proposal and their interaction with key threatening processes are described in the following Sections.

4.9.2 Vegetation clearing

The extent of vegetation within the subject site which would require clearing for the proposal and a comparison of this area with the total amount of each vegetation community present within the study area and within a 1 km radius is shown in Table 4.13.

For the purposes of this assessment, it has been assumed that vegetation clearing would be restricted to the subject site and that compound and materials storage areas would be located within existing cleared areas.

Table 4.13 Vegetation clearing extent comparison

Vegetation community	Extents[1]				
	Clearing in Non-certified lands[2]	Clearing in Certified lands[2]	Total clearing	Area within Investigation area (ha)	Area within 1 km of subject site
Shale Hills Woodland (Canopy Cover > 10 per cent)	0	0	0	0.6	36.1
Shale Hills Woodland (Canopy Cover < 10 per cent)	<0.1	2.9	2.9	6.0	100.3
Shale Hills Woodland (Total)	**<0.1**	**2.9**	**2.9**	**6.6**	**136.4**
Shale Plains Woodland (Canopy Cover > 10 per cent)	0	0.9	0.9	9.8	150.7
Shale Plains Woodland (Canopy Cover < 10 per cent)	1.3	23.1	24.4	58.3	322.6
Shale Plains Woodland (Total)	**1.3**	**24**	**25.3**	**68.1**	**473.3**
Alluvial Woodland (Canopy Cover > 10 per cent)	1.3	0.3	1.6	6.2	75.0
Alluvial Woodland (Canopy Cover < 10 per cent)	1.8	2	3.8	9.8	70.2
Alluvial Woodland (Total)	**3.1**	**2.3**	**5.4**	**16.0**	**145.2**

Note 1: Extents in hectares to one decimal point based on (NSW National Parks and Wildlife Service 2002a) mapping.

Note 2: Non-certified lands are those not covered by the biodiversity certification of the Growth Centres SEPP.

The extent of the corresponding Threatened ecological communities affected is shown in Table 4.14.

The removal of vegetation that comprises Cumberland Plain Woodland and River Flat Eucalypt Forest would result in a direct loss of these communities and contribute to the Key Threatening Processes: Clearing of native vegetation and Land clearance.

The impacts of vegetation clearing on other Key Threatening Processes are discussed below.

Table 4.14 Threatened ecological community clearing extent comparison

Threatened ecological community	Act	Clearing in Non-certified lands[2]	Clearing in Certified lands[2]	Total clearing	Area within Investig-ation area (ha)	Area within 1 km of subject site (ha)[3]
Cumberland Plain Woodland (Canopy Cover > 10 per cent)	TSC Act	0	0.9	0.9	10.4	186.8
Cumberland Plain Woodland (Canopy Cover < 10 per cent)	TSC Act	1.4	25.9	27.3	64.3	422.9
Cumberland Plain Woodland (Total)	**TSC Act**	**1.4**	**26.8**	**28.2**	**74.7**	**609.7**
River Flat Eucalypt Forest (Canopy Cover > 10 per cent)	TSC Act	1.3	0.3	1.6	6.2	75.0
River Flat Eucalypt Forest (Canopy Cover < 10 per cent)	TSC Act	1.8	2	3.8	9.8	70.2
River Flat Eucalypt Forest (Total)	**TSC Act**	**3.1**	**2.3**	**5.4**	**16.0**	**145.2**
Cumberland Plains Shale Woodland and Shale Gravel Transition Forest (Total)**	**EP BC Act**	**0**	**0.9**	**0.9**	**10.4**	186.8*

Note 1: Extents in hectares to one decimal point based on (NSW National Parks and Wildlife Service 2002a) mapping.

Note 2: Non-certified lands are those not covered by the biodiversity certification of the Growth Centres SEPP.

Note 3 Approximate figure not based on field verification of vegetation condition for EPBC Act criteria. Areas within the subject site and investigation area exclude areas of existing roadway mapped as vegetated. **= includes the TSC Act listed community in good condition.

Note 4 Includes the TSC Act listed community in good condition.

4.9.3 Weed proliferation

Fifty-nine species of weed were observed in the study area, including 14 species listed as noxious under the NW Act (refer Section 4.3 and Appendix B). The locations of the main occurrences of noxious weeds are shown in the maps in Appendix E.

The vegetation removal and earthworks has the potential to disperse weeds into areas of remnant vegetation where weed species do not currently occur. The most likely causes of weed dispersal associated with the proposal include earthworks and the movement of soil and attachment of seed and vegetative matter to vehicles, machinery, and clothing. This could in turn further reduce the quality of the remnant native vegetation.

The removal of trees would create gaps in the canopy resulting in altered light levels, wind speed, and/or temperature, which can all promote the growth of weeds.

Several Key Threatening Processes listed under the TSC Act relating to weeds and weed invasion of vegetation communities are currently operating and have the potential to be encouraged by the construction of the road upgrade. They are as follows:

- invasion of native vegetation communities by exotic perennial grasses
- invasion and establishment of exotic vines and scramblers
- invasion, establishment and spread *of Lantana camara*
- loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- invasion of Native Plant Communities by African Olive *Olea europaea* L. subsp. *cuspidata.*

4.9.4 Loss of fauna habitat

Removal of native vegetation, hollow bearing trees, and dead trees is likely to remove potential breeding, roosting and foraging habitat for Threatened birds and microchiropteran bats. The locations of Threatened species habitat including hollow-bearing trees, Cumberland land snail recorded locations and vegetation of regional habitat conservation significance is shown in Figure 4.3 and Figure 4.4.

The canopy may provide a foraging resource and temporary roosting resource for wide-ranging nomadic and migratory nectar-feeding birds and mammals (e.g. Swift Parrot, Regent Honeyeater, Little Lorikeet, Grey-headed Flying-fox) and predatory birds (e.g. Powerful Owl, Little Eagle and Spotted Harrier). This habitat is unlikely however to be important habitat for these species as it occurs in a degraded and fragmented state and has a low density of large mature trees which are capable of heavy and regular flowering and is likely to contain a low density of prey.

The main occurrence of hollow-bearing and potentially hollow-bearing trees within the study area is within the road reserve of the existing Bringelly Road. Thirty-eight of the mature eucalypts located here contain small hollows suitable for use by hollow-dependent birds such as parrots, small arboreal mammals and microchiropteran bat species. The study area also contains dead eucalypt trees that may be suitable habitat for these species. Evidence of

chewing of hollow entrances and scratches on some of these trees indicate that they are utilised by parrots and arboreal mammals. Other animals such as microchiropteran may also use these hollows without leaving any external indication of their presence. These hollow bearing and dead trees are shown in Figure 4.3 and Figure 4.4. No hollows of sufficient size to be utilised by large hollow-dependent birds (e.g. Powerful Owl) were recorded within the study area.

The clearing of groundcover vegetation and the removal of dead woody debris would result in the loss of habitat for the Cumberland Land Snail. Approximately 26.8 hectares of habitat for this species would be cleared in certified areas and approximately 1.4 hectares in non-certified areas. The habitat associated with the records of this species to the east of Fourth Ave (in non-certified lands) is likely to be of particular value to the species. The recording of a live snail and three empty shells in a number of locations in this area indicates that the species may be present in higher numbers here and that the area is more likely to contain a viable population than elsewhere in the study area. Removal of habitat in this location would be of particular concern for the local occurrence of the species.

The habitat of the species in this location is largely outside the construction envelope and it is anticipated that the vast majority of this habitat would be retained during construction as substantial areas of non-vegetated land are found in the immediate vicinity which could be used for compound or storage areas. The other two records of live snails and three records of dead shells are in certified areas which would be cleared for construction. Vegetation which would be cleared for the upgrade to North Ave is also likely to be suitable habitat for the species despite the lack of records in this location. This unavoidable loss of habitat is likely to place the local population of the species at increased risk of extinction.

The removal of these hollow bearing trees, dead trees and woody debris would result in the loss of fauna habitat and would directly contribute to following Key Threatening Processes listed under the TSC Act:

- removal of dead wood and dead trees
- loss of hollow-bearing trees.

The proposal would result in the removal of all 28 hollow-bearing trees in the study area including dead standing trees.

The impacts of this habitat clearing on Threatened fauna species are assessed in Appendix D.

4.9.5 Habitat fragmentation

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. Although the newly created habitat is generally used by some species, those species are usually generalists and are often considered aggressive (Grey *et al.* 1998), further decreasing population levels of the species remaining in the fragments. In addition to the loss of total habitat area, the process of fragmentation can impact on species within the newly created fragments in a number of ways, including barrier effects, genetic isolation, and edge effects.

Due to the existing fragmentation and high level of edge effects that exist within the study area, the removal of vegetation is unlikely to significantly increase habitat fragmentation, promote edge effects and barrier effects, or increase genetic isolation at a scale that would directly affect highly mobile species of animal such as birds and bats.

The increased fragmentation as a result of the proposal may however have an indirect impact on predatory birds such as the Powerful Owl and Little Eagle due to potential impacts on populations of non-Threatened terrestrial and arboreal fauna such as possums, gliders and reptiles which are food items for these species.

The fragmentation that would occur as a result of the proposal does however have potential to exacerbate the impact of the current fragmentation of habitat for the Cumberland Land Snail, due to its very limited dispersal abilities, and on the viability of affected patches of Threatened ecological communities.

4.9.6 Noise and vibration

During construction of the proposal, there would be increased noise in the local area. This could cause disturbance to fauna: although, given the proximity of habitat of the study area to existing roads and infrastructure, it is expected that the impact on most species would be minor.

There is some potential for construction activity resulting in noise and vibration to impact on Large-footed Myotis which were found roosting under the bridge over South Creek.

4.9.7 Erosion and soil disturbance

Earthworks and tree removal would expose soils that have the potential to enter surrounding areas of vegetation and waterways, if not properly managed. The volume of soil may be relatively large, as soil would adhere to tree roots during their removal. The nutrient and moisture load of the soil profile may change after a large amount of soil is removed or when trees are removed (as they consume more nutrients and water than smaller vegetation components).

4.9.8 Impact on aquatic ecosystems

The extension of existing culverts and construction of the new bridge over South Creek would result in disturbance to the aquatic ecosystems of the study area. Impacts would include clearing of emergent aquatic vegetation and earthworks within the banks and channel of waterways.

The native aquatic vegetation of the creeks is limited to disturbance tolerant emergent species such as *Persicaria* spp., *Typha* spp. and *Phragmites australis*. These species are likely to naturally regenerate over a short time-frame post construction and the extent of this habitat available is unlikely to be significantly affected.

The proposed measures to limit erosion and sediment input into waterways and maintain the current level of aquatic habitat connectivity are considered sufficient to ensure that the aquatic ecosystems of the study area are unlikely to be significantly affected by the proposal.

4.9.9 Mortality

Fauna injury or death has the greatest potential to occur during the early phase of construction when vegetation and habitats are being cleared. While some mobile species, such as birds, may be able to move away from the path of clearing, other species that are less mobile or those that are nocturnal and restricted to tree habitats, may find it difficult to move rapidly over relatively large distances. Threatened species that could be affected by the clearing include microchiropteran bat species that roost in tree hollows and under bark and the Cumberland Land Snail.

4.9.10 Cumulative impacts

The proposal is located in an area that is earmarked for significant development including other major infrastructure (e.g. the South West Rail Link) and residential development of town centres associated with the planned development of the South West Growth Centre.

While the proposal would contribute to these impacts, the biodiversity certification conditions for the South West Growth Centre are designed to offset the cumulative impacts of all planned development within the area subject to the certification.

4.9.11 Summary of impacts on key threatening processes

The proposal would involve the operation of or contribution to eight Key Threatening Processes as described in the preceding Sections and summarised in Table 4.15.

Table 4.15 Key threatening processes relevant to the proposal

Key threatening process	TSC Act	EPBC Act	Relevance
Invasion and establishment of exotic vines and scramblers	Y	-	Vegetation clearing activities may spread weeds and promote their proliferation
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	-	Y	Vegetation clearing activities may spread weeds and promote their proliferation
Invasion of native plant communities by exotic perennial grasses	Y	-	Vegetation clearing activities may spread weeds and promote their proliferation
Invasion, establishment and spread of *Lantana camara*	Y	-	Vegetation clearing activities may spread weeds and promote their proliferation
Invasion of Native Plant Communities by African Olive Olea europaea L. subsp. cuspidata (Wall ex G.Don Ciferri)	Y	-	Vegetation clearing activities may spread weeds and promote their proliferation
Clearing of native vegetation	Y	-	Would occur during vegetation clearing
Human-caused Climate Change	Y	-	Works would result in CO_2 emissions and may make a minor contribution to human-caused climate change.

Key threatening process	TSC Act	EPBC Act	Relevance
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	-	Y	Works would result in CO_2 emissions and may make a minor contribution to human-caused climate change.
Land clearance	-	Y	Would occur during vegetation clearing
Removal of dead wood and dead trees	Y	-	Would occur during vegetation clearing
Loss of Hollow-bearing Trees	Y	-	The removal of approximately 38 hollow-bearing trees would occur during vegetation clearing

4.10 Additional investigation areas

The following is a summary of the ecological values of four areas (refer Figure 4.1 and Figure 4.2) investigated for feasibility of accommodating the proposed South West Growth Centre road network strategy. These upgrades will not be constructed as part of the Bringelly Road Upgrade proposal and have not been assessed as such in this report.

The conclusions are indicative of the environmental condition of the site at the time of preparing the report. It should be recognised that site conditions, including vegetation structure and composition and the presence of Threatened species, can change with time particularly after disturbance events such as fire or clearing and after changes to management regimes.

It is therefore recommended that additional site investigations are conducted prior to any proposed development in these areas to account for any changes in condition.

4.10.1 Camden Valley Way/Bringelly Road/Cowpasture Road intersection

The only native vegetation community in this area is Shale Plains Woodland. The condition of this community on the site and its potential to provide habitat for Threatened species is discussed below.

4.10.1.1 Shale Plains Woodland

Two small, isolated and degraded patches of this community occur here, each with a sparse cover of remnant canopy trees over a highly disturbed understorey. These patches are surrounded by cleared areas, roads and residential development.

The Shale Plains Woodland remnants of the area are consistent with the Cumberland Plain Woodland community listed as Endangered under the TSC Act.

Due to the degraded condition and small size of these patches they are not included in the EPBC Act listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest community.

4.10.1.2 Habitat value for threatened species

Fauna habitat in the area includes highly disturbed woodland and cleared lands with scattered trees. The area generally lacks habitat features, such as a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna species. The groundcover in these disturbed areas still provides shelter for some species of reptile, amphibians and invertebrates, particularly where shelter in the form of large woody debris or rubbish is present.

This habitat type has a low density of mature and semi-mature eucalypts. A single tree hollow, potentially suitable for hollow-dependent animals such as parrots, arboreal mammals and tree roosting microchiropteran bat species, was observed in the area. It is possible that other hollows may exist, but due to the low tree cover they are unlikely to be abundant.

Trees here provide nectar, pollen, seeds and insect prey for migratory, nomadic and highly mobile canopy-foraging birds and flying-foxes. Air space within and surrounding the tree canopy is foraging habitat for bat species.

Overall, this fauna habitat type is in poor condition providing suitable habitat only for species of animal that occupy disturbed environments and species that are highly capable of moving within fragmented landscapes to utilise seasonably variable food sources such as nectar.

The only Threatened species of vertebrate likely to utilise the habitat of the area are birds and bats. All of the bird species likely to use this habitat have been recorded infrequently in the locality and have a only a moderate likelihood of occurring within the area due to the extent of habitat fragmentation, the paucity of mature trees and modification to the structure and composition of vegetation communities.

The highly weed-infested groundcover and shrub layers are marginal as habitat for a number of threatened species of plant.

4.10.1.3 Conclusion

The area contains a single Threatened ecological community (as listed under the TSC Act) and potential habitat for Threatened species of plants and animals. These are in poor condition and therefore represent only a moderate constraint to the future upgrade of the road provided that appropriate environmental management measures are implemented.

4.10.2 Byron Road extension

The native vegetation communities in this area were:

- Shale Plains Woodland.
- Alluvial Woodland.

Due to access restrictions, site inspections were not conducted in this area and the description below is based on broad-scale mapping and the ecological context of the area. The likely condition of these communities on the site and their potential to provide habitat for Threatened species is discussed below.

4.10.2.1 Shale Plains Woodland

A single small, isolated patch of this community is mapped within the area with a variable canopy cover. This patch is surrounded by cleared areas, roads and residences.

The Shale Plains Woodland remnants of the area may be consistent with the Cumberland Plain Woodland community listed as Endangered under the TSC Act however given its location adjacent to a patch of Alluvial Woodland and proximity to a stream, it may be attributable to the River-Flat Eucalypt Forest Endangered ecological community.

Due to the small size and unverified species composition of this patch it may not be included in the EPBC Act listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest community, however, measurement of species composition of this patch and surrounding vegetation would be required to confirm this.

4.10.2.2 Alluvial Woodland

Alluvial Woodland is mapped in the area as a patch with low canopy cover. The condition of this community is likely to be poor due to disturbance in the groundcover and understorey layers associated with previous clearing and current land uses. Analysis of aerial photographs indicates that the canopy layer and understorey here have been at least partially cleared.

The Alluvial Woodland of the area is consistent with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Department of Environment and Climate Change 2007a). This community is listed as Endangered under the TSC Act.

4.10.2.3 Habitat value for threatened species

Fauna habitat in the area appears to include highly disturbed woodland, a highly modified stream and cleared lands with scattered trees. The area is likely to have a low abundance of habitat features, such as a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna species.

Trees provide nectar, pollen, seeds and insect prey for migratory, nomadic and highly mobile canopy-foraging birds and flying-foxes. Air space within and surrounding the tree canopy is foraging habitat for bat species.

Overall, this fauna habitat type is likely to be in poor condition providing suitable habitat for species of animal that permanently occupy disturbed environments and species that are highly capable of moving within fragmented landscapes to utilise seasonably variable food sources such as nectar.

The only Threatened species of vertebrate likely to utilise the habitat of the area are birds and bats. All of the bird species likely to use this habitat have been infrequently recorded in the locality and have a moderate likelihood of occurring within the study area due to the habitat fragmentation, the paucity of mature trees and modification to the structure and composition of vegetation communities.

The area may be marginal as habitat for a number of Threatened species of plant.

4.10.2.4 Conclusion

The area contains Threatened ecological communities and potential habitat for Threatened species of plants and animals however these are likely to be in poor condition and only a moderate constraint to the upgrade of the road provided that appropriate environmental management measures are implemented.

4.10.3 Masterfield Road/Barry Avenue connection

Two native vegetation communities, Shale Plains Woodland and Alluvial Woodland, were mapped in this area in pre-existing broad-scale mapping (NSW National Parks and Wildlife Service 2002d). Field verification revealed however that all vegetation in this area is closer in composition to Alluvial Woodland as shown in Figure 4.2.

The condition of Alluvial Woodland on the site and its potential to provide habitat for Threatened species is discussed below.

4.10.3.1 Alluvial Woodland

Alluvial Woodland in the area occurs in association with South Creek. The Alluvial Woodland canopy and sub-canopy were dominated by *Eucalyptus amplifolia, E. moluccana* and *Casuarina glauca* with a sparse sub-canopy of *Melaleuca decora*. The shrub layer consisted of occasional patches of *Bursaria spinosa* and the ground cover was composed of a mixture of native and introduced grass and herb species such as *Pennisetum clandestinum*, Paspalum dilatatum**, *Microlaena stipoides, Dichondra repens, Commelina cyanea, Einadia hastata* and *Solanum pungetium*.

The condition of this community varied with the degree of clearing and soil disturbance associated with horse grazing and other land use activities such as materials storage and firewood collection. While some small areas retained a sparse understorey and native-species dominated ground layer with moderate tree cover, other areas had a very sparse canopy, lacked an understorey layer and had a ground layer dominated by introduced species. The overall condition of the patch was hence considered to be moderate.

The Alluvial Woodland of the area is consistent with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Department of Environment and Climate Change 2007a). This community is listed as Endangered under the TSC Act.

4.10.3.2 Habitat value for threatened species

Fauna habitat in the area includes moderately disturbed and highly disturbed woodland and cleared lands with scattered trees. Habitat features, such as a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna species were found in the south-west of the area nearer to South Creek but were generally absent from the remaining area. The groundcover in these disturbed areas still provides shelter for some species of reptile, amphibians and invertebrates, particularly where shelter in the form of large woody debris or rubbish is present.

This habitat type has a low density of mature and semi-mature eucalypts. No hollows suitable for hollow-dependent animals such as parrots, arboreal mammals and tree roosting microchiropteran bat species were observed in the area however it is possible that some

hollows may exist here but have gone undetected if they are in locations in which they are not readily visible.

Trees provide nectar, pollen, seeds and insect prey for migratory, nomadic and highly mobile canopy-foraging birds and flying-foxes. Air space within and surrounding the tree canopy is foraging habitat for bat species.

Overall, this fauna habitat type is in moderate condition providing suitable habitat for species of animal that permanently occupy disturbed environments, species that are capable of moving within fragmented landscapes to utilise seasonably variable food sources such as nectar and sedentary species which can occupy small and degraded forest residents.

The only Threatened species of animal likely to utilise the habitat of the area are birds and bats. All of the bird species likely to use habitat affected by the proposal have been infrequently recorded in the locality and have a moderate likelihood of occurring within the study area due to the habitat fragmentation, the paucity of mature trees and modification to the structure and composition of vegetation communities.

The continuously grazed groundcover and shrub layers are marginal as habitat for a number of threatened species of plant.

4.10.3.3 Conclusion

The area contains Threatened ecological communities and potential habitat for Threatened species of plants and animals however these are generally in poor to moderate condition. Due to their condition, these features are considered to be only a moderate constraint to the upgrade of the road provided that appropriate environmental management measures are implemented.

4.10.4 Cowpasture Road (south) upgrade

The native vegetation communities in this area were:

- Shale Plains Woodland.
- Shale Hills Woodland.
- Alluvial Woodland.

The condition of these communities on the site and their potential to provide habitat for Threatened species is discussed below.

4.10.4.1 Shale Hills Woodland

Several small patches of this variant occur within the northern section of area as remnant canopy trees over highly disturbed understorey along Cowpasture Rd. These patches occur adjacent to and intergrade with Shale Plains Woodland. The distinction between these variations was not apparent within the study area due to disturbance and weed invasion in the understorey and ground layers and they are treated as a single unit referred to as Shale Plains Woodland.

4.10.4.2 Shale Plains Woodland

The Shale Plains Woodland occurs as patches with sparse (less than 10 per cent) canopy cover.

The Shale Plains Woodland and Shale Hills Woodland remnants of the study area are consistent with the Cumberland Plain Woodland community listed as Endangered under the TSC Act.

Due to the degraded condition and small size of these patches they are marginal for inclusion in the EPBC Act listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest community.

4.10.4.3 Alluvial Woodland

Alluvial Woodland in the area was restricted to a small patch in association with Bonds Creek. The Alluvial Woodland canopy and sub-canopy were dominated by *Eucalyptus amplifolia,* and *Casuarina glauca*. This community lacked a shrub layer and the ground cover was dominated by introduced species such as *Pennisetum clandestinum*.

The condition of this community was uniformly poor throughout the area due to weed dominance in the groundcover and a sparse canopy layer.

The Alluvial Woodland of the study area is consistent with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Department of Environment and Climate Change 2007a). This community is listed as Endangered under the TSC Act.

4.10.4.4 Habitat value for threatened species

Fauna habitat in the area includes highly disturbed woodland, a highly modified stream and cleared lands with scattered trees. The area generally lacks habitat features, such as a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna species. The groundcover in these disturbed areas still provides shelter for some species of reptile, amphibians and invertebrates, particularly where shelter in the form of large woody debris or rubbish is present.

This habitat type has a low density of mature and semi-mature eucalypts. No hollows suitable for hollow-dependent animals such as parrots, arboreal mammals and tree roosting microchiropteran bat species were observed in the study area however it is possible that some hollows may exist here but have gone undetected if they are in locations in which they are not readily visible.

Trees provide nectar, pollen, seeds and insect prey for migratory, nomadic and highly mobile canopy-foraging birds and flying-foxes. Air space within and surrounding the tree canopy is foraging habitat for bat species.

Overall, this fauna habitat type is in poor condition providing suitable habitat for species of animal that permanently occupy disturbed environments and species that are highly capable of moving within fragmented landscapes to utilise seasonably variable food sources such as nectar.

The only Threatened species of vertebrate likely to utilise the habitat of the study area are birds and bats. All of the bird species likely to use habitat affected by the proposal have been infrequently recorded in the locality and have a moderate likelihood of occurring within the study area due to the habitat fragmentation, the paucity of mature trees and modification to the structure and composition of vegetation communities.

The highly weed-infested groundcover and shrub layers are marginal as habitat for a number of threatened species of plant.

4.10.4.5 Conclusion

The area contains Threatened ecological communities and potential habitat for Threatened species of plants and animals however these are generally in poor condition. Due to their poor condition, these features are considered to be only a moderate constraint to the upgrade of the road provided that appropriate environmental management measures are implemented.

5. Amelioration measures

This Section outlines the impact mitigation measures and offsets strategy proposed for the Bringelly Road Upgrade.

5.1 General principles

A general principle of environmental management is to, in order of preference:

- avoid environmental impacts
- reduce impacts
- mitigate the impacts.

As a last resort, once the above options have been investigated, compensate for the residual impacts (offset).

5.2 Avoidance

Given the location and nature of the proposal and its context within the planned road network of the South-West Growth Centre there is little scope for moving the proposal. Temporary infrastructure would be sited so as to avoid direct impacts to areas of significant biodiversity, such as areas of native vegetation and the locations of records of the Cumberland Land Snail.

Minimising the removal of native vegetation and associated habitat would be an important factor in the identification of appropriate locations for temporary construction areas during the detailed planning of the proposal.

The removal of vegetation within areas that are 'non-certified' would be a key consideration in the detailed design. Avoidance of vegetation removal in 'certified' areas, where practicable, is also important however 'certified' areas are considered to be a lower priority as impacts in these areas are not considered to be significant due to the applicability of the bio-certification of the Growth Centres SEPP.

5.3 Mitigation

5.3.1 Management of the mitigation process

Prior to construction, detailed flora and fauna mitigation measures would be developed and presented as part of the environmental management plans relating to the construction and operation of the proposal. The plans, particularly the environmental management plan (CEMP) would address:

- general impact mitigation
- staff/contractor inductions

- vegetation clearing protocols
- pre-clearing surveys and fauna salvage/translocation
- rehabilitation and restitution of adjoining habitat
- weed control
- pest management
- monitoring.

The plans would include clear objectives and actions for the proposal including:

- minimise human interferences to flora and fauna
- minimise vegetation clearing/disturbance
- minimise impact to threatened species and communities
- minimise impacts to aquatic habitats and species
- flora and fauna monitoring undertaken at regular intervals.

5.3.2 Vegetation clearing recommendations

Disturbance to areas of native vegetation and habitat would be unavoidable during the construction process.

Vegetation clearing should be restricted to the subject site and compound and materials storage areas should be located within existing cleared areas within the study area (refer Figure 4.1 and Figure 4.2).

In order to avoid unnecessary disturbance to sensitive areas outside of the subject site and proposed compound locations, vegetation clearing extents should be clearly identified during the construction process as 'no-go' areas. These should be marked on maps provided to contractors, as well as on the ground using high visibility fencing (such as barrier mesh). No direct disturbance should occur in these areas, including vehicle access.

Staff from the Mount Annan Botanic Gardens should be offered the opportunity to collect seed or vegetative material (e.g. cuttings or tubers) from the *Marsdenia viridiflora* ssp. *viridiflora* plants prior to vegetation clearing for propagation at the gardens to aid in the conservation of the population of the species.

A trained ecologist should accompany clearing crews in order to ensure disturbance is minimised and to assist any native animals to relocate to adjacent habitat. The adoption of these measures would limit the extent of habitat disturbance, prevent soil compacting and damage to trees.

Where feasible, revegetation of areas disturbed by construction of the proposal should be undertaken, thereby restoring some of the habitat lost from these areas.

5.3.3 Direct mortality and habitat loss

Fauna injury or death has the greatest potential to occur during the break-out phase of construction when vegetation and habitats are being cleared. Threatened species that could be affected by the clearing include the various species of micobats that may be roosting in the trees in the study area and the Cumberland Land Snail.

In order to minimise the likelihood of fauna injury or death during the clearing of vegetation, the following measures should be developed and presented as part of the environmental management plans:

- A staged habitat removal process (following RTA Biodiversity Guidelines) should be developed and put in place. This protocol should include:

    1. All habitat trees in the area to be cleared should be identified (by survey) and marked.

    2. Clearing of areas containing habitat trees should be undertaken in September-October and/or March-April when microbats are likely to be active (not hibernating) but are unlikely to be breeding or caring for young.

    3. Vegetation should be cleared from a 10 metre radius around habitat trees to encourage animals roosting in hollows to leave the tree. A 24 hour waiting period would allow animals to leave.

    4. After the 24 hour waiting period, standing habitat trees should be shaken to encourage animals roosting in hollows to leave the trees which tmay then be felled, commencing with the most distant trees from secure habitat. Felled habitat trees may be left on the ground for a further 24 hour waiting period prior to removal from the construction area.

    5. All contractors should have the contact numbers of wildlife rescue groups should animals be injured during clearing.

- Consideration should be given to fitting roost boxes to the bridge over South Creek to provide roost sites for the Large-footed Myotis which was recorded as roosting under this bridge and may be affected by vegetation clearing in this vicinity: provision of roost boxes is a priority action for the recovery of this species.

- As habitat trees are in short supply in the study area consideration should be given to placing artificial hollows (nest boxes) in nearby (secure) habitat before clearing at a one to one ratio to replace hollows lost. If nest/roost boxes are installed, this would be undertaken in consultation with OEH. Nest boxes of a variety of designs may be installed including boxes suitable for roosting by microbats. A recent review of the literature available on the use of artificial hollows by microbats (Goldingay & Stevens 2009) concluded that there is increasing evidence that roost boxes will be used by Australian microbats however the extent to which this can result in valuable research and management applications is not well understood. Artificial hollows have been used in recovery programs for several threatened bird species, but the deployment of roost boxes for threatened bats has only just begun (Goldingay & Stevens 2009). The Eastern False Pipistrelle has been recorded using nest boxes in Victoria suggesting there is potential to use roost boxes in the recovery of this species. If such a management application is used monitoring over a 2–5-year period is recommended to document the outcome (Goldingay & Stevens 2009).

- Consideration should be given to the development of a Cumberland Land Snail translocation plan in consultation with the OEH and in accordance with the Policy on the translocation of threatened fauna in NSW (Department of Environment and Conservation 2005) as part of the CEMP. Any plan should include removal of snails and important habitat elements (large woody debris) from the construction area and their relocation to locations within the study area which would not be cleared during the proposal. Translocation of Cumberland Land Snails should be undertaken by an ecologist during the supervision of vegetation removal. The technique is unlikely to prevent the loss of individuals altogether however it is likely to reduce the intensity of the impact of the proposal on the remaining population by preserving a larger number of individuals and greater genetic diversity making the population more likely to remain viable. Translocation is likely to be successful if the recipient site contains suitable habitat which is already inhabited by the species such that the existing sub-population is augmented. The availability of suitable sheltering and feeding opportunities is likely to limit the population size of the species in the locality and hence the translocation of woody debris is likely to increase the carrying capacity of the recipient site. Cumberland Land Snail translocation has been approved as a management measure in a number of infrastructure projects in western Sydney and is considered to be a suitable measure for reducing the intensity of the impact on this species.

- A bridge structure would be used to cross South Creek to maintain connectivity of terrestrial habitat along the creek banks underneath the road. Options for achieving this outcome should be investigated at the detailed design stage of the proposal including establishing native vegetation and placing habitat elements such as rock armouring and large woody debris under the bridge to provide cover for fauna. Bridge structures can create adverse environments for vegetation and fauna due to intense shading and a lack of rainfall. In order to overcome the lack of rainfall it is recommended that landscaping in the vicinity of the bridge is designed to funnel some surface water flow under the bridge allowing water to absorb into the soil and encourage plant growth. Plant species chosen for revegetation under the bridge should be chosen for their shade-tolerance (e.g. rainforest understorey species native to the Sydney Basin Bioregion) even if these species are not usually found in the Alluvial Woodland vegetation type.

- Where practical, culverts at waterway crossings and culverts within non-certified areas should be designed to provide dry passage for terrestrial fauna during low flow conditions. This may be achieved by providing a raised ledge (of approximately 100 mm) on one side of the culvert or to raise the outer cells where multiple culverts are constructed.

- Consideration should be given to the provision of fauna rope bridge crossings at the important wildlife movement corridors of South Creek and Kemps Creek to maintain the connectivity of habitat for arboreal species and reduce the potential for collisions between tree-dwelling animals and vehicles.

- Erosion and sediment control measures such as silt-fencing and hay bales should be used to minimise sedimentation of streams and resultant impacts on aquatic habitats and water quality.

- The existing fish passage conditions should be maintained with the extension of culverts and duplication of the bridge over South Creek. All crossings should, as a minimum adhere to the fish friendly passage guidelines (Fairfull & Witheridge 2003) for waterway crossings.

5.4 Offsets

5.4.1 Offsets under NSW legislation

Offsets may be required under some circumstances to compensate for impacts to biodiversity.

With the biodiversity certification of the Growth Centres SEPP, biodiversity offsets will be contributed to as part of the Special Infrastructure Contribution (refer Section 2.1.2). Biodiversity offsets under the SEPP will involve the protection and enhancement of habitat both within the growth centres (in certified and non-certified areas) and outside of the growth centres.

However, as the Special Infrastructure Contribution applies only to actions requiring development approval under Part 4 of the EP&A Act, the RTA is not required to contribute to offsets for impacts to biodiversity in the certified areas resulting from the Bringelly Road upgrade.

Impacts to vegetation in non-certified areas would require offsets in accordance with the conditions for biodiversity certification (Minister for Climate Change Environment and Water 2007). The non-certified areas of the study area are all located within riparian zones and adjacent flood-prone land. Impacts on the vegetation and habitat of these areas including the clearing of 1.3 hectares of highly disturbed Cumberland Plain Woodland and 3.1 hectares of highly disturbed River-Flat Eucalypt forest would be offset through the implementation of a riparian vegetation restoration plan. This plan would be developed in consultation with OEH and would include measures to re-establish native vegetation, provide fauna habitat, protect water quality and increase habitat connectivity within the riparian zones of the study area. The minimum extent of restoration compared to clearing of existing native vegetation must be undertaken at a ratio of at least 3:1 to reflect the greater ecological risks relative to retaining existing native vegetation (Minister for Climate Change Environment and Water 2007).

5.4.2 Offsets under Commonwealth legislation

The NSW Government is undertaking the preparation of a Strategic assessment of Sydney's growth centres (refer Section 3.7) which would assess potential impacts of urban development of the North West and South West Growth Centres on matters of National Environmental Significance protected under the EPBC Act. If the Commonwealth Government approves the strategic assessment, a strategic approach would be implemented to achieve conservation outcomes in the region (Department of Planning 2009). As the strategic assessment is not yet complete, it has not yet been determined whether offsetting of impacts would be required by the Commonwealth.

6. Impact significance assessment

All proposals assessed under the EP&A Act must include an examination of Threatened biodiversity, or their habitats, that:

- are likely to occur within the proposed subject site
- may be indirectly affected by the construction and operation of a proposal.

In the event that Threatened biodiversity occurs within the study area and could be affected by the proposal, an assessment of the potential impact must be undertaken.

Threatened species, populations and ecological communities listed as under the TSC Act are known or likely to occur within the study area (refer Section 4.7). Since part of the subject site occurs within the certified area of the South West Growth Centre, there is no requirement to undertake significance assessment of impacts in these areas under Section 5A of the EP&A Act. The study area also includes non-certified areas which do require assessment under the Act.

It is expected that all certified land would be developed and hence that the medium to long-term viability of these areas as habitat is limited. These areas may however provide interim habitat for fauna populations until revegetation within the growth centre and Western Sydney Parklands creates alternative habitat in the locality. Assessments were thus made with consideration of existing habitat in its current condition within both certified and non-certified areas in accordance with the precautionary principle. This approach provided a detailed understanding of potential impacts and information to guide the detailed design and development of appropriate mitigation measures.

The specific requirements and outcomes of the assessments of significance under the EP&A Act are summarised below with the detailed assessment shown in Appendix D.

Threatened species, populations, and ecological communities that are listed under the EPBC Act require a significance assessment, in this case the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest Critically Endangered ecological community, the Grey-headed Flying-fox, Swift Parrot, Regent Honeyeater and four threatened plant species. Consequently, an impact assessment has been completed in accordance with the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of the Environment and Heritage 2006) for these species.

The specific requirements and outcomes of the assessments of significance under the EPBC Act are summarised below with the detailed assessment shown in Appendix D.

6.1 Threatened ecological communities

The results of impacts assessments for Threatened ecological communities are summarised in Table 6.1 with detailed assessment provided in Appendix D.

Table 6.1 Summary of impact significance assessments on Threatened ecological communities

Threatened community	Conservation significance		Likelihood of significant impact	
Species Name	**TSC Act***	**EPBC Act***	**Certified lands**	**Non-certified lands**
Cumberland Plain Woodland	CE	-	Likely	Unlikely
River-Flat Eucalypt Forest on Coastal Floodplains	E	-	Unlikely	Unlikely
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	-	CE	Likely	Unlikely

* Key: V = Vulnerable, E = Endangered, CE = Critically Endangered

6.2 Threatened species and populations of plants

The results of impacts assessments for Threatened species and populations of plants are summarised in Table 6.2 with detailed assessment provided in Appendix D.

Table 6.2 Summary of impact significance assessments on Threatened species and populations of plants

Threatened species	Conservation significance		Likelihood of significant impact	
Species Name	**TSC Act***	**EPBC Act***	**Certified lands**	**Non-certified lands**
Acacia pubescens	V	V	Unlikely	Unlikely
Cynanchum elegans	E	E	Unlikely	Unlikely
Grevillea juniperina	V	-	Unlikely	Unlikely
Pimelea spicata	E	E	Unlikely	Unlikely
Pultenaea pedunculata	E	-	Unlikely	Unlikely
Marsdenia viridiflora subsp. *viridiflora.* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas.	E	-	Unlikely	Unlikely

* Key: V = Vulnerable, E = Endangered, CE = Critically Endangered

6.3 Threatened species of animal

The results of impacts assessments for Threatened species of animal are summarised in Table 6.3 with detailed assessment provided in Appendix D.

Table 6.3 Summary of impact significance assessments on Threatened species and populations of animals

Threatened species	Conservation significance		Likelihood of significant impact	
Species Name	**TSC Act***	**EPBC Act***	**Certified lands**	**Non-certified lands**
Cumberland Land Snail	E	-	Likely	Unlikely
Eastern Bentwing-bat	V	-	Unlikely	Unlikely
Eastern False Pipistrelle	V	-	Likely	Unlikely
Eastern Freetail-bat	V	-	Likely	Unlikely
Greater Broad-nosed Bat	V	-	Likely	Unlikely
Grey-headed Flying-fox	V	V	Unlikely	Unlikely
Large-footed Myotis	V	-	Unlikely	Unlikely
Little Eagle	V	-	Unlikely	Unlikely
Powerful Owl	V	-	Unlikely	Unlikely
Regent Honeyeater	E (CE#)	E	Unlikely	Unlikely
Scarlet Robin	V	-	Unlikely	Unlikely
Spotted Harrier	V	-	Unlikely	Unlikely
Swift Parrot	E	E	Unlikely	Unlikely
Varied Sittella	V	-	Unlikely	Unlikely
Yellow-bellied Sheathtail-bat	V	-	Unlikely	Unlikely

* Key: V = Vulnerable, E = Endangered, CE = Critically Endangered, # = preliminary determination

7. Conclusion

Habitats of ecological significance recorded in the study area include Cumberland Plain Woodland and River-Flat Eucalypt forest Threatened ecological communities. The proposal is unlikely to significantly affect River-Flat Eucalypt Forest however a significant impact on Cumberland Plain Woodland is likely to occur. These communities provide habitat for Threatened species of animals and potential habitat for Threatened species of plants.

The Cumberland Land Snail was recorded in several locations in the study area and may be significantly impacted by the proposal due to the potential loss of habitat in several of these locations within certified lands. Hollow-dependent microbats found in the study area are likely to be significantly impacted by the proposal due to the loss of a large proportion of potential hollow-tree roosting and breeding habitat located within certified lands in the study area.

The study area provides potential habitat for a variety of other Threatened species of plants and animals however none of these species are likely to be significantly affected by the proposal due to the marginal quality of the habitat present for these species and their specific habitat requirements.

Biodiversity certification is considered to be applicable to the proposal and hence there is no need to assess the significance of impacts for Threatened biodiversity listed under the TSC Act in certified areas. In accordance with RTA best practice however assessments of significance (7 part tests) for Threatened biodiversity have however been conducted covering both certified and non-certified areas.

Biodiversity certification however removes the need to progress to the preparation of a Species Impact Statement, to seek concurrence or offset impacts in 'certified areas'.

Most of the habitat likely to be affected by the proposal (26.8 hectares out of a total of 28.2 ha) is located within certified areas including:

- recorded locations of the Cumberland Land Snail
- the recorded location of *Marsdenia viridiflora* ssp. *viridiflora*
- potential tree-hollow roosting habitat for Threatened microbats
- high condition Cumberland Plain Woodland/Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

The non-certified areas contain important wildlife corridors and remnants of River-Flat Eucalypt Forest and habitat for Threatened species however the extent of impacts within these areas is relatively small and substantial post-construction habitat restoration is proposed which is likely to improve or at least maintain the current habitat availability in the locality in the medium to long term.

As the impacts of the proposal on 'non-certified' areas are not likely to be significant, preparation of a Species Impact Statement is not required for the proposal. Impacts within 'non-certified' areas would need to be offset through the implementation of a riparian vegetation restoration plan.

Biodiversity certification does not cover Commonwealth legislation. A strategic assessment of the potential impacts on NES Matters associated with the development of the growth centres is however under way. If as part of the assessment the Commonwealth agrees to endorse the Growth Centres SEPP development program, it does not automatically constitute approval under the EPBC Act for the taking of an action (such as the upgrade of Bringelly Rd) in accordance with the program. . However the Minister may subsequently decide to approve an action or class of action undertaken in accordance with the program removing the need for further approval (Department of Environment Water Heritage and the Arts 2009).

Referral of the proposal to the Commonwealth would be required due to the removal of approximately 0.9 hectares of the EPBC Act listed Cumberland Plains Shale Woodlands and Shale Gravel Transition Forest critically endangered ecological community. The requirement for approval by the Commonwealth and any additional conditions would be dependent on the outcome of the referral.

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Appendix A

Concept design

PB PARSONS BRINCKERHOFF

125 YEARS

Concept Design Footprint

Appendix B

Survey data and database search results

Likelihood Assessment for Threatened and Migratory species of animal

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
Amphibians					
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	No	Around the Sydney area there is a marked preference for sandstone ridgetop habitat and broader upland valleys. In these locations, the frog is associated with small headwater creeklines and along 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 the collected water. They have also been observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised over time and are still surrounded by other undisturbed habitat. Do not appear to inhabit areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks. Often spends significant periods of time underground during unfavourable conditions and to avoid detection during the day. (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	Low
Green and Golden Bell Frog (*Litoria aurea*)	E1	V	No	Has a fragmented distribution of mainly near coastal locations from Lakes Entrance (Victoria) to south of the NSW-Queensland border; as far west as Bathurst in the more elevated southern tablelands and central slopes of NSW. Various types of habitat use have been documented. For breeding 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. Is found in various small pockets of habitat in otherwise developed areas and has the tendency of often turning up in highly disturbed sites. Lotic situations such as fast flowing streams appear to be one of the few water bodies not utilised, at least for breeding purposes. Habitat attributes associated with the various waterbodies occupied by the GGBF, and that appear to make such habitat more likely to be occupied, 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 shown by GGBF for sites with a complexity of vegetation structure (Department of Environment and Conservation 2004, 2005b).	Low
Heath Frog, Littlejohn's Tree Frog (*Litoria littlejohni*)	V	V	No	Distributed along the eastern slopes of the Great Dividing Range from the Watagan State Forest near Wyong, south to Buchan in Victoria. Appears restricted to sandstone woodland and heath communities at mid to high altitude. Forages in the tree canopy and the ground, and has been	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
				observed sheltering under rocks on high exposed ridges in summer. It is not known from coastal habitats (NSW Scientific Committee 2000b).	
Southern Bell Frog (*Litoria raniformis*)	E1	V	No	Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. Breeding occurs during the warmer months and is triggered by flooding or a rise in water level. The species has been known to breed from early spring through to late summer/early autumn (Sept to April). During the breeding season, animals are found floating amongst aquatic vegetation (especially Reeds) within or at the edge of slow-moving streams, marshes, lagoons, lakes, farm dams and rice crops. Outside the breeding season animals disperse away from the water and take shelter beneath ground debris such as fallen timber and bark, rocks, grass clumps and in deep soil cracks. Prey includes a variety of invertebrates as well as other small frogs, including young of their own species (Department of Environment and Climate Change 2007b).	Low
Giant Barred Frog (*Mixophyes iteratus*)	E1	E	No	A terrestrial species which occurs in rainforests, Antarctic beech or wet sclerophyll forest. Feeds on insects and smaller frogs (Cogger 2000). The species is associated with permanent flowing drainages, from shallow rocky rainforest streams to slow-moving rivers in lowland open forest. It is not known to utilise still water areas (NSW Scientific Committee 1999d). More prevalent at lower altitudes and in larger streams than its congeners, although has been recorded in areas up to 1000 metres asl. (NSW National Parks and Wildlife Service 1999h).	Low
Red-crowned Toadlet (*Pseudophryne australis*)	V		No	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone geology. Breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding, individuals are found scattered around sandstone ridges under rocks and logs (Cogger 2000).	Low
Fish					
Macquarie Perch (*Macquaria australasica*)		E	No	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 includes deep water holes covered with rocks. Spawning occurs above shallow running water (Department of Primary Industries 2006)	Low
Australian Grayling (*Prototroctes maraena*)		V	No	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).	Low
Invertebrates					Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
Cumberland Land Snail (*Meridolum corneovirens*)	E1		Yes Recorded during survey	Restricted to the Cumberland Plain and Castlereagh Woodlands of Western Sydney and also along the fringes of River Flat Forest, especially where it meets Cumberland Plain Woodland. It is typically found under logs and other debris, amongst leaf litter and bark around bases of trees. It is also sometimes found under grass clumps and where possible it will burrow into loose soil (NSW National Parks and Wildlife Service 1999c).	Known to occur
Birds					
Spotted Harrier (*Circus assimilis*)	V		Yes Not recorded during study	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals, birds and reptiles, occasionally insects and rarely carrion (Department of Environment Climate Change and Water 2010).	Moderate
Fork-tailed Swift (*Apus pacificus*)		M	Yes Not recorded during study	Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks (Higgins 1999).	Low
Great Egret (*Ardea alba*)		M	Yes Not recorded during study	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).	Low
Cattle Egret (*Ardea ibis*)		M	Yes Not recorded during study	The Cattle Egret is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan 2005).	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
Australasian Bittern (*Botaurus poiciloptilus*)	V		No	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 2002n).	Low
Bush Stone-curlew (*Burhinus grallarius*)	E1		Yes Not recorded during study	Requires sparsely grassed, lightly timbered, open forest of woodland. In southern Australia they often occur where there is a well structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots (NSW National Parks and Wildlife Service 1999b, 2003c).	Low
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	V		No	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey & Knight 2007).	Low
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	V		No	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 1999d).	Low
Brown Treecreeper (eastern subsp) (*Climacteris picumnus victoriae*)	V		No	Found in eucalypt woodlands and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts. Nesting occurs in tree hollows (Department of Environment and Conservation 2005a).	Low
Varied Sittella (*Daphoenositta chrysoptera*)	V		Yes	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west(Higgins & Peter 2002; Royal Australian Ornithologists Union 2003). 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 (Debus & Soderquist 2008).	Known to occur
Painted Honeyeater (*Grantiella picta*)	V		No	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus Amyema, though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks,	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
				than in wider blocks (Garnett & Crowley 2000).	
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)		M	Yes Not recorded during study	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	Low
Little Eagle (*Hieraaetus morphnoides*)	V*		Yes Not recorded during study	The Little Eagle occupies habitats rich in prey within open eucalypt forest, woodland or open woodland (Marchant & Higgins 1993); Aumann 2001a). 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. Young fledge in early summer. Generation length has been estimated as 10 years (Debus & Soderquist 2008). It eats birds, reptiles and mammals, occasionally adding large insects and carrion (Marchant & Higgins 1993); Aumann 2001b; Debus *et al.* 2007). It was formerly heavily dependent on rabbits, but following the spread of rabbit calicivirus disease, and consequent decline in rabbit numbers by 65-85% in the arid and semi-arid zones (Sharp *et al.* 2002), the Little Eagle is increasingly dependent on native prey.	Moderate
White-throated Needletail (*Hirundapus caudacutus*)		M	Yes Not recorded during study	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 2007)	High
Comb-crested Jacana (*Irediparra gallinacean*)	V		No	Occurs in floating vegetation of permanent well-vegetated wetlands and dams. Walks on floating plants. Occasionally feeds along muddy wetland margins on east coast of NSW (Garnett & Crowley 2000).	Low
Black Bittern (*Ixobrychus flavicollis*)	V		No	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 2002n).	Low
Swift Parrot (*Lathamus discolor*)	E1	E	No	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	Moderate

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
				coast's 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).	
Black-tailed Godwit (*Limosa limosa*)	V	M	No	A coastal species found on tidal mudflats, swamps, shallow river margins and sewage farms. Also, found inland on larger shallow fresh or brackish waters. A migratory species visiting Australia between September and May (Pizzey & Knight 2007).	Low
Square-tailed Kite (*Lophoictinia isura*)	V		No	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes (Garnett & Crowley 2000).	Low
Hooded Robin (*Melanodryas cucullata*)	V		No	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia (Garnett & Crowley 2000; Traill & Duncan 2000).	Low
Black-chinned Honeyeater (*Melithreptus gularis gularis*)	V		No	Found in dry eucalypt woodland particularly those containing ironbark and box. Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps (Garnett & Crowley 2000).	Low
Rainbow Bee-eater (*Merops ornatus*)		M	No	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).	Low
Black-faced Monarch (*Monarcha melanopsis*)		M	No	Occurs in rainforests, eucalypt woodlands, coastal scrubs, and damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 2007).	Moderate
Satin Flycatcher (*Myiagra cyanoleuca*)		M	No	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 2007).	Moderate
Turquoise Parrot (*Neophema pulchella*)	V		No	Occurs in the foothills of the great dividing range in eucalypt woodlands and forests with a grassy or sparsely shrubby understorey. Nests in hollows in trees, stumps or even fence posts. It feeds on seeds of both native and introduced grass and herb species (Garnett & Crowley 2000).	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
Barking Owl (*Ninox connivens*)	V		No	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).	Low
Powerful Owl (*Ninox strenua*)	V		No	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 dense 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).	Moderate
Flame Robin (*Petroica phoenicea*)	V		No	The Flame Robin is found in south-eastern Australia (Queensland border to Tasmania, western Victoria and south-east South Australia). In NSW it breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains (Higgins & Peter 2002). There may be two disjunct breeding populations in NSW on the Northern Tablelands and the Central–Southern Tablelands (inferred from distributional data in (Royal Australian Ornithologists Union 2003)and the NSW Wildlife Atlas).	Low
Scarlet Robin (*Petroica boodang*)	V		Yes	The Scarlet Robin is found in south-eastern Australia (extreme south-east Queensland to Tasmania, western Victoria and south-east South Australia) and south-west Western Australia. In NSW it occupies open forests and woodlands from the coast to the inland slopes (Higgins & Peter 2002). Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. The Scarlet Robin breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within 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. The Scarlet Robin builds an open cup nest of plant fibres and cobwebs, sited in the fork of tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (Higgins & Peter 2002).	Moderate
Superb Fruit-Dove (*Ptilinopus superbus*)	V		No	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lilly pillies and	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
				blackberries (Pizzey & Knight 2007).	
Speckled Warbler (*Pyrrholaemus sagittatus*)	V		No	Occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and insects and builds domed nests on the ground (Garnett & Crowley 2000).	Low
Rufous Fantail (*Rhipidura rufifrons*)		M	No	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 2007).	Moderate
Painted Snipe (*Rostratula benghalensis*)	E1	VM	No	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).	Low
Diamond Firetail (*Stagonopleura guttata*)	V		No	Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Feed on seeds, mostly of grasses (Garnett & Crowley 2000).	Low
Freckled Duck (*Stictonetta naevosa*)	V		No	In most years, this species appear to be nomadic between ephemeral inland wetlands. In dry years, they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (Muehlenbeckia cunninghamii) within which they build their nests (Garnett & Crowley 2000).	Low
Masked Owl (*Tyto novaehollandiae*)	V		No	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett & Crowley 2000).	Low
Sooty Owl (*Tyto tenebricosa*)	V		No	Occurs in wet eucalypt forest and rainforest on fertile soils with tall emergent trees. Typically found in old growth forest with a dense understorey but also occurs in younger forests if nesting trees are present nearby. It nests in large hollows within eucalypts and occasionally caves. It hunts in open and closed forest for a range of arboreal and terrestrial mammals including introduced species and sometimes birds (Garnett &	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
				Crowley 2000).	
Regent Honeyeater (*Xanthomyza phrygia*)	E1	EM	No	Occurs mostly in box-ironbark forests and woodland and prefers the 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. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), E. melliodora (Yellow Box) and E. leucoxylon (Yellow Gum) (Garnett & Crowley 2000).	Low
Mammals					
Eastern Pygmy-possum (*Cercartetus nanus*)	V		No	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).	Low
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	No	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects (Churchill 1998).	Low
Spotted-tailed Quoll (*Dasyurus maculatus*)	V	E	No	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 1999h). 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 1999f, 1999h).	Low
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V		Yes Probable record during study	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)	High
Eastern Bent-wing Bat (*Miniopterus schreibersii*)	V	C	Yes Not recorded during	Usually found in well timbered valleys where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008)	Moderate

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
			study		
East Coast Freetail Bat (*Mormopterus norfolkensis*)	V		Yes Not recorded during study	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. Solitary and probably insectivorous (Churchill 2008).	High
Large-footed Myotis (*Myotis macropus*)	V		Yes Recorded during study	Colonies occur in caves, mines, tunnels, under bridges and buildings. Colonies always occur close to bodies of water where this species feeds on aquatic insects (Churchill 2008)	Known to occur
Squirrel Glider (*Petaurus norfolcensis*)	V		No	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999g).	Low
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	E1	V	No	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 2003b).	Low
Koala (*Phascolarctos cinereus*)	V		Yes Not recorded during study	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum Eucalyptus tereticornis, Grey Gum E. punctata, Monkey Gum E. cypellocarpa and Ribbon Gum E. viminalis. In coastal areas, Tallowwood E. microcorys and Swamp Mahogany E. robusta are important food species, while in inland areas White Box E. albens, Bimble Box E. populnea and River Red Gum E. camaldulensis are favoured (NSW National Parks and Wildlife Service 1999e, 2003d).	Low
Long-nosed Potoroo (*Potorous tridactylus*)	V	V	No	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	Low

Species Name	TSC Act[1]	EPBC Act[2]	Recorded in locality[3]	Preferred habitat[4]	Likelihood of occurrence[5]
				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 1999h).	
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Yes Recorded during study	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 lilly pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001b)	High
Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	V		Yes Probable record during study	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 in tree hollows. Thought to be a migratory species (Churchill 2008).	High
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V		Yes Probable record during study	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically, it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 2008)	High
Reptiles					
Broad-headed Snake (*Hoplocephalus bungaroides*)	E1	V	No	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).	Low
Heath Monitor, Rosenberg's Goanna (*Varanus rosenbergi*)	V		No	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).	Low

Notes:

1. V= Vulnerable, E1 = Endangered, E2 = Endangered Population (*Threatened Species Conservation Act 1995*)

2. V = Vulnerable, E = Endangered, M = Migratory, C = Conservation Dependent (*Environment Protection and Biodiversity Conservation Act 1999*)

3. . Previously recorded' refers to records of Threatened species that were identified within the locality from the Atlas of NSW Wildlife (Department of Environment and Climate Change 2007a).

4. Based on database searches and field surveys

5. Likelihood of Occurrence – see methods in the table below

*. Preliminary Threatened species determination

Likelihood Assessment for Threatened species of plant

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
Fabaceae (Mimosoideae)	*Acacia bynoeana* (Bynoe's Wattle)	E1	V	3V	No	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).	Low
Fabaceae (Mimosoideae)	*Acacia gordonii*	E1	E	2K	No	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 1997b).	Low
Fabaceae (Mimosoideae)	*Acacia pubescens* (Downy Wattle)	V	V	3Va	Yes Not recorded during survey	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 2003a).	Moderate
Casuarinaceae	*Allocasuarina glareicola*	E1	E		No	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).	Low
Celastraceae	*Apatophyllum constablei*	-	E	2E	No	Occurs in dry sclerophyll forest on slopes with a north to north-westerly aspect. It typically grows near cliffs (i.e. near the base or just above). The soils at sites are sandy and skeletal, mostly on Narrabeen sandstone. Found in association with *Eucalyptus piperita*, *E. punctata*, *E. sparsifolia*, *Banksia serrata*, *Acacia linifolia*, *Cleistochloa rigida*, *Lomandra obliqua* (Australian Government 2007).	Low
Orchidaceae	*Caladenia tessellata* (Thick Lip Spider Orchid, Tessellated	E1	V	3V	No	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
	Spider Orchid)					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 2002a).	
Myrtaceae	*Callistemon linearifolius* (Netted Bottle Brush)	V		2Ri	No	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).	Low
Hygrophoraceae	*Camarophyllopsis kearneyi*	E1			No	A small, pale, gilled fungus 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).	Low
Euphorbiaceae	*Chamaesyce psammogeton* (Sand Spurge)	E1			No	Occurs in coastal regions of NSW where it grows on sand dunes near the sea (Harden 2000). Grows on fore-dunes and exposed headlands, often with Spinifex (*Spinifex sericeus*) (Department of Environment and Conservation 2005c).	Low
Asclepiadaceae	*Cynanchum elegans* (White-flowered Wax Plant)	E1	E	3Ei	Yes Not recorded during survey	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997b; NSW National Parks and Wildlife Service 2002b).	Moderate
Myrtaceae	*Darwinia biflora*	V	V	2Va	No	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	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
						Change 2008).	
Myrtaceae	*Darwinia peduncularis*	V		3Ri	No	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 2007b).	Low
Poaceae	*Deyeuxia appressa*	E1	E	2E	No	Occurs in the Hornsby area on wet ground. (Harden 1993; Sharp & Simon 2002).	Low
Fabaceae (Faboideae)	*Dillwynia tenuifolia*	V	V	2Vi	Yes Not recorded during survey	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 1997b).	Low
Orchidaceae	*Diuris aequalis* (Buttercup Doubletail)	E1	V	3V	No	Occurs chiefly in the ranges and tablelands from Braidwood to Kanangra and Liverpool where it grows among grass in sclerophyll forest (Harden 1993). It typically occurs on gentle slopes, in gravely clay-loam soil within montane eucalypt forest with a grass or heath understorey (Bishop 2000). Three small populations are known to occur within Kanangra Boyd National Park, other populations are restricted to remnant vegetation within roadsides and agricultural lands (NSW Scientific Committee 2002c).	Low
Ericaceae (Styphelioideae)	*Epacris purpurascens* var. *purpurascens*	V		2K	No	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 2002c).	Low
Myrtaceae	*Eucalyptus benthamii* (Nepean River Gum)	V	V	2Vi	No	*Eucalyptus benthamii* occurs only in wet open forest on sandy alluvial soils along valley floors at an elevation of 140-750m. Restricted to Wallacia and Camden areas, Nepean River and Kedumba Creek, and Reedy and Cedar creeks in	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
						the central Blue Mountains (NSW National Parks and Wildlife Service 2000d).	
Myrtaceae	*Eucalyptus camfieldii* (Heart-leaved Stringybark)	V	V	2Vi	No	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park (Department of Environment and Climate Change). Occurs within poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges (Department of Environment and Climate Change).	Low
Myrtaceae	*Eucalyptus scoparia* (Wallangarra White Gum)	E1	V	2Vi	No	Occurs in Queensland and reaches its southern limit in NSW near Tenterfield. In NSW it is known from three locations all near Tenterfield in the far northern New England Tableland Bioregion where it grows on well drained granitic hilltops, slopes and outcrops, often as scattered trees in open forest and woodland (Royal Botanic Gardens 2004).	Low Local specimens planted.
Myrtaceae	*Eucalyptus* sp. Cattai	E1			No	Occurs in the area between Colo Heights and Castle Hill, historic records include the Royal Botanic Gardens, Sydney. It grows as an emergent tree in scrub, heath and low woodland on sandy soils, generally on flat ridge tops. It usually occurs as isolated individuals or occasionally in small clustered groups (Harden 2002).	Low
Rubiaceae	*Galium australe* (Tangled Bedstraw)	E1			No	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 2005c; Royal Botanic Gardens 2005).	Low
Orchidaceae	*Genoplesium bauera* (Bauer's Midge Orchid)	V		3R	No	Grows in sparse sclerophyll forest and moss gardens over sandstone; from the Hunter Valley to Nowra district (Royal Botanic Gardens 2004).	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
Grammitaceae	*Grammitis stenophylla* (Narrow-leaf Finger Fern)	E1			No	A fern which occurs in coastal regions from Queensland to the NSW south coast where it grows on rocks in rainforest and in wet sclerophyll forest (Harden 2000).	Low
Proteaceae	*Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea)	V			No	Restricted to the western Cumberland Plain, Marsden Park, Rooty Hill, Riverstone, Plumpton, Castlereagh NR, Blacktown, Penrith and north to Pitt Town, where it grows in open dry sclerophyll (eucalypt-dominated) forest or woodland in sandy to clay-loam soils and red pseudolateritic or sandy gravels (Fairley, Alan 2004; Royal Botanic Gardens 2005).	Moderate
Proteaceae	*Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea)	V	V		No	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales (Harden 2002; NSW Scientific Committee 1998a).	Low
Proteaceae	*Grevillea parviflora* subsp. *supplicans*	E1			No	Has a very restricted known distribution (approximately 8 by 10 km) and is confined to the north-west of Sydney near Arcadia and the Maroota Marramarra Creek area. It grows in heathy woodland on skeletal sandy soil over sandstone (NSW Scientific Committee 2000a).	Low
Haloragaceae	*Haloragis exalata* subsp. *exalata* (Square Raspwort)	V*	V	3Va	No	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 2002).	Low
Haloragaceae	*Haloragodendron lucasii*	E1	E	2Ea	No	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 2005c).	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
Dilleniaceae	*Hibbertia superans*	E1			No	Occurs from Castle Hill to South Maroota where it grows in ridgetop woodlands usually near Shale/Sandstone Transition Forest. It is often associated with other Threatened flora including *Pimelea curviflora* var. *curviflora*, *Darwinia biflora*, *Epacris purpurascens* var. *purpurascens*, *Leucopogon fletcheri* subsp. *fletcheri*, *Acacia bynoeana*, *Eucalyptus* sp. Cattai and *Persoonia hirsuta* (NSW Scientific Committee, 2001).	Low
Hygrophoraceae	*Hygrocybe anomala* var. *ianthinomarginata*	V			No	A small, brightly-coloured gilled fungus found in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from the Royal and Blue Mountains National Parks (NSW National Parks and Wildlife Service 2002d).	Low
Hygrophoraceae	*Hygrocybe aurantipes*	V			No	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 (NSW National Parks and Wildlife Service 2002e).	Low
Hygrophoraceae	*Hygrocybe austropratensis*	E1			No	Small, brightly-coloured gilled fungus 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).	Low
Hygrophoraceae	*Hygrocybe collucera*	E1			No	Small, brightly-coloured red 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 2002g).	Low
Hygrophoraceae	*Hygrocybe griseoramosa*	E1			No	Small, buff to brown gilled fungus 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 2002h).	Low
Hygrophoraceae	*Hygrocybe lanecovensis*	E1			No	Small, brightly-coloured gilled fungus 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 2002i).	Low
Hygrophoraceae	*Hygrocybe reesiae*	V			No	Small, lilac coloured gilled fungus 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	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
						Mountains National Park (Hazelbrook Area). It is also found in Tasmania (NSW National Parks and Wildlife Service 2002j).	
Hygrophoraceae	*Hygrocybe rubronivea*	V			No	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 (NSW National Parks and Wildlife Service 2002k).	Low
Sterculiaceae	*Lasiopetalum joyceae*	V	V	2R	No	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).	Low
Brassicaceae	*Lepidium hyssopifolium* (Aromatic Peppercress)	E1	E	3Ei	No	In NSW, there is a population consisting of 6 plants near Bathurst, a population near Bungendore and Crookwell both on the Southern Tablelands. The species was also recorded near Armidale in 1945 and 1958. The species occurs in a variety of habitats including woodland with a grassy understorey and grassland (Department of Environment and Conservation 2005c).	Low
Ericaceae (Styphelioideae)	*Leucopogon exolasius* (Woronora Beard-heath)	V	V	2V	No	Restricted chiefly to the Woronora and Grose Rivers and Stokes Creek, Sydney catchments and the Royal National Park. One old record from the Grose River. Grows in woodland on sandstone (Royal Botanic Gardens 2004).	Low
Ericaceae (Styphelioideae)	*Leucopogon fletcheri* subsp. *fletcheri*	E1		2R	No	Grows in dry Eucalypt woodland or in shrubland on clay, lateritic soils or Hawkesbury sandstone (Fairley, Alan 2004). Found on sandstone ridges and upper slopes in heath or woodland, sometimes in or below sandstone-shale ecotone; often associated with lateritic soils with some clay influence (James 1997a; James *et al.* 1999).	Low
Juncaginaceae	*Maundia triglochinoides*	V			No	Occurs north from Sydney. Grows in swamps, creeks or shallow freshwater 30 to 60 cm deep on heavy clay, low nutrients. Associated with wetland species such as *Triglochin procerum* (Harden 1993).	Low
Apocynaceae	*Marsdenia viridiflora subsp. viridiflora - endangered*	E2	-	-	No	Grows in vine thickets and open shale woodland. Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys.	Moderate

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
	population					Previously known north from Razorback Range (Department of Environment Climate Change and Water 2010)	
Myrtaceae	*Melaleuca biconvexa* (Biconvex Paperbark)	V	V		No	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie. The main concentration of records is in the Gosford/Wyong area (NSW Scientific Committee 1998b). 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).	Low
Myrtaceae	*Melaleuca deanei*	V	V	3R	No	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 1997b).	Low
Myrtaceae	*Micromyrtus minutiflora*	E1	V	2V	No	Occurs in the western part of the Cumberland Plain between Richmond and Penrith where it grows on Tertiary sediments in dry sclerophyll forest (Harden 2002; NSW Scientific Committee 2002b).	Low
Polygonaceae	*Persicaria elatior* (Tall Knotweed)	V	V	3V	No	Occurs infrequently in coastal regions where it grows in damp places especially beside streams and lakes. Also occasionally occurs in swamp forest or associated with disturbance (Department of Environment and Conservation 2005c; Harden 2000).	Low
Proteaceae	*Persoonia bargoensis*	E1	V	2V	No	Grows in woodland to dry sclerophyll forest, on sandstone and laterite. Restricted to the Bargo area (Harden 2002).	Low
Proteaceae	*Persoonia glaucescens* (Mittagong Geebung)	E1	V	2V	No	Occurs from Picton to Berrima where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) ridge-tops, plateaux and upper slopes. Prefers the interface between Lucas Heights and the Hawkesbury and Gymea Soil Landscapes. Commonly associated canopy species are *Corymbia gummifera*, *Eucalyptus sieberi* and *E. sclerophylla* as well as *E. pauciflora* (NSW National Parks and Wildlife Service 2000a).	Low
Proteaceae	*Persoonia hirsuta*	E1	E	3Ki	No	Occurs in central coast and central tableland districts where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) and	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
						rarely shale (NSW Scientific Committee 1998c). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997b).	
Proteaceae	*Persoonia mollis* subsp. *maxima*	E1	E	2E	No	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 2000b).	Low
Proteaceae	*Persoonia nutans* (Nodding Geebung)	E1	E	2Ei	No	Confined to the Cumberland Plain where it grows in Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (Harden 2002; James 1997b; NSW National Parks and Wildlife Service 2001c).	Low
Marsileaceae	*Pilularia novae-hollandiae* (Austral Pillwort)	E1			No	Grows in seasonally dry depressions and margins of marshes and may grow submerged (Harden 2000). It grows in shallow swamps and waterways, often among grasses and sedges. It is most often recorded in drying mud, as this is when it is most conspicuous (Department of Environment and Climate Change 2008).	Low
Thymelaeaceae	*Pimelea curviflora* var. *curviflora*	V	V		No	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. Usually occurs in woodland in the transition between shale and sandstone, often on the Lucas Heights soil landscape (Harden 2000; James 1997b; James *et al.* 1999; NSW Scientific Committee 1998d).	Low
Thymelaeaceae	*Pimelea spicata* (Spiked Rice-flower)	E1	E	3Ei	Yes	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	Moderate

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
					Not recorded during survey	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 1997b; NSW National Parks and Wildlife Service 2000c).	
Rhamnaceae	*Pomaderris brunnea*(Brown Pomaderris)	V	V	2V	No	Confined to the Colo and Upper Nepean Rivers where it grows in open forest (Harden 2000); in western Sydney (Camden to Picton area) known from sandy alluvium on levee and creek banks (James 1997b).	Low
Orchidaceae	*Pterostylis saxicola* (Sydney Plains Greenhood)	E1	E		No	Known now only from Freemans Reach to Picton district. Grows in Sydney Sandstone Gully Forest in shallow or skeletal soils over sandstone shelves, often near streams (Department of Environment and Climate Change 2007b; Harden 1993; James 1997b)	Low
Fabaceae (Faboideae)	*Pultenaea parviflora*	E1	V	2E	Yes Not recorded during survey	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Also occurs in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (James 1997b; NSW National Parks and Wildlife Service 2002l).	Low
Fabaceae (Faboideae)	*Pultenaea pedunculata* (Matted Bush-pea)	E1			No	Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. It grows on a variety of soils in dry sclerophyll forest and disturbed sites (Harden 2000; NSW National Parks and Wildlife Service 2002m; NSW Scientific Committee 1999c). It is largely confined to loamy soils in dry gullies in populations in the Windellama area (Department of Environment and Climate Change 2008).	Moderate
Sterculiaceae	*Rulingia prostrate* (Dwarf Kerrawang)	E1	E	2Ei	No	Occurs south of Picton lakes where it mainly grows in gullies along the escarpment, south from Picton Lakes (Harden 2000), on the Southern Tablelands (one plant at Penrose State Forest, one plant at Rowes Lagoon and one plant at Tallong) and on the North Coast. It occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
						(*Eucalyptus pauciflora*) Woodland at Rose Lagoon; Blue leaved Stringybark (*E. agglomerata*) Open Forest at Tallong; and in Brittle Gum (*E. mannifera*) Low Open Woodland at Penrose; Scribbly Gum (*Eucalyptus haemastoma*)/ Swamp Mahogany (*E. robusta*) Ecotonal Forest at Tomago (Department of Environment and Climate Change 2007b).	
Myrtaceae	*Syzygium paniculatum* (Magenta Lilly Pilly)	E1	V	3Ri	Yes	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 Climate Change and Water 2010)	Local specimens likely planted.
Elaeocarpaceae	*Tetratheca glandulosa*	V	V**	2V	No	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. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar) (Department of Environment and Climate Change 2008).	Low
Orchidaceae	*Thelymitra* sp. Kangaloon (Kangaloon Sun Orchid)		Z		No	Only known only from three locations near Robertson in the Southern Highlands. The species has an estimated extent of occurrence of 300 kml. The Kangaloon Sun-orchid has an estimated area of occupancy of 10 kml. The three localities are Butler's Swamp, Stockyard Swamp, and Wildes Meadow Swamp, all located above what is known as the Kangaloon Aquifer (Department of Environment Climate Change and Water 2010).	Low
Convolvulaceae	*Wilsonia backhousei* (Narrow-leafed Wilsonia)	V			No	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	Low

Family	Species Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Recorded in the locality[4]	Preferred Habitat	Likelihood of occurrence[5]
						Committee 2000c).	
Rutaceae	*Zieria involucrata*	E1	V	2Va	No	Occurs in the Blue Mountains where it grows in wet sclerophyll forest (Harden 2002). Occurs primarily on Hawkesbury sandstone. Also occurs on Narrabeen Group sandstone and on Quaternary alluvium. Found primarily in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. Also known from at least two atypical ridgetop locations. The canopy typically includes *Syncarpia glomulifera* subsp. *glomulifera* (Turpentine), *Angophora costata* (Smooth-barked Apple), *Eucalyptus agglomerata* (Blue-leaved Stringybark) and *Allocasuarina torulosa* (Forest Oak) (Department of Environment and Climate Change 2008).	Low

Notes:

1: TSC Act - *Threatened Species and Conservation Act 1995*. CE = Critically Endangered, E1 = Endangered V = Vulnerable E2= Endangered Population, P = Protected (NPWS Act)

2. EPBC Act - *Environmental Protection and Biodiversity Conservation Act 1999*. CE = Critically Endangered, E = Endangered V = Vulnerable

3. ROTAP (Rare or Threatened Australian Plants (Briggs & Leigh 1996) is a conservation rating for Australian plants. Codes are:

- 1 Species only known from one collection
- 2 Species with a geographic range of less than 100 km in Australia
- 3 Species with a geographic range of more than 100 km in Australia
- X Species presumed extinct; no new collections for at least 50 years
- E Endangered species at risk of disappearing from the wild state if present land use and other causal factors continue to operate
- V Vulnerable species at risk of long-term disappearance through continued depletion.
- R Rare, but not currently considered to be endangered.
- K Poorly known species that are suspected to be threatened
- C Known to be represented within a conserved area
- a At least 1,000 plants are known to occur within a conservation reserve(s).
- i Less than 1,000 plants are known to occur within a conservation reserve(s).

4. Based on database searches and field surveys

5. Likelihood of Occurrence – see methods (below)

*. Proposed delisting of Vulnerable species listing under the TSC Act

**. Proposed delisting of Vulnerable species under the EPBC Act

Likelihood	Description
Low	Species considered to have a **low likelihood of occurrence** include species not recorded during the field surveys that fit one or more of the following criteria: Have not been recorded previously in the study area and surrounds and for which the study area is beyond the current distribution range. Use specific habitat types or resources that are not present in the study area. Are considered locally extinct.
Moderate	Species considered to have a **moderate likelihood of occurrence** include species not recorded during the field surveys that fit one or more of the following criteria: Have infrequently been recorded previously in the study area and surrounds. Use habitat types or resources that are present in the study area, although generally in a poor or modified condition. Are unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically during variable seasons or migration.
High	Species considered to have a **high likelihood of occurrence** include species recorded during the field surveys or species not recorded that fit one or more of the following criteria: Have frequently been recorded previously in the study area and surrounds. Use habitat types or resources that are present in the study area that are abundant and/or in good condition within the study area. Are known or likely to maintain resident populations surrounding the study area. Are known or likely to visit the site during regular seasonal movements or migration.

Animal Species List

Class Name	Family	Common Name	Scientific name	TSC Act	EPBC Act	Site 1	Site 2	Site 3	Site 4	Opportunistic
Amphibians										
	Hylidae									
		Bleating Tree Frog	*Litoria dentata*			-	-	-	-	H
		Broad-palmed Frog	*Litoria latopalmata*			-	-	-	-	H
		Eastern Dwarf Tree Frog	*Litoria fallax*			-	H	-	H	H
		Peron's Tree Frog	*Litoria peronii*			-	H	-	H	H
		Tyler's Tree Frog	*Litoria tyleri*			-	-	-	-	H
	Myobatrachidae									
		Brown-striped Frog	*Limnodynastes peronii*			-	O	-	H	H
		Common Eastern Froglet	*Crinia signifera*			H	H	-	H	H
		Spotted Grass Frog	*Limnodynastes tasmaniensis*			-	-	-	-	H
Reptiles										
	Agamidae									
		Bearded Dragon	*Pogona barbata*			-	-	-	-	-
	Elapidae									
		Eastern Brown Snake	*Pseudonaja textilis*			O	-	-	-	-
	Scincidae									
		Barred-side Skink	*Eulamprus tenuis*			-	-	-	-	O
		Eastern Blue-tongued Lizard	*Tiliqua scincoides*			-	-	-	-	O
		Eastern Water Skink	*Eulamprus quoyii*				O	-	O	O
		Garden Skink	*Lampropholis guichenoti*			O	-	-	-	O
		Grass Skink	*Lampropholis delicata*			O	O	-	O	O
		Striped Skink	*Ctenotus robustus*			-	-	O	-	O
		Wall Lizard	*Cryptoblepharus virgatus*			O	-	-	-	O
Native Birds										
	Accipitridae									
		Brown Goshawk	*Accipiter fasciatus*			-	-	-	-	O
	Anatidae									
		Australian Wood Duck	*Chenonetta jubata*			-	O	-	O	O
		Pacific Black Duck	*Anas superciliosa*			-	O	-	O	O
	Apodidae									
		White-throated Needletail	*Hirundapus caudacutus*		M	-	-	-	-	O
	Artamidae									

Class Name	Family	Common Name	Scientific name	TSC Act	EPBC Act	Site 1	Site 2	Site 3	Site 4	Opportunistic
		Australian Magpie	*Gymnorhina tibicen*			-	O	O	O	O
		Grey Butcherbird	*Cracticus torquatus*			O	-	O	-	O
	Cacatuidae									
		Galah	*Cacatua roseicapilla*			O	-	-	O	O
		Sulphur-crested Cockatoo	*Cacatua galerita*			-	-	-	-	O
	Campephagidae									
		Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			O	-	-	O	O
	Columbidae									
		Crested Pigeon	*Ocyphaps lophotes*			O	-	-	-	O
	Corcoracidae									
		White-winged Chough	*Corcorax melanorhamphos*			O	-	-	-	O
	Corvidae									
		Australian Raven	*Corvus coronoides*			O	O	-	-	O
	Cuculidae									
		Brush Cuckoo	*Cacomantis variolosus*			-	H	-	-	O
	Dicaeidae									
		Mistletoebird	*Dicaeum hirundinaceum*			O	-	-	-	O
	Dicruridae									
		Grey Fantail	*Rhipidura fuliginosa*			-	O	-	O	O
		Willie Wagtail	*Rhipidura leucophrys*			O	-	-	O	O
	Halcyonidae									
		Forest Kingfisher	*Todiramphus macleayii*			O	-	-	-	O
	Hirundinidae									
		Welcome Swallow	*Hirundo neoxena*			-	O	-	O	O
	Maluridae									
		Superb Fairy-wren	*Malurus cyaneus*			O	O	-	O	O
	Meliphagidae									
		Bell Miner	*Manorina melanophrys*			-	-	-	-	O
		Noisy Miner	*Manorina melanocephala*			O	O	-	-	O
		Red Wattlebird	*Anthochaera carunculata*			O	-	-	-	O
		White-naped Honeyeater	*Melithreptus lunatus*			-	-	-	O	O
		Yellow-faced Honeyeater	*Lichenostomus chrysops*			-	-	-	-	O
	Muscicapidae									
		Golden-headed Cisticola	*Cisticola exilis*			-	-	-	-	O
	Neosittidae									
		Varied Sittella	***Daphoenositta chrysoptera***	**V**		-	-	-	-	O

Class Name	Family	Common Name	Scientific name	TSC Act	EPBC Act	Site 1	Site 2	Site 3	Site 4	Opportunistic
	Pardalotidae									
		Brown Thornbill	*Acanthiza pusilla*			O	O	-	-	O
		Yellow Thornbill	*Acanthiza nana*			-	-	-	O	O
	Passeridae									
		Red-browed Finch	*Neochmia temporalis*			-	-	-	O	O
	Petroicidae									
		Eastern Yellow Robin	*Eopsaltria australis*			-	-	-	-	O
	Psittacidae									
		Rainbow Lorikeet	*Trichoglossus haematodus*			O	-	-	H	O
		Red-rumped Parrot	*Psephotus haematonotus*			-	-	O	-	O
	Rallidae									
		Dusky Moorhen	*Gallinula tenebrosa*			-	O	-	O	O
	Scolopacidae									
		Latham's Snipe	*Gallinago hardwickii*		M	-	-	-	-	O
	Threskiornithidae									
		Australian White Ibis	*Threskiornis molucca*			-	-	-	-	O
Introduced Birds										
	Columbidae									
		Spotted Turtle-Dove	*Streptopelia chinensis*	U		O	O	-	O	O
	Passeridae									
		House Sparrow	*Passer domesticus*	U		-	-	-	-	O
	Sturnidae									
		Common Myna	*Acridotheres tristis*	U		O	-	O	-	O
		Common Starling	*Sturnus vulgaris*	U		-	-	O	-	O
Native Mammals										
	Emballonuridae									
		Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V		-	-	-	A	O
	Molossidae									
		White-striped freetail bat	*Austronomus australis*			-	H	-	H	H
	Petauridae									
		Sugar Glider	*Petaurus breviceps*			O	-	-	-	-
	Pteropodidae									
		Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	-	-	-	-	O
	Vespertilionidae			V	-	A	A	-	-	-
		Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*							

Class Name	Family	Common Name	Scientific name	TSC Act	EPBC Act	Site 1	Site 2	Site 3	Site 4	Opportunistic
		Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V		A	-	-	-	-
		Gould's Wattled Bat	*Chalinolobus gouldii*			A	A	-	-	-
		Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		-	A	-	-	-
		Large-footed Myotis	*Myotis adversus*	V		-	O	-	-	-
		Unidentified Forest Bat	*Vespadelus sp.*			A	A	-	-	-
Introduced Mammals										
	Bovidae									
		Goat (feral)	*Capra hircus*	U		-	-	-	-	O
	Leporidae									
		Rabbit	*Oryctolagus cuniculus*	U		-	-	-	-	S

Plant Species list

Class Name	Scientific Name	Common name	Native	TSC Act	EPBC Act	Quad 1	Quad 2	Quad 3	Quad 4
Acanthaceae									
	Brunoniella australis	Blue Trumpet	Y	-	-	S	S	-	S
Adiantaceae				-	-				
	Cheilanthes sieberi	Mulga Fern	Y	-	-	S	S	-	-
Aizoaceae				-	-				
	Tetragonia tetragonioides	New Zealand Spinach	Y	-	-	-	-	S	-
Amaranthaceae				-	-				
	Alternanthera denticulata	Lesser Joyweed	Y	-	-	-	-	S	S
Anthericaceae				-	-				
	Caesia parviflora	Pale Grass-lily	Y	-	-	S	-	-	-
Apiaceae				-	-				
	Centella asiatica	Pennywort	Y	-	-	-	-	-	-
	Foeniculum vulgare	Fennel	N	-	-	-	-	S	-
Asclepiadaceae				-	-				
	Araujia sericifera	Moth Vine	N	-	-	S	S	-	S
Asparagaceae				-	-				
	Asparagus asparagoides		N	-	-	S	S	S	S
Asphodelaceae				-	-				
	Aloe maculata	Common Soap Aloe	N	-	-	-	-	-	S
Asteraceae				-	-				
	Aster subulatus	Wild Aster	N	-	-	-	-	-	S
	Bidens pilosa	Cobbler's Pegs	N	-	-	-	S	-	-
	Bidens subalternans	Greater Beggar's Ticks	N	-	-	S	-	S	S
	Calotis lappulacea	Yellow Burr-daisy	Y	-	-	-	-	-	S
	Cirsium vulgare	Spear Thistle	N	-	-	S	-	-	-
	Conyza bonariensis	Flaxleaf Fleabane	N	-	-	-	S	-	S
	Epaltes australis	Spreading Nut-heads	Y	-	-	-	-	-	-
	Erechtites valerianifolia	Brazilian Fireweed	N	-	-	-	-	S	-
	Ozothamnus diosmifolius	White Dogwood	Y	-	-	S	-	-	-
	Senecio madagascariensis	Fireweed	N	-	-	-	-	S	-
	Solenogyne bellioides		Y	-	-	S	-	-	-
	Taraxacum officinale	Dandelion	N	-	-	-	S	-	S
	Vittadinia cuneata	Fuzzweed	Y	-	-	-	-	-	-
	Xanthium occidentale	"Noogoora Burr, Cockle	N	-	-	-	-	S	-

Class Name	Scientific Name	Common name	Native	TSC Act	EPBC Act	Quad 1	Quad 2	Quad 3	Quad 4
		Burr"							
Basellaceae				-	-				
	Anredera cordifolia	Madeira Vine	N	-	-	-	-	-	-
Bignoniaceae				-	-				
	Jacaranda mimosifolia	Jacaranda	N	-	-	-	-	-	-
Boraginaceae				-	-				
	Heliotropium amplexicaule	Blue Heliotrope	N	-	-	-	S	-	-
Brassicaceae				-	-				
	Brassica fruticulosa	Twiggy Turnip	N	-	-	-	S	-	-
	Lepidium africanum		N	-	-	-	-	-	S
Cactaceae				-	-				
	Opuntia stricta	Prickly Pear	N	-	-	S	-	-	S
Campanulaceae				-	-				
	Wahlenbergia gracilis	Sprawling or Australian Bluebell	Y	-	-	-	-	-	-
Casuarinaceae				-	-				
	Casuarina glauca	Swamp Oak	Y	-	-	-	S	S	-
Chenopodiaceae				-	-				
	Atriplex prostrata		N	-	-	-	-	S	-
	Chenopodium album	Fat Hen	N	-	-	-	-	-	-
	Einadia hastata	Berry Saltbush	Y	-	-	S	-	-	S
	Einadia nutans	Climbing Saltbush	Y	-	-	S	-	-	S
	Einadia trigonos	Fishweed	Y	-	-	S	S	-	S
Commelinaceae				-	-				
	Commelina cyanea	Native Wandering Jew	Y	-	-	S	-	-	S
	Tradescantia fluminensis	Wandering Jew	N	-	-	-	S	-	-
Convolvulaceae				-	-				
	Dichondra repens	Kidney Weed	Y	-	-	S	S	-	S
	Ipomoea indica	Blue Morning Glory	N	-	-	-	-	S	-
Crassulaceae				-	-				
	Bryophyllum delagoense	Mother of millions	N	-	-	S	-	-	-
	Crassula multicava		N	-	-	-	-	-	S
	Crassula sarmentosa var. sarmentosa		N	-	-	-	-	-	S
Cyperaceae				-	-				
	Carex appressa	Tussock Sedge	Y	-	-	-	-	S	-
	Cyperus brevifolius		N	-	-	S	-	-	-

Class Name	Scientific Name	Common name	Native	TSC Act	EPBC Act	Quad 1	Quad 2	Quad 3	Quad 4
	Cyperus eragrostis	Umbrella Sedge	N	-	-	-	S	-	-
	Fimbristylis dichotoma		Y	-	-	S	-	-	-
Euphorbiaceae				-	-				
	Phyllanthus virgatus		Y	-	-	S	-	-	-
Fabaceae (Faboideae)				-	-				
	Daviesia genistifolia	Broom Bitter Pea	Y	-	-	-	-	-	-
	Dillwynia sieberi		Y	-	-	S	-	-	-
	Glycine clandestina		Y	-	-	S	S	-	-
	Hardenbergia violacea	False Sarsaparilla	Y	-	-	S	-	-	-
	Indigofera australis		Y	-	-	-	-	-	S
Fabaceae (Mimosoideae)				-	-				
	Acacia baileyana	Cootamundra Wattle	Y	-	-	-	S	-	-
	Acacia decurrens	Black Wattle	Y	-	-	S	-	-	-
	Acacia falcata		Y	-	-	S	-	-	S
	Acacia podalyriifolia	Queensland Silver Wattle	Y	-	-	-	-	-	-
Goodeniaceae				-	-				
	Goodenia bellidifolia		Y	-	-	S	-	-	-
Juncaceae				-	-				
	Juncus usitatus		Y	-	-	-	-	-	-
Lamiaceae				-	-				
	Plectranthus parviflorus		Y	-	-	-	-	-	S
Lobeliaceae				-	-				
	Pratia purpurascens	Whiteroot	Y	-	-	S	S	-	-
Lomandraceae				-	-				
	Lomandra filiformis	Wattle Matt-rush	Y	-	-	-	-	-	S
	Lomandra longifolia	Spiny-headed Mat-rush	Y	-	-	S	-	-	S
	Lomandra multiflora		Y	-	-	S	-	-	-
Loranthaceae				-	-				
	Amyema cambagei		Y	-	-	S	-	-	-
Malvaceae				-	-				
	Modiola caroliniana	Red-flowered Mallow	N	-	-	-	-	-	-
	Sida rhombifolia	Paddy's Lucerne	N	-	-	-	S	S	S
Meliaceae				-	-				
	Melia azedarach	White Cedar	Y	-	-	-	-	S	-
Myoporaceae				-	-				
	Eremophila debilis	Amulla	Y	-	-	S	-	-	-

Class Name	Scientific Name	Common name	Native	TSC Act	EPBC Act	Quad 1	Quad 2	Quad 3	Quad 4
Myrtaceae				-	-				
	Angophora subvelutina	Broad-leaved Apple	Y	-	-	-	S	-	-
	Eucalyptus amplifolia	Cabbage Gum	Y	-	-	-	S	S	-
	Eucalyptus crebra	Narrow-leaved Ironbark	Y	-	-	S	-	-	-
	Eucalyptus longifolia	Woollybutt	Y	-	-	-	-	-	-
	Eucalyptus moluccana	Grey Box	Y	-	-	S	S	-	S
	Eucalyptus tereticornis	Forest Red Gum	Y	-	-	S	S	-	-
	Melaleuca decora	White Feather Honeymyrtle	Y	-	-	S	-	-	-
	Melaleuca styphelioides	Prickly-leaved Tea Tree	Y	-	-	-	-	-	-
Oleaceae				-	-				
	Ligustrum lucidum	Large-leaved Privet	N	-	-	-	-	S	-
	Olea europaea ssp. cuspidata		N	-	-	S	-	S	S
Onagraceae				-	-				
	Ludwigia peploides		Y	-	-	-	-	S	-
Oxalidaceae				-	-				
	Oxalis corniculata	Creeping Oxalis	N	-	-	S	S	S	-
	Oxalis latifolia		N	-	-	-	S	-	-
Phytolaccaceae				-	-				
	Phytolacca octandra	Inkweed	N	-	-	S	-	-	-
Pittosporaceae				-	-				
	Bursaria spinosa	Native Blackthorn	Y	-	-	S	S	S	S
Plantaginaceae				-	-				
	Plantago gaudichaudii		Y	-	-	S	-	-	-
	Plantago lanceolata	Lamb's Tongues	N	-	-	-	-	-	S
Poaceae				-	-				
	Aristida ramosa		Y	-	-	S	-	-	S
	Austrodanthonia sp.		Y	-	-	S	-	-	-
	Austrostipa ramosissima	Stout Bamboo Grass	Y	-	-	-	-	-	S
	Bromus catharticus	Prairie Grass	N	-	-	-	S	S	-
	Chloris gayana	Rhodes Grass	N	-	-	-	-	-	S
	Chloris truncata	Windmill Grass	Y	-	-	-	-	-	-
	Cynodon dactylon	Common Couch	Y	-	-	S	-	-	-
	Echinochloa crus-galli	Barnyard Grass	N	-	-	-	-	S	S
	Eleusine indica	Crowsfoot Grass	N	-	-	-	-	-	S
	Entolasia marginata	Bordered Panic	Y	-	-	-	-	S	-
	Eragrostis benthamii		Y	-	-	S	-	-	-

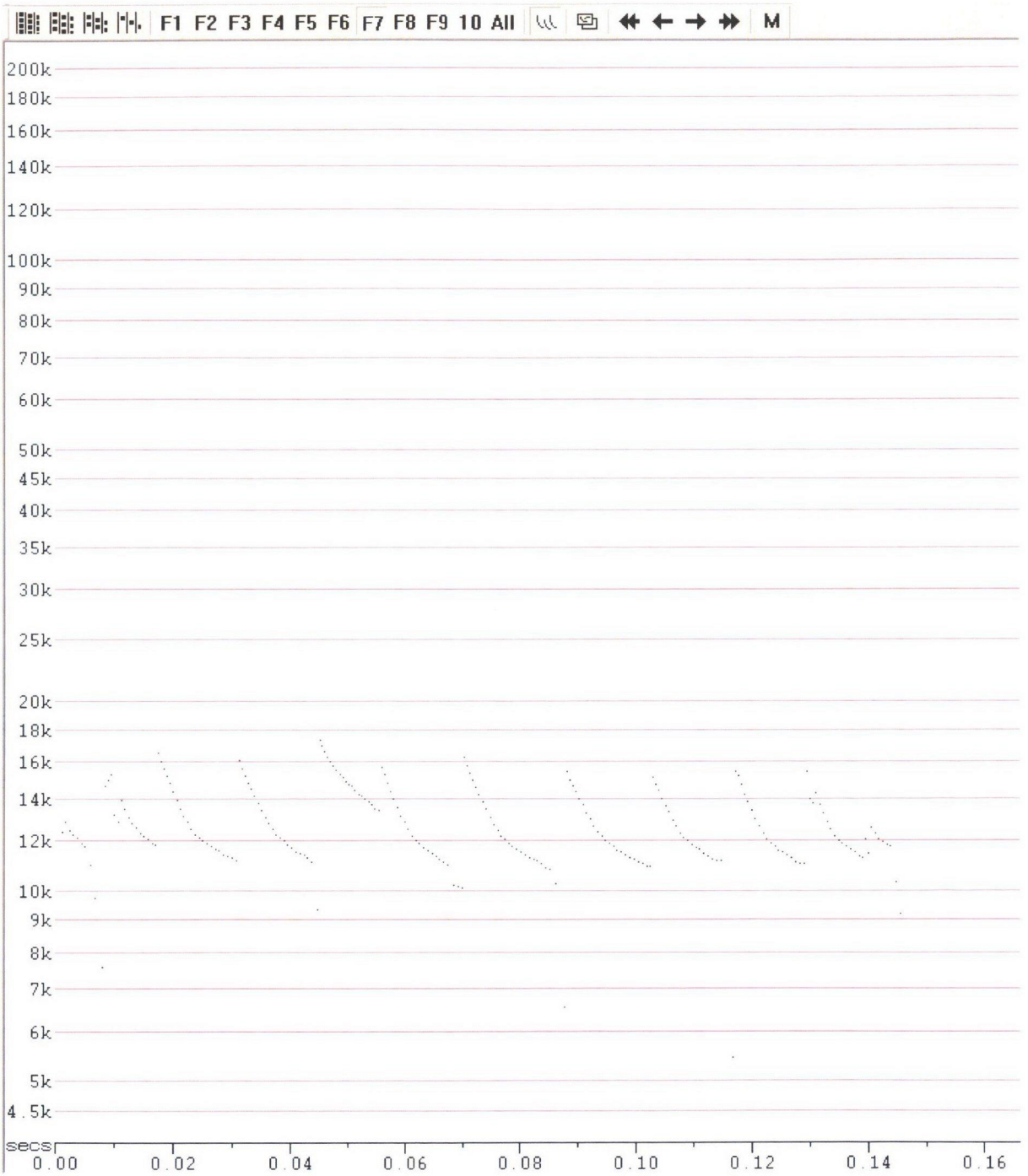
Class Name	Scientific Name	Common name	Native	TSC Act	EPBC Act	Quad 1	Quad 2	Quad 3	Quad 4
	Eragrostis curvula	African Lovegrass	N	-	-	S	-	-	S
	Eriochloa pseudoacrotricha	Early Spring Grass	Y	-	-	S	-	-	S
	Microlaena stipoides		Y	-	-	-	S	S	-
	Oplismenus aemulus		Y	-	-	-	-	S	-
	Panicum maximum	Guinea Grass	N	-	-	-	-	S	-
	Paspalidium distans		Y	-	-	-	-	-	-
	Paspalum dilatatum	Paspalum	N	-	-	-	S	S	S
	Pennisetum clandestinum	Kikuyu Grass	N	-	-	-	-	S	-
	Setaria gracilis	Slender Pigeon Grass	N	-	-	-	S	-	-
	Sporobolus africanus	Parramatta Grass	N	-	-	-	S	-	S
	Sporobolus creber	Slender Rat's Tail Grass	Y	-	-	-	-	-	-
Polygonaceae				-	-				
	Acetosa sagittata	Rambling Dock	N	-	-	-	-	S	-
	Persicaria decipiens	Slender Knotweed	Y	-	-	-	-	S	-
	Persicaria lapathifolia	Pale Knotweed	Y	-	-	-	-	S	-
	Polygonum aviculare	Wireweed	N	-	-	-	-	-	S
Portulacaceae				-	-				
	Portulaca oleracea	Pigweed	Y	-	-	-	-	S	S
Proteaceae				-	-				
	Grevillea robusta	Silky Oak	Y	-	-	-	-	-	-
Ranunculaceae				-	-				
	Clematis glycinoides	Headache Vine	Y	-	-	-	-	S	-
Rosaceae				-	-				
	Rubus ssp.	Blackberry	N	-	-	-	-	S	-
Rubiaceae				-	-				
	Opercularia aspera	Coarse Stinkweed	Y	-	-	-	-	S	-
	Richardia brasiliensis	Mexican Clover	N	-	-	S	-	-	-
Salicaceae				-	-				
	Salix nigra	Black Willow	N	-	-	-	-	S	-
Salviniaceae				-	-				
	Salvinia molesta		N	-	-	-	-	S	-
Santalaceae				-	-				
	Exocarpos cupressiformis	Native Cherry	Y	-	-	S	-	-	-
Sapindaceae				-	-				
	Dodonaea viscosa ssp. cuneata	Wedge-leaf Hop-bush	Y	-	-	-	-	-	-
Solanaceae				-	-				

Class Name	Scientific Name	Common name	Native	TSC Act	EPBC Act	Quad 1	Quad 2	Quad 3	Quad 4
	Lycium ferocissimum	African Boxthorn	N	-	-	-	-	-	S
	Solanum chenopodioides	Whitetip Nightshade	N	-	-	-	-	S	-
	Solanum nigrum	Black-berry Nightshade	N	-	-	S	-	S	S
	Solanum prinophyllum	Forest Nightshade	Y	-	-	S	S	-	-
	Solanum pseudocapsicum	Madeira Winter Cherry	N	-	-	S	-	S	-
	Solanum seaforthianum	Brazilian Nightshade	N	-	-	S	-	-	-
Typhaceae				-	-				
	Typha orientalis	Broad-leaved Cumbungi	Y	-	-	-	-	S	-
Urticaceae				-	-				
	Parietaria judaica	Pellitory	N	-	-	-	-	S	-
Verbenaceae				-	-				
	Verbena officinalis	Common Verbena	N	-	-	-	-	-	-

Sample of sonograms attributed to bat species recorded

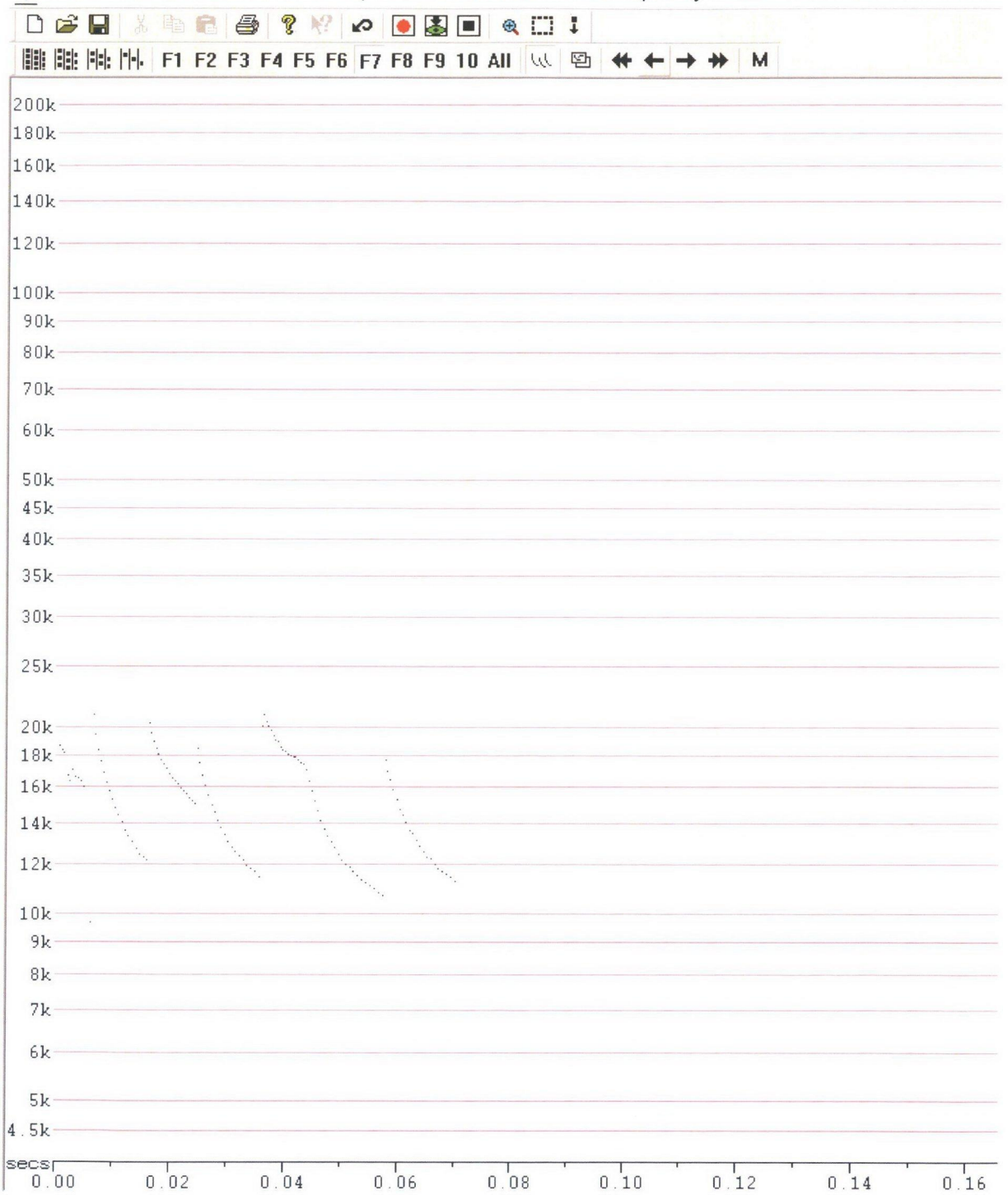
Tadarida australis

Species identified based on characteristic call frequency between 10 and 15 kHz.



Saccolaimus flaviventris

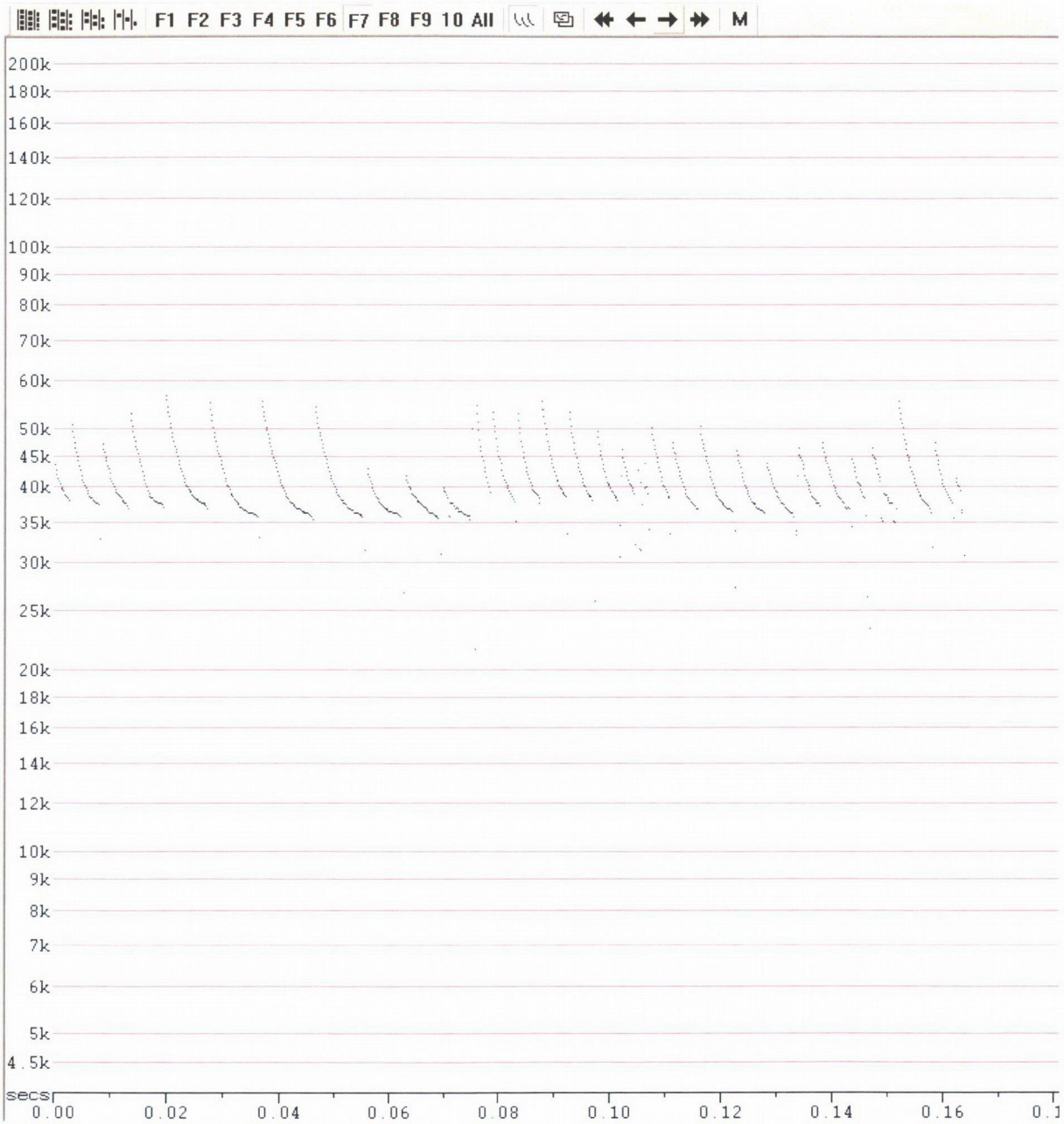
Species identified based on call shape and characteristic call frequency between 17.5 and 22.5 kHz.



Scoteanax rueppellii or *Falsistrellus tasmaniensis*

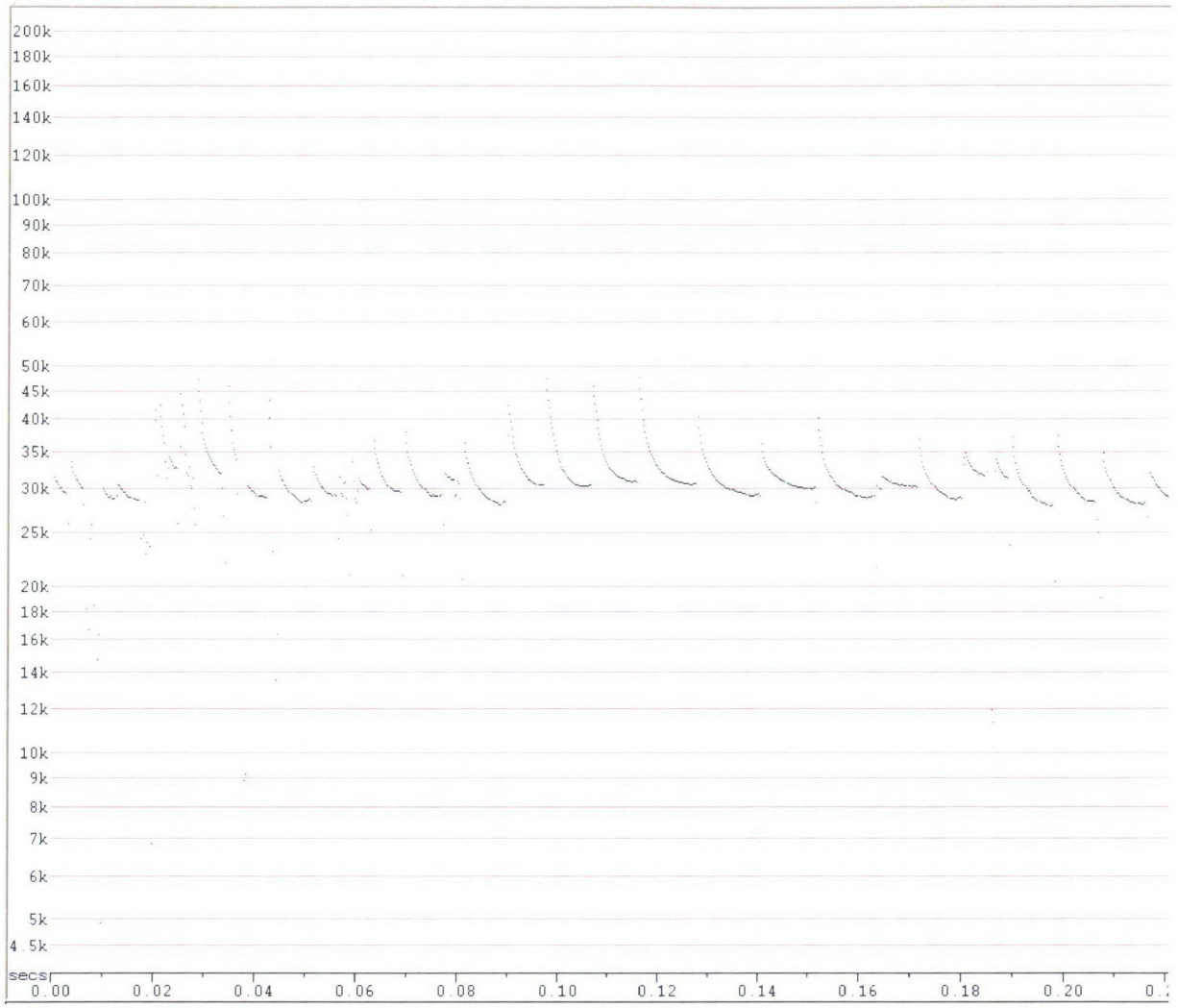
Call differentiated from *Scotorepens* spp. due to lack of upsweeping tail.

Scoteanax rueppellii and *Falsistrellus tasmaniensis* are easily confused and the characteristic call frequency of the calls recorded is within the range of both species.



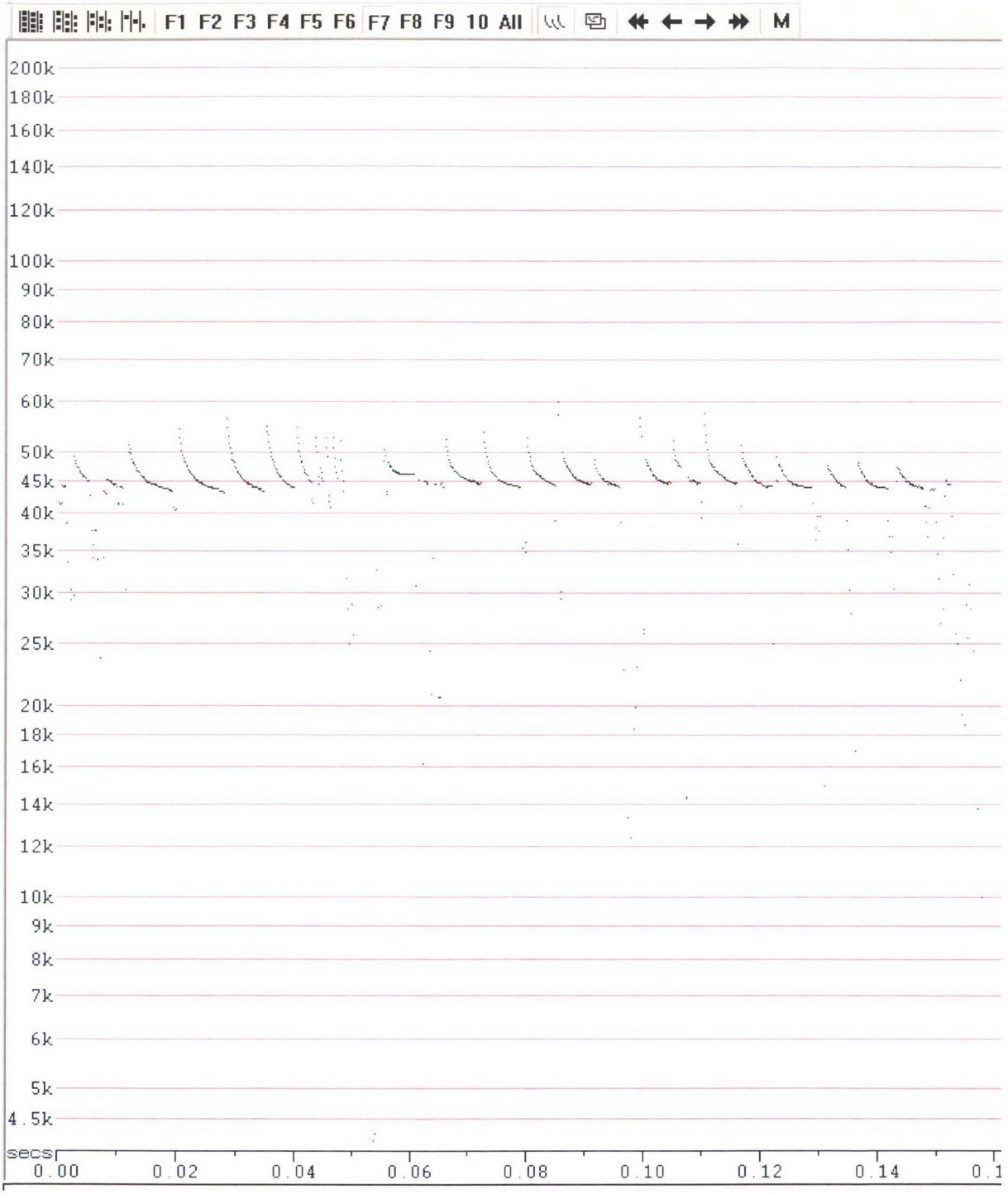
Chalinolobus gouldii

Identified by curved, alternating call with characteristic frequency between 25 and 34kHz and down-sweeping tail in some calls in sequence.



Vespadelus sp. or *Miniopterus schreibersii oceanensis*

Characteristic call frequency of around 45 kH consistent with several *Vespadelus* species and with *Miniopterus schreibersii oceanensis*. Calls not of sufficient quality to differentiate species.



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Appendix C

Licences and approvals for study

Scientific licence and animal research authority

All team members were suitably qualified and licensed to carry out the ecological surveys. The team was licensed to capture and pick animals and plants under a Scientific Licence issued by DECCW (S10445). The wildlife survey procedures used were covered under an Animal Research Authority (Animal Ethics) approved by the Department of Primary Industries (06/2467).

Appendix D1

State impact assessments

1. Cumberland Plain Woodland

1.1 Status

Cumberland Plain Woodland is listed as a Critically Endangered Ecological Community under the *Threatened Species Conservation Act 1995* (TSC Act).

Patches of this vegetation community in high condition are also included within the definition of Cumberland Shale Plains Woodland and Shale Gravel Transition Forest listed under the under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (refer Appendix D2 Section 2 below for assessment of this community).

1.2 Description

Shale Plains Woodland and Shale Hills Woodland are sub-units of the Cumberland Plain Woodland ecological community and occur on soils derived from shale on the Cumberland Plain. The community has a characteristically woodland structure, but may include both more open and dense areas of vegetation (Department of Environment and Water Resources 2007; NSW Scientific Committee 1997). *Eucalyptus moluccana* and *E. tereticornis* are the dominant canopy trees, with *E. crebra*, *Corymbia maculata* and *E. eugenioides* occurring less frequently. The shrub layer is dominated by *Bursaria spinosa*. Diversity is highest in the ground stratum with a high diversity of grasses and other small shrubs and herbaceous species occurring. The species composition is a good indicator of condition, with native groundcover species, including less common and slower-growing native grasses and herbs, being good indicators of regeneration potential (resilience, Department of Environment and Conservation 2005).

The definition of the listed community of Cumberland Plain Woodland includes disturbed or modified sites. However, this is the case only if they have potential to re-establish the characteristic native understorey (NSW Scientific Committee 1997) or regrowth that is likely to achieve a near natural structure or is a seral stage towards that structure (Department of Environment and Water Resources 2007).

The original extent of this ecological community is highly reduced with estimates ranging from 6% (Department of Environment and Water Resources 2007, NSW Scientific Committee 1997) to 9% remaining (Department of Environment and Climate Change 2007c).

1.3 Specific impacts

Approximately 28.2 ha of Cumberland Plain Woodland will be directly affected by the proposal. Approximately 1.3 ha of this woodland is located in non-certified areas. The woodland in the non-certified areas is in poor condition with reduced canopy cover, sparse native understorey and extensive weed invasion.

The remaining 26.9 ha of woodland is located in certified areas and consists of approximately 26 ha in poor condition and 0.9 ha in moderate to good condition.

Approximately half of the woodland affected consists of small and fragmented patches that are of 'other remnant vegetation' conservation significance assessment class (NSW National Parks and Wildlife Service 2002b) (refer Figure 4.1, Figure 4.2 of main report).

One patch of Cumberland Plain Woodland located in certified lands in the vicinity of the North Avenue intersection consists of 'Core Habitat' conservation significance assessment classes (NSW National Parks and Wildlife Service 2002b). Areas identified as 'Support for Core Habitat' are also found adjacent to this patch. This vegetation is in better condition than other vegetation in the investigation area and is likely to be important in maintaining the viability of the local occurrence of the ecological community.

1.4 Threats

Recognised threats to this community include:

- Clearing for urban or rural development, and the subsequent impacts from fragmentation.
- Grazing and mowing, which prevent regrowth of the community.
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation.
- Weed invasion, particularly by African lovegrass, African olive, bridal veil creeper and Rhodes grass.
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

Key threatening processes that affect this community include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion and establishment of exotic vines and scramblers.
- High frequency fire.
- Removal of dead wood and trees.
- *Lantana camara*.

1.5 Recovery

A draft recovery plan has been prepared for vegetation communities on the Cumberland Plain under the TSC Act and the EPBC Act (Department of Environment Climate Change and Water 2009). The Department of Environment, Climate Change and Water have also identified 17 priority actions (also referred to at the Priorities Action Statement or PAS) to help recover the ecological community (refer Table 1).

Table 1 Priority actions for Cumberland Plain Woodland

Description of priority action[1]	Does action relate to the Project?
Management of Endangered Ecological Communities is to be included in school environmental management plans where the school land contains Endangered Ecological Communities.	Not applicable
Management of Endangered Ecological Communities to be included in the conditions for Crown land trusts, lease and licence holders.	Not applicable
Prepare and implement community awareness, education and involvement strategy.	Not applicable
Support community conservation by providing nursery or other facilities, for regeneration activities.	Not applicable
Local Govt prepare plans of management in accordance with the Local Government Act for reserves containing Endangered Ecological Communities, which have conservation as a primary objective, or where conservation is compatible.	Not applicable
Promote best practice management guidelines.	Not applicable
Incorporate consideration of EEC protection in regional open space planning.	Not applicable
Encourage planning authorities to address Endangered Ecological Communities in development of environmental planning instruments and, where possible, seek biodiversity certification.	Not applicable
Manage, to best practice standards, areas of Endangered Ecological Communities which have conservation as a primary objective, or where conservation is compatible. Priorities are to be based on DECC conservation significance assessment.	Not applicable
Encourage and promote best-practice management of Endangered Ecological Communities on private land.	Not applicable
Develop and implement a coordinated program for removal of African Olive across all tenures.	Weed control within the proposal area will be managed through implementation of a Environmental Management Plan
Ensure the consideration of impacts on Endangered Ecological Communities when enforcing noxious weed or pest species control in Endangered Ecological Communities.	Not applicable
Develop and implement Cumberland Plain Reservation Strategy and create a protected bushland network through targeted land acquisition as land becomes available.	Not applicable
Public authorities will promote management agreements to landholders through their ongoing land use planning activities.	Not applicable
Investigate the preparation of a recommendation for the declaration of critical habitat.	Not applicable
Investigate the development of a regular monitoring program to assess the change in extent of vegetation across the Cumberland Plain.	Not applicable
Finalise the multi-EEC recovery plan as a State priority in accordance with contractual obligations with DEH, by July 2007.	Not applicable
Liaise with institutions to facilitate research relevant to the recovery of Cumberland Plain Endangered Ecological Communities.	Not applicable

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

1.6 Significance assessment

This assessment is based on the extent of Cumberland Plain Woodland affected by the Bringelly Road Upgrade works, the ancillary works areas including temporary access roads, stockpile and compound areas.

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

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

Not applicable to a threatened ecological community.

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

Not applicable to a threatened ecological community.

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

a) 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

b) 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.

Cumberland Plain Woodland within and surrounding the investigation area consists of relatively small, fragmented, patches that are subject to existing effects. Development of the Bringelly Road Upgrade will result in the loss of approximately 26.9 ha of Cumberland Plain Woodland in certified areas and 1.3 ha in non-certified areas. The proposal is also likely to result in changes to the structure and composition of Cumberland Plain Woodland outside the construction footprint as a result of additional fragmentation and edge effects.

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

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

b) 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

c) 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.

Development of the Bringelly Road Upgrade will result in the loss of approximately 26.9 ha of Cumberland Plain Woodland from certified areas. This includes both highly disturbed and relatively intact woodland and represents approximately 36% of the community within the investigation area and less than 5% within a 1 km radius of the construction footprint. As such, this represents a substantial loss of the local extent of the ecological community.

The 0.9 ha of woodland to be lost from non-certified areas is in poor condition and represents a small proportion of the community in the locality. This loss is unlikely to significantly affect the viability of the local occurrence of the community.

Cumberland Plain Woodland within and surrounding the investigation area largely consist of small, highly fragmented, patches that are subject to existing edge effects and are unlikely to be substantially modified by the proposal. Several larger areas of more intact vegetation occur. Where the proposal footprint is at the edge of these areas, substantial fragmentation is unlikely. Where they are traversed by the footprint (e.g. the certified lands on the southern side of the North Avenue intersection) substantial fragmentation would occur.

Much of the habitat in the investigation area consists of cleared areas and 'other remnant vegetation' conservation significance assessment class (NSW National Parks and Wildlife Service 2002b) that are highly modified and in poor condition. This habitat is likely to be of low importance to the ecological community.

One patch of Cumberland Plain Woodland located in the vicinity of the North Avenue intersection within certified lands consists of 'Core Habitat' conservation significance assessment classes (NSW National Parks and Wildlife Service 2002b). Areas identified as 'Support for Core Habitat' are also found adjacent to this patch. This vegetation is in better condition than other vegetation in the investigation area and is likely to be important in maintaining the viability of the local occurrence of the ecological community.

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 Cumberland Plain Woodland under the TSC Act The habitat within the investigation area is unlikely to be critical to the survival of Cumberland Plain Woodland in accordance with Section 37 of the TSC Act.

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

A draft recovery plan has been prepared for vegetation communities on the Cumberland Plain under the TSC Act and the EPBC Act (Department of Environment Climate Change and Water 2009). The Department of Environment, Climate Change and Water have also identified 17 priority actions (also referred to at the Priorities Action Statement or PAS) to help recover the ecological community (refer Table 1). The proposal will not interfere with 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 will constitute three key threatening processes (KTPs) under the TSC Act:

- Clearing of native vegetation.

- Loss of hollow bearing trees.
- Removal of dead wood and dead trees.

The proposal also has contribute to two additional KTPs, *Invasion and establishment of exotic vines and scramblers* and *Invasion of native plant communities by exotic perennial grasses,* as a result of earthworks and vegetation fragmentation. Weed management during and after construction will however minimise these potential impacts.

1.7 Conclusion

Cumberland Plain Woodland is listed as a Critically Endangered Ecological Community under the TSC Act. Patches of this vegetation community in high condition are also included within the definition of Cumberland Shale Plains Woodland and Shale Gravel Transition Forest listed under the EPBC Act (refer Appendix D2 Section 2 below for assessment of this community).

Given the extent of Cumberland Plain Woodland that will be affected by the development both directly and indirectly, the combined impact on this community in certified and non-certified area is likely to be significant.

The impact to the ecological community in certified areas alone (26.9 ha) is likely to be significant. While much of the habitat that will be affected in certified areas is of low importance to the survival of the ecological community as a whole, potentially important vegetation in moderate to high condition will also be affected.

The impact in non-certified areas alone (1.3 ha in low to moderate condition) is unlikely to cause a significant impact and hence the preparation of a Species Impact Statement is not required.

2. River-Flat Eucalypt Forest on Coastal Floodplains

2.1 Status

River-Flat Eucalypt Forest on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner bioregions is listed as an Endangered Ecological Community under the TSC Act. This ecological community is not listed under the EPBC Act.

2.2 Description

River-Flat Eucalypt Forest on Coastal Floodplains is a variable community consisting of a tall open tree layer of eucalypts associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water.

River-Flat Eucalypt Forest on Coastal Floodplains is distinguished from other floodplain threatened ecological communities by its dominance of either a mixed or single species eucalypt tree layer (including *Angophora* spp.), with few *Casuarina* spp. or *Eucalyptus robusta*, and a prominent groundcover of soft leaved herbs and grasses (Department of Environment and Climate Change 2007a). While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis*, *E. amplifolia*, *Angophora floribunda* and *A. subvelutina* and *Casuarina glauca*.

2.3 Specific impacts

Approximately 4 ha of River-Flat Eucalypt Forest on Coastal Floodplains is likely to be directly affected by the proposal. Most of this vegetation (approximately 5.4 ha) is in very poor condition however some patches, particularly in the vicinity of South Creek, are in moderate condition (refer Figure 4.1, Figure 4.2). Adjacent areas would be subject to increased edge effects however as these areas are already highly disturbed, this impact is unlikely to be substantial.

Approximately 3.1 ha of this forest is located in non-certified areas with the remaining 2.4 ha in certified areas. The woodland in both certified and non-certified areas is in poor condition with reduced canopy cover, sparse native understorey and extensive weed invasion.

2.4 Threats

Recognised threats to this community include:

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation.

- Flood mitigation and drainage works.
- Landfilling and earthworks associated with urban and industrial development.
- Gazing and trampling by stock and feral animals (particularly pigs).
- Changes in water quality, particularly increased nutrients and sedimentation.
- Weed invasion.
- Climate change.
- Activation of acid sulfate soils.
- Removal of dead wood.
- Rubbish dumping.
- Frequent burning which reduces the diversity of woody plant species.

Key threatening processes that may affect this community include:

- Clearing of native vegetation.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.
- Invasion of native plant communities by exotic perennial grasses.
- High frequency fire.
- Removal of dead wood and trees.
- *Lantana camara*.

2.5 Recovery

A recovery plan has not been prepared for the River-Flat Eucalypt Forest on Coastal Floodplains ecological community under the TSC Act. The Department of Environment and Climate Change has, however, identified ten priority actions to help recover the ecological community (Table 2).

Table 2 Priority actions for River-Flat Eucalypt Forest

Description of priority action[1]	Does action relate to the proposal?
Collect seed for NSW Seedbank. Develop collection program in collaboration with Botanical Gardens Trust - all known provenances (conservation collection).	Not applicable
Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).	Not applicable
Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made.	Not applicable
Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human	Not applicable

Description of priority action[1]	Does action relate to the proposal?
disturbance.	
Prepare identification and impact assessment guidelines and distribute to consent and determining authorities.	Not applicable
Where this EEC occurs in western Sydney, implement relevant Priorities Action Statement actions identified for Cumberland Plain Woodland.	See Table 1.
Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan.	No Bitou Bush and Boneseed was recorded in the investigation area. General weed control and monitoring within the proposal area will be managed through implementation of an Environmental Management Plan.
Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land.	Not applicable
Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works.	Not applicable.
Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants.	Not applicable.

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

2.6 Significance assessment

This assessment is based on the extent of River-Flat Eucalypt Forest on Coastal Floodplains affected by the Bringelly Road Upgrade works, the ancillary works areas including temporary access roads, stockpile and compound areas.

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

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

Not applicable to a threatened ecological community.

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

Not applicable to a threatened ecological community.

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

a) 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

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

The proposal will result in the clearing of 5.4 ha of River-Flat Eucalypt Forest on Coastal Floodplains (refer Figure 4.1, Figure 4.2). Revegetation within riparian corridors would however replace some of the extent cleared during construction and is likely to improve the quality of adjacent retained patches.

The areas affected represent 34% of the ecological community within the investigation area and less than 5% within a 1 km radius of the construction footprint. This ecological community extends north and south of the investigation area with a particularly substantial occurrence in association with South Creek. This loss of the local extent of the ecological community is unlikely to negatively affect the long-term viability of the local occurrence of the community.

The proposal is unlikely to result in processes such as substantial hydrological changes or increased weed invasion that would be likely to result in changes to the structure or composition of River-Flat Eucalypt Forest on Coastal Floodplains outside of the construction footprint

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

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

b) 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

c) 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 proposal will result in the clearing of 5.4 ha of River-Flat Eucalypt Forest on Coastal Floodplains (refer Figure 4.1, Figure 4.2). Revegetation within the riparian corridor would however replace some of the extent cleared during construction and is likely to improve the quality of adjacent retained patches.

The areas affected represent 34% of the ecological community within the investigation area and less than 5% within a 1 km radius of the construction footprint. This ecological community extends north and south of the investigation area with a particularly substantial occurrence in association with South Creek. This loss of the local extent of the ecological community is unlikely to negatively affect the long-term viability of the local occurrence of the community.

The vegetation affected is already fragmented by existing roadways cleared areas and in poor condition. The clearing associated with the proposal is considered unlikely to substantially increase the fragmentation or isolation of patches of this community.

The vegetation to be removed is highly modified and in poor condition with a weed dominated ground cover. The patch of this community in association with South Creek is

however forms an important link between the vegetation north and south of Bringelly Road. With the weed management and riparian vegetation restoration proposed however, the important linkage function of this vegetation is unlikely to be substantially affected.

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 River-Flat Eucalypt Forest on Coastal Floodplains under the TSC Act. The habitat within the investigation area is unlikely to be critical to the survival of River-Flat Eucalypt Forest on Coastal Floodplains in accordance with Section 37 of the TSC Act.

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

A draft recovery plan has been prepared for vegetation communities on the Cumberland Plain under the TSC Act and the EPBC Act (Department of Environment Climate Change and Water 2009). The Department of Environment, Climate Change and Water have also identified 10 priority actions (also referred to at the Priorities Action Statement or PAS) to help recover the ecological community (refer Table 2). The proposal will not interfere with 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 will constitute three key threatening processes (KTPs) under the *TSC Act*:

- Clearing of native vegetation.
- Loss of hollow bearing trees.
- Removal of dead wood and dead trees.

The proposal also has contribute to two additional KTPs, *Invasion and establishment of exotic vines and scramblers* and *Invasion of native plant communities by exotic perennial grasses,* as a result of earthworks and vegetation fragmentation. Weed management during and after construction will however minimise this potential impact.

2.7 Conclusion

River-Flat Eucalypt Forest is listed as an Endangered Ecological Community under the TSC Act.

5.4 ha of this community will be affected of which 3.1 ha occurs within non-certified lands. The 5.4 ha to be removed constitutes less than 5% of the occurrence of this community within a 1 km radius of the subject site.

Given the limited extent of River-Flat Eucalypt Forest that will be affected by the development both directly and indirectly and the proposed vegetation restoration, the impact to the ecological community is unlikely to be significant in either certified or non-certified lands or for the proposal as a whole. The proposal is unlikely to cause a significant impact and hence the preparation of a Species Impact Statement is not required.

3. Threatened plant species and populations

3.1 Status and habitat description

The habitat requirements for the Threatened species and populations of plants with potential to occur within the investigation area are shown in Table 3. *Marsdenia viridiflora* subsp. *viridiflora* was recorded in a single location in the investigation area. This location is within the subject site and would be affected by the proposal. None of the other species were recorded in the investigation area however they may be present in small numbers or be present in soil seedbanks and have gone undetected during surveys.

Table 3 Habitat of state listed Threatened species of plant

Species Name	TSC Act Status	Habitat
Acacia pubescens	V	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 2003b).
Cynanchum elegans	E	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997; NSW National Parks and Wildlife Service 2002a).
Grevillea juniperina,	V	Restricted to the western Cumberland Plain, Marsden Park, Rooty Hill, Riverstone, Plumpton, Castlereagh NR, Blacktown, Penrith and north to Pitt Town, where it grows in open dry sclerophyll (eucalypt-dominated) forest or woodland in sandy to clay-loam soils and red pseudolateritic or sandy gravels (Fairley 2004; Royal Botanic Gardens 2005).
Pimelea spicata	E	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 2000).
Pultenaea pedunculata	E	Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. It grows on a variety of soils in dry sclerophyll forest and disturbed sites (Harden 2000; NSW National Parks and Wildlife Service 2002c; NSW Scientific Committee 1999). It is largely confined to loamy soils in dry gullies in populations in the Windellama area (Department of Environment and Climate Change 2008).
Marsdenia viridiflora subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	E (pop.)	Grows in vine thickets and open shale woodland (Department of Environment Climate Change and Water 2010b).

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

3.2 Specific impacts

Approximately 0.9 ha of high condition Cumberland Plain Woodland (canopy cover >10%) that is considered to be potential habitat for these species occurs within certified lands within the subject site. A further 27.3 hectares of poor condition woodland that is considered to be marginal as habitat for these species is also found within the subject site (refer Figure 4.1, Figure 4.2). Of this poor condition habitat, 26 hectares is located in certified areas with the remaining 1.3 hectares in non-certified lands.

Approximately ten stems of *Marsdenia viridiflora* ssp. *viridiflora* were found within an area of approximately 3 square metres within certified lands. These stems may represent a single mature plant and multiple seedlings or vegetative growth from a smaller number of individuals. These plants will require removal.

3.3 Threats

Recognised threats to these species include:

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation.
- Weed invasion.
- Mowing, grazing or other types of habitat modification such as weed invasion, rubbish dumping or urban runoff.
- Inappropriate fire regimes.

Key threatening processes that may affect this community include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- High frequency fire.

3.4 Recovery

A draft recovery plan has been prepared for *Pimelea spicata* (Department of Environment and Conservation 2004).

The objectives of this plan include:

- Conserve *P. spicata* using land-use and conservation planning mechanisms.
- Identify and minimise the operation of threats at sites where *P. spicata* occurs.
- Implement a survey and monitoring program that will provide information on the extent and viability of *P. spicata*.

- Provide the community with information that assists in conserving the species.
- Raise awareness of the species and involve the community in the recovery program.

An approved recovery plan has been prepared for *Acacia pubescens* (NSW National Parks and Wildlife Service 2003a).

Specific objectives of the plan are to:

- Ensure that a representative sample of *A. pubescens* populations occurring on public and private lands are protected from habitat loss and managed for conservation.
- Reduce the impacts of threats at sites across the species' range.
- Ensure that any planning and management decisions that are made which affect the species, are made in accordance with the recovery objectives of this plan.
- Understand the biology, ecology, health and distribution of the species including the range of genetic variation.
- Develop the awareness and involvement of the broader community in the species and its conservation.
- Re-assess the conservation status of the species (NSW National Parks and Wildlife Service 2003a).

Recovery plans have not been prepared for the remaining species however the Department of Environment and Climate Change has identified priority actions to help recover these species. These strategies primarily relate to management of threats known populations of the species, research and policy development and are of limited relevance to the proposal.

Table 3-1 Priority actions for Threatened species of plant

Description of priority action[1]	Relevant to species or population				Does action relate to the proposal?
	Cynanchum elegans	*Grevillea juniperina,*	*Pultenaea pedunculata*	*Marsdenia viridiflora subsp. viridiflora* population	
Include this species in regional information packages on rainforest communities and management.	Y				Not applicable
Bush Fire Risk Management Plans should consider fire management of ecotonal habitat where this species occurs.	Y				Not applicable
Exclude fire from habitat until fire ecology is understood.	Y				Not applicable
EIA guidelines to be revised and updated to avoid unnecessary loss of populations.	Y				Not applicable
Undertake weed control using DEC guidelines for bush regeneration activities. Implement Bitou bush control as described in the approved TAP.	Y				Not applicable
Prepare a site management plan prior to on-ground works commencing. Ensure personnel can distinguish the species from the exotic Moth Plant (*Araujia sericifera**).	Y				Not applicable
Develop and implement a monitoring program for the species and its habitat at 6 key sites. Re-assess tagged populations for use in monitoring program.	Y				Not applicable
Undertake genetics and pollinator studies directed to improving management of the species.	Y				Not applicable
Undertake habitat restoration and ecotone maintenance.	Y				Not applicable
Liaise with public and private land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures, particularly in fire management and fencing and signage to prevent accidental loss.		Y			Not applicable
Seek to increase the level of legislative protection for priority sites (public and private) through land use planning mechanisms and conservation agreements.		Y			Not applicable
Monitor known populations, so that potential local extinctions are detected before they occur and mechanisms can be put in place to reverse trends.		Y			Not applicable
Identify and survey potential habitat to detect new populations.		Y			Not applicable
Collect seed from Villawood and Prestons populations for NSW Seedbank. Develop collection program in collaboration with BGT - multiple provenances			Y		Not applicable

Description of priority action[1]	Relevant to species or population				Does action relate to the proposal?
	Cynanchum elegans	*Grevillea juniperina,*	*Pultenaea pedunculata*	*Marsdenia viridiflora subsp. viridiflora* population	
Liaise with landholders of the Villawood, Prestons and Appin populations regarding management.			Y		Not applicable
Liaise and negotiate with other landholders of other freehold populations regarding appropriate management.			Y		Not applicable
Review against the criteria for critically endangered.			Y		Not applicable
Install protective measures (fencing, signs, etc), if necessary, at Villawood, Appin and Prestons sites.			Y		Not applicable
Install structures to prevent accidental destruction, such as roadside signage or fencing within grazed paddocks.			Y		Not applicable
Conduct soil conservation works to prevent further erosion, where appropriate.			Y		Not applicable
Resurvey Appin, Villawood and Prestons populations to assess status.			Y		Not applicable
Prepare a regional recovery plan for this and other threatened species in the Bungonia Windellama area.			Y		Not applicable
Review conservation status against the new criteria for endangered population				Y	Not applicable
Ensure appropriate management regimes are in place at known sites.				Y	Not applicable
Re-survey those known sites where little information is available.				Y	Not applicable

Source: Department of Environment and Climate Change (2008)

3.5 Significance assessment

This assessment is based on the extent of potential habitat for these species which may be affected by the road upgrade and ancillary works areas including temporary access roads, stockpile and compound areas.

As these species have similar habitat requirements and threatening processes and a similar likelihood of occurrence they are considered together for the purpose of this impact significance assessment.

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

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 proposal is unlikely to significantly affect processes such as pollination, seed dispersal and recruitment which could affect the breeding of any population of a Threatened species of plant in the investigation area. It is unknown whether a viable population of any of these species exists within the investigation area. The presence of a substantial population of any of these species with potential for long-term viability is unlikely as these species were not recorded on the site. If present, these species would exist as small, isolated populations.

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

The species appears to exist in the investigation area as a small, isolated population however interaction with other members of the species in the broader locality is possible via insect-assisted pollen transfer and wind-dispersal of seeds.

The proposal is unlikely to significantly affect processes such as pollination, seed dispersal and recruitment which could affect the breeding of members of a broader population of *Marsdenia viridiflora* outside of the subject site.,

It is unlikely that the loss of this small sub-population would adversely affect the broader local population to such an extent that it would be at significantly higher risk of extinction.

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

a) **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**

b) **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:

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

b) 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

c) 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 proposal will result in the clearing of approximately 0.9 ha of high quality potential habitat for these species and 26 ha of poor quality and marginal potential habitat (refer Figure 4.1, Figure 4.2) in certified areas. Approximately 1.3 ha of marginal potential habitat would be removed from non-certified areas.

The habitat affected is already fragmented by existing roadways and cleared areas. The clearing associated with the proposal is unlikely to substantially increase the fragmentation or isolation of patches of this habitat in relation to other such habitat in the locality.

The lack of any records of these species within the investigation area (with the exception of *Marsdenia viridiflora*) and the modification and fragmentation that this habitat has undergone suggests that this habitat is unlikely to be important for the conservation of any of these species.

The total area affected represents approximately 9% of high quality potential habitat within the investigation area and approximately 2% within a 1 km radius of the construction footprint. This loss of habitat is unlikely to significantly affect the long-term survival of any of these species 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 listed for these species.

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

The recovery plans and strategies of relevance to these species are described in Section 1.2.1.3 of this Appendix.

These strategies primarily relate to management of threats to known populations of the species, research and policy development and are of limited relevance to the proposal. The proposal is not considered likely to substantially contribute to or interfere with the implementation of these recovery plans and strategies.

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 will constitute three key threatening processes (KTPs) under the *Threatened Species Conservation Act 1995*:

Clearing of native vegetation.

Invasion of native plant communities by exotic perennial grasses.

The proposal would result in some clearing of native vegetation and has potential to result in weed proliferation. The vegetation clearing protocols proposed and weed management during and after construction will however minimise these impacts.

3.6 Conclusion

Acacia pubescens and *Grevillea juniperina* are listed as Vulnerable species under the TSC Act.

Pimelea spicata, Cynanchum elegans and *Pultenaea pedunculata* are listed as Endangered species under the TSC Act.

Marsdenia viridiflora subsp. *viridiflora* is listed as an Endangered Population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas under the TSC Act.

Given the limited extent of habitat for Threatened species and populations of plant that will be affected by the development both directly and indirectly in certified and non-certified areas the impact to these species is unlikely to be significant.

Preparation of a Species Impact Statement is not required for these species.

4. Cumberland Land Snail

4.1 Status

The Cumberland Land Snail is listed as an Endangered species under the TSC Act.

4.2 Description

The Cumberland Land Snail (*Meridolum corneovirens*) is a terrestrial species of snail that is generally tan to dark orange in colour ranging from 15-30 mm in size (National Parks and Wildlife Service 2000). The species can be confused with introduced and other native snail, particularly the common garden snail (*Cantareus aspersus* *) which is larger in size and yellowish brown with blotchy patterns of brown and/ or black. Currently, there is little known about the biology, dispersal patterns and distance movement, however, current knowledge suggest the species is restricted to the Cumberland Plain and Castlereagh Woodlands of Western Sydney and also along the fringes of River Flat Forest, especially where it meets Cumberland Plain Woodland. Microhabitat features used by the species include the underparts of logs and other debris, leaf and bark accumulations around the bases of trees and sometimes under grass clumps. Loose soil is sometimes used by the species for burrowing, and *Meridolum corneovirens* is fungal feeder and is generally active at night. The bulk of the known populations are small, isolated and vulnerable to impacts from clearing and habitat modification such as the removal of ground cover as this removes shelter, breeding habitat and sources of food (National Parks and Wildlife Service 2000).

The species is known to be genetically structured over short distances. Population studies have shown that individuals from any one location (within a few metres of each other) are very likely to be genetically related and the genetic neighbourhood is limited to about 350 m (Clarke & Richardson 2002).

4.3 Specific impacts

Empty shells are considered to be sufficient evidence for the existence of a population of this species (National Parks and Wildlife Service 2000). This species is able to occupy disturbed woodland vegetation if suitable cover (fallen timber, rubbish and leaf litter) is available. In the investigation area, the species was found in moderately to highly disturbed woodland under fallen branches and dumped rubbish. Given the species' very limited dispersal ability (Clarke & Richardson 2002), the recordings of the species in the investigation area are considered to represent at least four sub-populations with limited interaction between one another due to habitat fragmentation.

Insufficient information about the population dynamics of the species is available to determine whether these sub-populations or the broader population are likely to be viable. For the purpose of this assessment however all sub-populations in the investigation area are considered to be viable.

Three live individuals of the species were recorded in three locations (CLS 1, CLS 2, CLS10 refer Figure 4.3, Figure 4.4) with empty shells found in a further seven locations. The CLS 1 sub-population is located in a highly disturbed patch of woodland which is likely to be directly affected by the proposal. The CLS2-CLS 5 sub-population however is located in a more intact patch of woodland outside of but immediately adjacent to the concept design footprint and may be susceptible to accidental or indirect impacts. The proposed mitigation measures would minimise the potential for impacts on the CLS2-CLS 5 sub-population.

The remaining two apparent sub-populations (CLS6/CLS7 and CLS8/CLS9) were only represented by empty shells and may be extinct, however for the purposes of this assessment they are considered to be extant. The habitat for both of these sub-populations would be removed for the proposal.

The proposal would include the clearing of up to approximately 26.9 ha of potential habitat for this species in certified areas however only a small proportion of this habitat appears to be occupied by the species and much of this habitat is in poor condition. Approximately 1.3 ha of potential habitat for the species would be cleared in non-certified areas within the subject site.

4.4 Threats

There is generally a poor understanding of other threats to this species however the main recognised threat is clearing and degradation of Cumberland Plain Woodland remnants (Department of Environment Climate Change and Water 2010b)

Key threatening processes that may affect this species include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion and establishment of exotic vines and scramblers.
- High frequency fire.
- Removal of dead wood and trees (Department of Environment Climate Change and Water 2010b).

4.5 Recovery

No recovery plans have been developed for this species however nine priority actions have been identified for its recovery (Department of Environment Climate Change and Water 2010b).

Table 4 Priority actions for Cumberland Land Snail

Description of priority action[1]	Does action relate to the proposal?
Approach priority private site landholders to negotiate implementing protective management regimes.	Not applicable
Review species' conservation status with consideration of data obtained since listing as endangered.	Not applicable
Implement appropriate fire regimes (ones that allow build up of grass and litter layers).	Not applicable
Reserve Fire Management Strategy to include operational guidelines to protect this species from fire	Not applicable
Ensure public land plans of management include appropriate actions for species' protection.	Not applicable
Install structures (where necessary) to prevent accidental slashing and removal of plant debris.	Not applicable
Implement weed control at sites where necessary.	Weed control would be implemented throughout the proposal which would minimise the potential for weed spread into retained areas of the species' habitat
Investigate population census techniques and responses to environmental conditions, with the aim of developing estimates of true population size based on numbers detected in standard surveys.	Not applicable
Identify priority sites for conservation actions on private land.	Not applicable.

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

4.6 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.

Insufficient information about the population dynamics of the species is available to determine whether the sub-populations within the investigation area are likely to be viable. For the purpose of this assessment however all populations in the investigation area are considered to be viable.

Two of the locations in which the species was detected are within the construction footprint. The size and geographic extent of these populations is unknown however given the small number of individuals recorded they are presumed to be small and may be restricted to the affected vegetation within the construction footprint.

The proposed habitat removal may affect the life cycle of individuals within these two groups to the extent that the broader population may become extinct.

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:

a) 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

b) 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:

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

b) 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

c) 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 proposal would include the clearing of up to approximately 26.9 ha of potential habitat for this species in certified areas however only a small proportion of this habitat appears to be occupied by individuals of the species. A further 1.3 ha of potential habitat in poor to moderate condition would be removed from non-certified areas.

As the groups of this species in the investigation area appear to be small and somewhat isolated from one another due to intervening areas of unsuitable habitat, such as roadways and areas with highly modified groundcover, the proposal is considered unlikely to substantially increase the present level of fragmentation of these groups.

The importance of the groups affected to the long-term survival of the species in the locality is unknown. Given the limited opportunity for genetic interaction between isolated groups, the contribution of each group to the viability of nearby groups (and the broader population) also appears limited. There may however be potential for currently isolated groups to contribute to one another's viability through the possible translocation of individuals to supplement nearby groups in the locality thereby increasing the genetic diversity of the recipient groups (sub-populations).

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.

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 this species however nine priority actions have been identified for its recovery (Department of Environment Climate Change and Water 2010b). Most of these strategies (refer Table 5) are not applicable to the proposal. The proposed weed management and relocation of woody debris are however considered to be consistent with the objectives 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 may result in or contribute to the following key threatening processes that may affect this species:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion and establishment of exotic vines and scramblers.
- Removal of dead wood and trees (Department of Environment Climate Change and Water 2010b).

The proposed vegetation clearing protocol, weed management and relocation of woody debris would minimise the impact of these processes.

4.7 Conclusion

The Cumberland Land Snail is an Endangered Species listed under the TSC Act.

Two groups of Cumberland Land Snails and a substantial area of potential habitat are likely to be lost from certified areas. Impacts in certified areas alone are likely to cause a significant impact on the species. The combined impact on this species in certified and non-certified lands is thus likely to be significant.

One group located within non-certified land immediately adjacent to the subject site may be indirectly affected by the proposal however with the implementation of appropriate safeguards such as exclusion fencing, impacts on non-certified lands alone are unlikely to significantly impact the species.

Consideration is also being given to the implementation of a translocation plan for this species which, if implemented, may lead to greater long-term viability of the species in certified areas through habitat and population supplementation. The implementation of this plan was not however considered in the determination of the significance of impacts on the species.

The impact in non-certified areas is considered unlikely to cause a significant impact on this species and hence the preparation of a Species Impact Statement is not required.

5. Microchiropteran bats

5.1 Status

The following microchiropteran bats (microbats) are each listed as Vulnerable under the TSC Act.

5.2 Eastern Freetail-bat Bat

This species lives in sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge (Churchill 2008).

This species has previously been recorded within one kilometres of the investigation area (Department of Environment Climate Change and Water 2010a).

Possible threats for this species include forest harvesting and habitat clearance (Duncan *et al.* 1999a).

5.3 Greater Broad-nosed Bat

The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Strahan 1995).

It is distributed along the east coast of Australia from the New South Wales/ Victorian border to the north coast of Queensland.

This species has previously been recorded within one kilometres of the investigation area (Department of Environment Climate Change and Water 2010a) and a probable record of this species was made during the current survey using identification of echolocation calls (Anabat).

Possible threats for this species include forest harvesting and habitat clearance (Duncan *et al.* 1999b).

5.4 Eastern False Pipistrelle

This species usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. It prefers wet habitats where trees are more than 20 metres high but Forages within the canopy of dry sclerophyll forest (Churchill 2008).

This species has previously been recorded within one kilometres of the investigation area (Department of Environment Climate Change and Water 2010a) and a probable record of this species was made during the current survey using identification of echolocation calls (Anabat).

5.5 Yellow-bellied Sheathtail-bat

Yellow-bellied Sheathtail Bats occur in almost all habitats from wet and dry sclerophyll forest, open woodland, Acacia shrubland, and grasslands. This species roosts in hollows of live and dead hollow-bearing trees, the outside walls of buildings, under exfoliating bark, or in burrows of terrestrial mammals in treeless areas. They have also been found in the abandoned nests of Sugar Glider (*Petaurus breviceps*) or birds (Richards 1998b).

Yellow-bellied Sheathtail Bats forage above the tree canopy. Foraging height varies with the height of the canopy; they fly high and fast. In more open country they forage lower to the ground (Lumsden & Bennett 1995). This species eats a variety of prey mainly beetles (up to 90 per cent) but also long-horned grasshoppers, shield bugs and few flying ants (Churchill 2008).

Yellow-bellied Sheathtail Bats tend to be solitary for most of the year but may form small groups of up to six. Breeding has been recorded from December to mid-March, when a single young is born. Seasonal movements are unknown and there is speculation about a migration to southern Australia in late summer and autumn (Richards 1998b).

5.6 Eastern Bentwing-bat

This species is usually found in well timbered valleys where it forages on small insects above the canopy. It roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008).

Populations of this highly mobile and species are centred on maternity and hibernation caves. Outside of the breeding and hibernation seasons bats disperse over wider areas to forage and roost in a variety of natural caves and man-made structures (Churchill 2008). Local populations of these species therefore tend to cover large geographic areas and consist of many individuals.

This species has previously been recorded in the locality.

Possible threats for this species include disturbance of roost sites, introduced predators and pollutants (Duncan et al. 1999).

5.7 Large-footed Myotis

The Large-footed Myotis is a cave dwelling bat that also roosts in mine shafts, stormwater tunnels, under bridges and in buildings usually in small colonies of 10 -15 individuals. This species occasionally roosts in tree hollows amongst vegetation, often in clumps of pandanus palms. The species usually select roosts close to water, often choosing caves that overhang pools. They have been caught in mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River red gum woodland along the east coast of Australia (Churchill 2008; Richards 1998a).

Colonies always occur close to bodies of water where this species feeds on aquatic invertebrates and small fish by trawling across the water surface and catching flying insects (Churchill 2008).

This species has previously been recorded within the investigation area and two individuals were recorded roosting under the bridge over South Creek and foraging over pools there during the current survey. The species was visually identified at roost and identified whilst foraging by its distinctive flight pattern and its habit of foraging just above the water surface.

5.8 Specific impacts

The air spaces within and around all native vegetation within the investigation area is considered to provide foraging opportunities for these bat species. Larger woodland patches with more intact vegetation structure are however considered likely to be the most important foraging areas.

Potential breeding and roosting habitat is largely restricted to locations which contain mature hollow-bearing trees (refer to Figure 4.3, Figure 4.4). Mature trees within the investigation area are concentrated along Bringelly Road and are largely within the construction footprint.

The proposal would include the clearing of up to approximately 29.2 ha of potential foraging habitat for these species (with the exception of the Large-footed Myotis which chiefly forages over water bodies) within certified areas and 4.4 ha in non-certified areas. 26 hollow-bearing and potentially hollow-bearing trees, which provide potential roosting and breeding habitat for hollow-dependent species, would be removed from certified areas and 2 would be removed from non-certified areas.

Of the bat species likely to occur in the investigation area, the Eastern Bentwing-bat is not known to utilise tree hollows.

Some disturbance to Large-footed Myotis roosting under the existing bridge over South Creek and disturbance to foraging habitat for this species due to vegetation clearing in the vicinity of the creek would also occur. Impacts on this species are chiefly located within non-certified areas.

5.9 Threats

Recognised threats to these species include:

- Loss or disturbance of roosting sites and maternity caves.
- Disturbance to winter roosting sites and breeding sites.
- Clearing adjacent to foraging areas.
- Application of pesticides in or adjacent to foraging areas.
- Loss of vegetation for foraging and hollow-bearing trees for roosting.
- Application of pesticides in or adjacent to foraging areas (Department of Environment Climate Change and Water 2010b).

Key threatening processes that may affect these species include:

- Clearing of native vegetation.

- Loss of hollow-bearing trees.
- Removal of dead wood and trees
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (Department of Environment Climate Change and Water 2010b).

5.10 Recovery

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 has potential to contribute to the implementation of three of these actions (refer Table 5) through the installation of bat boxes under the bridge over South Creek and the restoration of riparian vegetation in this location. The proposal is not considered likely to interfere with the implementation of any of the other recovery actions of relevance to these species.

Table 5 Recovery actions for Threatened species of microbat

Description of priority action[1]	Relevant to species or population						Does action relate to the proposal?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing - bat	Large-footed Myotis	
Assess the importance by survey of estuaries and other tidal waterways for the species across its range.						Y	Not applicable
Better define species distribution through survey in coastal lowlands on- and off-reserve.		Y					Not applicable
Better regulate pollution of waterways e.g. sewage and fertilizer run-off (eutrophication) and pesticide/herbicide leakage (chemical pollution) and thermal pollution.						Y	Not applicable
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.					Y		Not applicable
Confirm species taxonomy of NSW populations, relative to other Australian populations.					Y		Not applicable
Confirm species taxonomy of NSW populations, relative to other Australian populations.					Y		Not applicable
Control foxes and feral cats around roosting sites, particularly maternity caves and hibernation sites.					Y		Not applicable
Determine susceptibility to logging.					Y	Y	Not applicable
Determine the effectiveness of PVP assessment, offsets and actions for bats.					Y		Not applicable
Determine the effectiveness of PVP assessment, offsets and actions for bats.					Y		Not applicable
Develop and promote State-wide bat awareness programs for schools, CMAs, landholders and industry groups etc.	Y	Y	Y	Y			Not applicable
Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation.						Y	The proposed measures to minimise vegetation clearing and rehabilitate riparian

Description of priority action[1]	Relevant to species or population						Does action relate to the proposal?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing - bat	Large-footed Myotis	
							vegetation are consistent with this action.
Ensure protection of known roosts and forest within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments.					Y		Not applicable
Ensure the Code of Practice for private native forestry includes adequate measures to protect large, hollow-bearing trees and viable numbers of recruit trees. .	Y	Y	Y	Y			Not applicable
Ensure the largest hollow bearing trees, inc. dead trees and paddock trees, are given highest priority for retention in PVP assessments. Offsets should include remnants in high productivity.	Y	Y	Y	Y		Y	Not applicable
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.					Y		Not applicable
Exclude prescription burns from 100m from cave entrance, ensure smoke/flames of fires do not enter caves/roosts in artificial structures.					Y		Not applicable
For roost caves vulnerable to human disturbance, monitor their visitation by people, particularly during winter and spring/summer maternity season and in school holidays.	Y						Not applicable
Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).					Y		Not applicable
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.	Y	Y	Y	Y			Not applicable
Identify important foraging range and key habitat components for this species.	Y	Y	Y				Not applicable
Identify the effects of fragmentation in a range of fragmented landscapes i.e. the farmland/forest interface and the urban/forest interface e.g. movement and persistence across a range of fragment	Y	Y	Y	Y			Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the proposal?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing - bat	Large-footed Myotis	
sizes.							
Identify the spatial population structure, including genetic isolation, movement and persistence across the species range.						Y	Not applicable
Identify the susceptibility of the species to pesticides.	Y	Y		Y	Y		Not applicable
Identify, protect and enhance roost habitat beneath artificial structures (e.g. bridges), especially when due for replacement, and assess effectiveness of the actions.						Y	Consideration will be given to fitting roost boxes to the bridge over South Creek to provide roost sites for the Large-footed Myotis. This measure is consistent with this action.
Investigate the effectiveness of logging prescriptions.	Y	Y	Y	Y		Y	Not applicable
Measure genetic population structure among cave roosts of maternity colonies to estimate dispersal and genetic isolation, and vulnerability to regional population extinction.					Y		Not applicable
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.	Y						Not applicable
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.	Y	Y	Y	Y		Y	Not applicable
Prepare fire management plans for significant roost caves, disused mines, culverts, especially maternity and winter roosts.					Y		Not applicable
Prepare management plans for significant bat roosts especially all known maternity colonies and winter colonies.					Y		Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the proposal?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing - bat	Large-footed Myotis	
Promote bats throughout the rural community as ecologically interesting and important, but sensitive to disturbance at caves/disused mine tunnels.					Y		Not applicable
Promote roosting habitat in new artificial structures within the species range.						Y	Consideration will be given to fitting roost boxes to the bridge over South Creek to provide roost sites for the Large-footed Myotis. This measure is consistent with this action.
Promote the conservation of HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means.	Y	Y	Y	Y			Not applicable
Promote the conservation of these key roost areas using measures such as incentive funding to landholders, offseting and biobanking, acquisition for reserve establishment or other means					Y		Not applicable
Quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops.	Y	Y	Y	Y			Not applicable
Raise awareness of the effects of pesticides.		Y		Y			Not applicable
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.	Y						Not applicable
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.	Y	Y	Y	Y			Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the proposal?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing - bat	Large-footed Myotis	
Research the effect of different burning regimes on cave disturbance and surrounding foraging habitat.					Y		Not applicable
Research the effect of different burning regimes.	Y	Y	Y	Y			Not applicable
Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes, such as revegetating and installing bat boxes.	Y	Y	Y	Y			Not applicable
Research the potential for long distance/seasonal movement.				Y			Not applicable
Research the roosting ecology of tree-roosting bats. For example identifying the attributes of key roosts. .	Y	Y	Y	Y			Not applicable
Research to identify important foraging range and key habitat components around significant roosts.					Y		Not applicable
Research to identify important foraging range and key habitat components for this species. Identify the importance of riparian vegetation to the species.						Y	Not applicable
Resolve species taxonomy by morphology/genetics and reassess conservation status.						Y	Not applicable
Restrict access where possible to known maternity sites. (e.g.: signs; bat-friendly, preferably external gates at caves).					Y		Not applicable
Restrict caving activities at significant roosts during important stages of the annual bat life cycle (eg winter hibernation, summer maternity season).					Y		Not applicable
Restrict caving activity during critical times of year in important roosts used by species, particularly maternity and hibernation roosts.					Y		Not applicable
Search for significant roost sites and restrict access where possible (e.g. gating of caves). Significant includes maternity, hibernation and transient sites including in artificial structures. .					Y		Not applicable
Study the ecological requirements of maternity colonies and their environs and migratory patterns.					Y		Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the proposal?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing - bat	Large-footed Myotis	
Study the ecology, habitat requirements and susceptibility to logging and other forestry practices of this little-known species.	Y	Y	Y		Y	Y	Not applicable
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.				Y			Not applicable
Study the susceptibility of this species to pesticide accumulation				Y			Not applicable
Survey large inland waterways for this species to determine distribution in Murray Darling Basin.	High					Y	Not applicable
Undertake a systematic survey of productive coastal river valleys to quantify the importance of private land relative to public lands.		Y					Not applicable
Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes.	Y	Y	Y	Y		Y	Not applicable
Undertake non-chemical removal of weeds (e.g. lantana, blackberry) to prevent obstruction of cave entrances.					Y		Not applicable
Use radio-tracking to identify important foraging range and help interpret density of records.				Y			Not applicable

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

5.11 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 bridge over South Creek provides a known roosting and potential breeding site for the Large-footed Myotis. Only two individuals of the species were observed roosting under the bridge in a relatively exposed situation suggesting that the bridge has a limited capacity to provide roosting and breeding habitat due to an apparent paucity of suitable spaces between bridge members. This species may also utilise tree hollows, building and other artificial structures within 500 m of the creek. The other minor creeks and dams in the investigation area are considered unlikely to provide suitable habitat for the species due to the extensive growth of emergent plants and lack of open stretches of water preferred as foraging habitat. Disturbance to potential breeding habitat for the Large-footed Myotis would be limited to the construction phase of the proposal. Placement of a bat box under the existing bridge is under consideration by the RTA. This would provide a potential roosting and breeding habitat distant from the main construction activities providing a visual and sound buffer between these activities and the roosting bats. This and a second box under the new bridge (also under consideration) would remain available for use by the bats after construction. Regardless of whether or not bat boxes are installed the impact on the breeding of Large-footed Myotis is unlikely to be significant as disturbance to the existing bridge will be of short duration and the bridge is likely to remain suitable as habitat post-construction.

The Eastern Bentwing-bat breeds in communal maternity caves migrating long distances between these and summer foraging habitat and is highly unlikely to breed in the investigation area.

The 26 hollow-bearing and potentially hollow-bearing trees that would be removed in certified areas within the subject site constitute the majority of potential breeding habitat for microbat species within the investigation area. Only two of these hollows are within 500 m of creeks and hence few of these trees are likely to be utilised by the Large-footed Myotis.

Whilst additional potential breeding habitat is likely to be available to hollow-dependent microbat species in the locality, the loss of 26 hollows from the certified areas of the subject site is considered likely to represent a significant proportion of the locally available breeding habitat for the following species:

- Eastern Freetail-bat-bat
- Greater Broad-nosed Bat
- Eastern False Pipistrelle
- Yellow-bellied Sheathtail Bat.

This reduction in breeding habitat is considered likely to place local populations of these species at elevated risk of extinction.

The loss of 2 hollow-bearing trees from non-certified areas represents a far smaller proportion of available breeding habitat and is considered unlikely to place local microbat populations at a significantly higher 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:

a. **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**

b. **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:

a. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

b. **(b) 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**

c. **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.**

Some disturbance to Large-footed Myotis roosting under the existing bridge over South Creek and disturbance to foraging habitat due to vegetation clearing in the vicinity of the creek would also occur.

The Eastern Bentwing-bat migrates over large distances between maternity and hibernation caves and summer foraging habitat where it uses a variety of natural caves and artificial structures for roosting.

The proposal would include the clearing of up to approximately 29.2 ha of potential foraging habitat for microbat species in certified areas and 4.4 ha in non-certified areas. Potential foraging habitat for these species is considered to be relatively abundant in the locality. The foraging habitat that the species would lose is considered to be of only moderate importance to local populations of these species.

As these species are highly mobile they are considered unlikely to be significantly affected by the additional habitat fragmentation that would occur as a result of the proposal.

The 26 hollow-bearing and potentially hollow-bearing trees that would be removed in certified areas within the subject site constitute the majority of potential breeding habitat for microbat species within the investigation area. Only two of these hollows are within 50 m of creeks and hence few of these trees are likely to be utilised by the Large-footed Myotis.

Whilst additional potential breeding habitat is likely to be available to hollow-dependent microbat species in the locality, the loss of 26 hollows from the certified areas of the subject site is likely to represent a significant proportion of the locally available breeding habitat for the following species:

- Eastern Freetail-bat-bat
- Greater Broad-nosed Bat
- Eastern False Pipistrelle
- Yellow-bellied Sheathtail Bat.

This reduction in breeding habitat is considered likely to place local populations of these species at elevated risk of extinction.

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 has potential to contribute to the implementation of three of these actions (refer Table 6) through the installation of bat boxes under the bridge over South Creek and the restoration of riparian vegetation in this location. The proposal is unlikely 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 the following key threatening processes that may affect these species:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.
- Removal of dead wood and trees (Department of Environment Climate Change and Water 2010b).

5.12 Conclusion

Habitat removal in certified areas alone is substantial and has potential to have a significant impact on local populations of the following hollow-dependent bat species, which are listed as Vulnerable species under the TSC Act, due to the loss of a substantial proportion of potential roosting and breeding habitat in the locality:

- Eastern Freetail-bat-bat
- Greater Broad-nosed Bat
- Eastern False Pipistrelle
- Yellow-bellied Sheathtail Bat.

The combined impact on these four species in certified and non-certified lands is thus likely to be significant.

The proposal is unlikely to have a significant impact on local populations of the Large-footed Myotis or Eastern Bentwing-bat, which are also listed as Vulnerable species under the TSC Act, due to the low potential for impacts (in either certified or non-certified areas) on roosting and breeding habitat for these species and the relatively minor impact on foraging habitat.

Impacts on these six microbat species in non-certified areas are unlikely to be significant due to the relatively small amount of clearing and hollow-bearing tree removal required in these areas and preparation of a Species Impact Statement is not required.

6. Grey-headed Flying-fox

6.1 Status

The Grey-headed Flying-fox is listed as Vulnerable under Schedule 2 of *the Threatened Species Conservation Act*.

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 (Parry-Jones & Augee 1991). 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 (Parry-Jones & Augee 1991).

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 (Eby 1991).

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 (Churchill 2008).

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 (Parry-Jones & Augee 1991; Parry-Jones & Augee 1992; Spencer *et al.* 1991).

6.3 Specific impacts

Grey-headed Flying-fox have been previously recorded in the locality and a single individual was recorded flying over the investigation area during field surveys.

The approximately 33.6 ha of woodland (including 29.2 ha in certified lands and 4.4 ha in non-certified lands) affected is likely to be used as a foraging habitat by this species on a seasonal basis when the dominant eucalypt species are flowering heavily.

6.4 Threats

Recognised threats include:

- Loss of foraging habitat.
- Disturbance of roosting sites.

- Unregulated shooting.
- Electrocution on powerlines (Department of Environment Climate Change and Water 2010b).

Key threatening processes that may affect the species include:

- clearing of native vegetation

6.5 Recovery

No NSW plan has been developed for this species however thirty-one priority actions have been identified for its recovery (Department of Environment Climate Change and Water 2010b).

These strategies primarily relate to research, education and policy development and are of limited relevance to the proposal. The proposal is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies

Table 6 Priority actions for the Grey-headed Flying-fox

Description of priority action[1]	Does action relate to the proposal?
Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.	Not applicable
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.	Not applicable
Monitor public attitudes towards flying-foxes.	Not applicable
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.	Not applicable
Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.	Not applicable
Grey-headed Flying-fox National Recovery Team to undertake an annual review of the national recovery plan's implementation.	Not applicable
Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.	Not applicable
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.	Not applicable. Habitat of the investigation area is not considered to be priority foraging habitat.
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.	Not applicable

Description of priority action[1]	Does action relate to the proposal?
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.	Not applicable
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.	Not applicable
Systematically document the levels of flying-fox damage to the horticulture industry within the range of the Grey-headed Flying-fox.	Not applicable
Develop guidelines to assist land managers dealing with controversial flying-fox camps.	Not applicable
Complete national recovery plan in 2007.	Not applicable
Develop and promote incentives to reduce killing of flying-foxes in commercial fruit crops.	Not applicable
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.	Not applicable
Review and improve methods used to assess population size of Grey-headed Flying-foxes.	Not applicable
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.	Not applicable
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.	Not applicable
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.	Not applicable
Investigate the age structure and longevity of Grey-headed Flying-foxes.	Not applicable
Assess the impacts Grey-headed Flying-fox camps have on water quality, and publish results in a peer-reviewed journal.	Not applicable
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.	Not applicable
Investigate between-year fidelity of Grey-headed Flying-fox individuals to seasonal camps.	Not applicable
Investigate the differences in genetic relatedness, sex, age etc. between sedentary and transient Grey-headed Flying-foxes.	Not applicable
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.	Not applicable
Investigate the patterns of juvenile Grey-headed Flying-fox dispersal and mortality, allowing identification of the specific habitat requirements of juveniles.	Not applicable

Description of priority action[1]	Does action relate to the proposal?
Identify the commercial fruit industries that are impacted by Grey-headed Flying-foxes, to provide an information base for use by the various stakeholders.	Not applicable
Set priorities for protecting foraging habitat critical to the survival of Grey-headed Flying-foxes and generate maps of priority foraging habitat.	Not applicable
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.	Not applicable

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

6.6 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 investigation area. Breeding habitat for the species is hence unlikely to be 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:

a. 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

b. 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:

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

b. 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

c. 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,

Approximately 33.6 ha of woodland that would be cleared which is likely to be used as a foraging habitat by this species on a seasonal basis when the dominant eucalypt species are flowering heavily.

As this species is highly mobile it is considered unlikely to be significantly affected by the additional habitat fragmentation that would occur as a result of the proposal.

Potential foraging habitat for this species is considered to be relatively abundant in the locality. The foraging habitat that the species would lose is considered to be of only moderate importance to the local occurrence of 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 this species.

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 (refer Table 7).

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 the clearing of native vegetation key threatening process that may affect this species. 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.

6.7 Conclusion

The Grey-headed Flying-fox is listed as a Vulnerable species under the TSC Act. The Grey-headed Flying-fox is unlikely to be significantly impacted by the proposal as a result of vegetation clearing in either certified or non-certified areas or from the combined impact in these areas. The proposal is considered unlikely to cause a significant impact and hence the preparation of a Species Impact Statement is not required.

7. Migratory and nomadic nectarivorous birds

The following three bird species are all migratory or nomadic nectar-feeding species which are only likely to utilise the investigation area on a seasonal or sporadic basis in response to the flowering of the dominant eucalypt species.

7.1 Status

The Little Lorikeet is listed as a Vulnerable species under the TSC Act. The Swift Parrot and Regent Honeyeater are listed as Endangered species under the TSC Act.

7.2 Little Lorikeet

In NSW Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range (Royal Australian Ornithologists Union 2003). 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 (Higgins 1999).

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 (NSW Scientific Committee 2009).

7.3 Swift Parrot

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 coast's 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).

7.4 Regent Honeyeater

Occurs mostly in box-ironbark forests and woodland and prefers the 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. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), E. melliodora (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett & Crowley 2000).

Regent Honeyeaters are highly mobile, rarely remaining long in one place unless breeding. Even then, they usually depart as soon as their young are independent. During winter, Regent Honeyeaters disperse widely in small groups. In spring they concentrate into the main breeding areas around Chiltern and Benalla in Victoria and Capertee Valley and Bundarra District in NSW. Other sites regularly visited include Canberra and the Warrumbungles, Mudgee and Gosford areas in New South Wales (Garnett & Crowley 2000).

The species also utilises the woodland communities of the Cumberland Plain.

7.5 Specific impacts

The approximately 33.6 ha of woodland affected may be used as a foraging habitat by these species on a seasonal or sporadic basis when the dominant eucalypt species are flowering heavily.

Some of the 26 hollow-bearing trees that would be lost may contain hollows suitable for nesting by the Little Lorikeet however most breeding records for the species are from the western slopes region and breeding by this species is infrequently recorded on the Cumberland Plain.

7.6 Threats

Recognised threats applicable to these species in NSW include:

- Loss of and degradation of habitat through vegetation clearing and grazing.
- For swift parrots, collisions with wire netting fences, windows and cars, during the breeding season and winter migration (especially where such obstacles are in close proximity to suitable habitat) (Department of Environment Climate Change and Water 2010b).

Key threatening processes that may affect the species include:

- Clearing of native vegetation.
- Loss of hollow-bearing trees (Little Lorikeet only).

7.7 Recovery

No NSW recovery plan has been developed for the Swift Parrot however thirty-one priority actions have been identified for its recovery (Department of Environment Climate Change and Water 2010b).

These strategies primarily relate to research, education and policy development and are of limited relevance to the proposal. The proposal is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies

No recovery plan has been prepared for the Little Lorikeet and no recovery actions have been identified for the species to date.

Table 7 Priority actions for the Swift Parrot

Description of priority action[1]	Does action relate to the proposal?
Consult and involve Indigenous community through employment of community liaison officer	Not applicable
Reduce the incidence of Swift Parrot collisions by raising community awareness of the threat of man-made hazards (including windows/glass panes and high wire-mesh fences) in the vicinity of suitable habitat.	Not applicable
Compile, produce and distribute the annual Swift Parrot volunteer newsletter "Swifts Across the Strait".	Not applicable
Employ community liaison officer to coordinate conservation actions for the species, including the maintenance of community and volunteer networks.	Not applicable
Manage the recovery process through the continued operation of the Swift Parrot Recovery Team.	Not applicable
Develop and distribute EIA guidelines to decision makers.	Not applicable
Protect, manage and restore Swift Parrot habitat on private land through conservation agreements, management agreements and incentive payments (refer to species profile for regionally specific habitat information).	Not applicable
Enhance habitat for Swift Parrots by planting suitable tree species to complement natural regeneration or to enhance remnants (refer to species profile for regionally specific habitat information).	Not applicable..
Finalise review of National Recovery Plan by 2007.	Not applicable
Conduct Swift Parrot habitat research on both private and public land.	Not applicable
Coordinate volunteer surveys at known and potential Swift Parrot sites on private and public land.	Not applicable
Identify and map the extent and quality of Swift Parrot foraging and roosting habitat on private and public land (refer to species profile for regionally specific habitat information).	Not applicable

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

Table 7-1 Priority actions for the Regent Honeyeater

Description of priority action[1]	Does action relate to the proposal?
Maintain captive exhibits.	Not applicable
Complete the trials of harness attachment techniques for radio transmitters, which were commenced during 1997.	Not applicable
Develop an ageing and sexing guide for use by field ornithologists.	Not applicable
Maintain a viable captive population.	Not applicable
Produce a Regent Honeyeater Husbandry Manual.	Not applicable
Appoint Regional Work Plan Facilitators.	Not applicable
Establish and Maintain Operation Groups.	Not applicable

Description of priority action[1]	Does action relate to the proposal?
Develop a species profile for land holders.	Not applicable
Disseminate information at a local level.	Not applicable
Educate and provide information to CMAs.	Not applicable
Production of a twice yearly newsletter and various leaflets.	Not applicable
Promote awareness of the recovery efforts to the general community.	Not applicable
Promote best practise natural resource management throughout the range of the species.	Not applicable
Provide education and encouragement to protect Regent Honeyeater habitat on private land.	Not applicable
	Not applicable
DEC to co host National Recovery Effort.	Not applicable
DEC to employ National Coordinator.	Not applicable
Finalise National Recovery Plan in 2007.	Not applicable
Implement threat abatement programs in the regularly use areas.	Not applicable
Liaise with other recovery efforts for aligned species, communities.	Not applicable
Maintain National Recovery team.	Not applicable
Maintain a Scientific sub -committee.	Not applicable
Produce a Population Management Plan.	Not applicable
Ensure appropriate environmental impact assessment of proposals impacting on Regent Honeyeater habitat.	Not applicable
Develop Regional/Local Plans.	Not applicable
Continue to implement the Warrumbungle's Revegetation plan ensuring that plant species chosen contribute as habitat of the Regent Honeyeater.	Not applicable
Protect and enhance habitat containing 'significant habitat'.	Not applicable
Ensure Regent Honeyeater habitat on Public Land is managed appropriately.	Not applicable
Undertake on–ground habitat enhancement work in the Capertee Valley region of the Hawkesbury-Nepean, Central West and Hunter – Central Rivers Catchments.	Not applicable
Implement on-ground protection programs targeting priority vegetation types in Border Rivers – Gwydir & Namoi Catchments.	Not applicable
Analysis of Data and Development of Monitoring Program.	Not applicable
Conduct surveys and monitor population dynamics within the Hunter Valley and Central Coast.	Not applicable
Implement Population Monitoring Program in the Capertee Valley region of the Hawkesbury-Nepean, Central West and Hunter – Central Rivers Catchments.	Not applicable
Assess competition with the Honeybee.	Not applicable

Description of priority action[1]	Does action relate to the proposal?
Conduct radio-tracking studies.	Not applicable
Continue to assess the degree of movement between populations.	Not applicable
Conduct research into movement patterns of Regent Honeyeaters in the Hawkesbury-Nepean, Central West and Hunter – Central Rivers Catchments.	Not applicable
Monitor Changes in distribution.	Not applicable
Obtain an annual estimate of recruitment.	Not applicable
Conduct regular surveys in the Chiltern Albury 'regularly used area' of Murray Catchment.	Not applicable
Conduct regular surveys in the South Coast region.	Not applicable
Participate in biannual Community Regent Honeyeater and Swift Parrot National Survey in preferred habitat.	Not applicable

Source: Department of Environment and Climate Change (Department of Environment Climate Change and Water 2010b)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

7.8 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 Swift Parrot only breeds in Tasmania. The Regent Honeyeater chiefly breeds in several main breeding areas and is unlikely to breed in the disturbed habitat of the investigation area.

Most breeding records for the Little Lorikeet are from the South-west slopes region and it is unlikely that an ecologically significant proportion of any population of the species would breed in the investigation area.

No significant impact on the lifecycle of these species is considered likely to occur as result of the proposal.

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:

a) 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

b) 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:

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

b) 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

c) 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.

Approximately 33.6 ha of woodland would be cleared which is likely to be used as a foraging habitat by these species on a seasonal basis when the dominant eucalypt species are flowering heavily.

As these species are highly mobile it is considered unlikely that they would be significantly affected by the additional habitat fragmentation that would occur as a result of the proposal.

Potential foraging habitat for these species is considered to be relatively abundant in the locality. The foraging habitat that the species would lose is considered to be of only moderate importance to the local occurrence of 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 these species in NSW.

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 (refer Table 8, Table 9).

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 the clearing of native vegetation key threatening process that may affect these species. The proposal would also contribute to the loss of hollow-bearing trees key threatening process that may affect the Little Lorikeet. The increased impact of these KTPs as a result of the proposal is not however considered likely to significantly impact the local occurrence of these species.

7.9 Conclusion

Both the Swift Parrot and Regent Honeyeater are listed as Endangered species under the TSC Act. The Little Lorikeet is listed as a Vulnerable species under the TSC Act.

These migratory or nomadic nectar-feeding birds are unlikely to be significantly impacted by the effects of the proposal on either certified or non-certified areas or of the combined impact in these areas.

The proposal is unlikely to cause a significant impact and hence the preparation of a Species Impact Statement is not required.

8. Wide-ranging predatory birds

8.1 Status

The Powerful Owl, Little Eagle and Spotted Harrier are listed as Vulnerable species under the TSC Act.

8.2 Powerful Owl

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 (Debus, S. J. S. & Chafer 1994). 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 (Higgins 1999).

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. (Kavanagh & Debus 1994). 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 (NSW National Parks and Wildlife Service 1998).

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 (Kavanagh et al. 1995).

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 (Debus, S. J. S. 1995).

8.3 Little Eagle

The Little Eagle occupies habitats rich in prey within open eucalypt forest, woodland or open woodland (Marchant & Higgins 1993); Aumann 2001a). 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. Young fledge in early summer. Generation length has been estimated as 10 years (Debus, S. & Soderquist 2008). It eats birds, reptiles and mammals, occasionally adding large insects and carrion (Marchant & Higgins 1993); Aumann 2001b; Debus et al. 2007). It was formerly heavily dependent on rabbits, but following the spread of rabbit calicivirus disease, and consequent decline in rabbit numbers by 65-85% in the arid and semi-arid zones (Sharp et al. 2002), the Little Eagle is increasingly dependent on native prey.

8.4 Spotted Harrier

The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population.

The species occurs in grassy open woodland, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals, birds and reptiles, occasionally insects and rarely carrion (Department of Environment Climate Change and Water 2010b).

8.5 Specific impacts

The approximately 33.6 ha of woodland affected may be used as a foraging habitat by these species on an occasional basis as part of a large home range.

The vegetation of the investigation area is considered to be marginal at best as nesting habitat due to the lack of large entrance diameter hollows suitable for the Powerful Owl and the location of most large mature trees near roadways where nests would be subject to traffic noise and other forms of disturbance.

8.6 Threats

Recognised threats to the Powerful 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 Owl (Department of Environment Climate Change and Water 2010b).

Recognised threats to the Spotted Harrier include:

- Clearing and degradation of foraging and breeding habitat, particularly that which affects prey densities.
- Secondary poisoning from rodenticides.
- Secondary poisoning from rabbit baiting (Department of Environment Climate Change and Water 2010b).

Recognised threats to the Little Eagle include:

- Rural-residential subdivision and associated land uses (e.g. horse and goat grazing).
- Clearing and degradation of foraging and breeding habitat.
- Urban expansion.
- Secondary poisoning from rabbit baiting (Department of Environment Climate Change and Water 2010b).

Key threatening processes that may affect these species include:

- Clearing of native vegetation.
- Loss of hollow-bearing trees (Powerful Owl only).

8.7 Recovery

A recovery plan has been prepared for the Threatened large forest owls of NSW which includes the Powerful Owl (Department of Environment Climate Change and Water 2010b).

The recover actions identified in this plan are shown in Table 10.

Table 8 Recovery actions for the Powerful Owl

Description of recovery action[1]	Does action relate to the proposal?
Update and refine existing owl habitat models using the best available information.	Not applicable
Map the amount of modelled habitat across forested land in NSW.	Not applicable
Design a sampling strategy to test the modelled habitat for the presence of owls and locate identified sites.	Not applicable
Field validation of modelled habitat for the presence of owls.	Not applicable
Estimate the areal amount of mapped modelled habitat for each owl species that is occupied (based on the proportion of sample sites with owls in them) and use this estimate to further estimate the number of owl territories present within different land tenures (based on home range data).	Not applicable
Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.	Not applicable
Seek cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.	Not applicable
Implement a regional monitoring program.	Not applicable
Investigate the implementation by DPI (Forests NSW) of the forestry TSL owl prescriptions by carrying out proactive audits targeting these prescriptions (DEC) and through IFOA monitoring and reporting DPI	Not applicable

Description of recovery action[1]	Does action relate to the proposal?
(Forests NSW).	
Carry out post harvest surveys in locations where owls were detected prior to logging to determine if they are continuing to occupy the habitat.	Not applicable
Encourage post-graduate student radio tracking proposals examining the use of logged and unlogged forest by the three owl species.	Not applicable
Make an assessment of the implementation and effectiveness of forestry owl prescriptions using data collected in this action and if necessary refine the prescriptions and negotiate changes to the forestry TSLs.	Not applicable
Prepare and disseminate environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess and mitigate the impacts of developments on the large forest owls and their habitats.	Not applicable
Monitor and report on the effectiveness of concurrence and licence conditions that have previously been applied to reduce the impacts of developments on the three large forest owl species or their habitats. This will involve keeping a record of such conditions, selecting case studies and then checking for the presence of owls at long intervals post development.	Not applicable
Use this information to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the three large forest owls.	Not applicable
Provide up-to-date and accurate large forest owl and habitat information in the 'PVP Developer – Threatened Species Tool'. This will ensure that broadscale clearing is only approved under the NV Act if the 'improve or maintain' test is met.	Not applicable
Facilitate the adequate consideration of large forest owls during biodiversity certification of environmental planning instruments. This may include ensuring that correct survey methods are used, informed habitat assessments are undertaken and adequate conservation measures are included in EPIs to assist the recovery of the owls.	Not applicable
Provide up to date information and data for the BioBanking assessment methodology.	Not applicable
Prepare guidelines addressing issues associated with habitat protection and management, and survey and assessment. The guidelines are to provide detailed information on the identification of significant habitat for owls, appropriate strategies for its protection, and for habitat creation as part of revegetation programs. The guidelines will be published on the DEC threatened species website and link to species profile information.	Not applicable
Encourage CMAs to invest in actions that actively manage and/or conserve large forest owl habitat as part of their Catchment Action Plans. In addition, seek other funding opportunities in partnership with community groups, to promote owl conservation on private lands.	Not applicable
Encourage private landholders to undertake management options to conserve and/or actively manage large forest owl habitat (and particularly nest sites) through incentive Property Vegetation Plans, Voluntary Conservation Agreements or other management initiatives.	Not applicable
Seek an Australian Research Council (ARC) Linkage grant or other joint funding opportunity to initiate research into identified key areas of the biology and ecology of the large forest owls.	Not applicable

Description of recovery action[1]	Does action relate to the proposal?
Promote awareness and involvement of the research and management needs of the three large forest owls among the scientific and academic community.	Not applicable
Seek scholarship funds for an aboriginal student to investigate the cultural and historic significance of the three species.	Not applicable
Encourage and coordinate the involvement of community-based groups (eg the Australian Bird and Bat Study Association) and animal care groups (eg WIRES) in the implementation of recovery actions.	Not applicable
Ensure the DEC threatened species website provides current information on owl identification (including photographs and samples of calls), habitat identification and protection, any current activities the community can be involved in, as well as information on how and where to report sightings and other relevant information. Ensure the site has links to other key internet sites such as the Australasian Raptor Association.	Not applicable
Coordinate implementation of actions.	Not applicable
Review plan and rewrite in final year.	Not applicable
Convene a threatened owl workshop with relevant experts and stakeholders to reassess the NSW conservation status of the three large forest owls. This action will be undertaken upon conclusion of the implementation of all of the above actions.	Not applicable

Source: Department of Environment and Climate Change (2008)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

No recovery plan has been developed for the Spotted Harrier or Little Eagle and to date, no priority actions have been identified their recovery however the following are identified in the Threatened species profiles for the species ads being necessary for these recovery of these species (Department of Environment Climate Change and Water 2010b):

- Protect areas of habitat from overgrazing.
- Protect areas of habitat from development.
- Retain and protect nesting and foraging habitat.
- Buffer habitat areas from the impacts of other activities.
- Protect known populations and areas of potential habitat from clearing, fragmentation or disturbance.
- Rehabilitate known and potential habitat.
- Retain and protect nesting and foraging habitat.
- Report cases of illegal shooting to the DECCW.

These strategies primarily relate to research, education and policy development and are of limited relevance to the proposal. The proposal is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies.

8.8 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 tree hollows of suitable size for Powerful Owl nests were found in the investigation area. No nests of birds of prey were located in the investigation area.

Trees of suitable size for nesting by birds of prey were chiefly located in close proximity to roadways. These trees are considered unlikely to be used as nesting habitat due to the disturbance associated with vehicular traffic and other human activity in these locations.

None of these species are considered likely to breed in the investigation area.

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:

a. 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

b. 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:

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

b. 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

c. 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.

27.4 ha of woodland would be cleared which may be used as a foraging habitat would form only part of the home range of a single individual or breeding pair of these species. The home range of the Powerful Owl is 400-1450 ha (Department of Environment Climate Change and Water 2010b).

The Little Eagle and Spotted Harrier are also likely to large home ranges of at least several hundred hectares, often inhabit sparsely forested habitats including grasslands and are highly mobile. They are hence unlikely to be significantly affected by the fragmentation of woodland that is likely to occur.

The Powerful Owl is likely to move along corridors of riparian vegetation in the locality and to forage in nearby woodland remnants. These riparian corridors are unlikely to be significantly fragmented by the proposal.

The foraging habitat that the species would lose is considered to be of only moderate importance to the local occurrence of 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 this species.

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 (refer Table 10).

8.9 Conclusion

The Powerful Owl, Little Eagle, and Spotted Harrier are listed as Vulnerable species under the TSC Act. These wide-ranging predatory birds are unlikely to be significantly impacted by effects of the proposal on either certified or non-certified areas or of the combined impact in these areas.

The proposal is considered unlikely to cause a significant impact on these species and hence the preparation of a Species Impact Statement is not required.

9. Woodland birds

9.1 Status

The Scarlet Robin and Varied Sittella are listed as Vulnerable species under the TSC Act.

9.2 Scarlet Robin

The Scarlet Robin is found in south-eastern Australia (extreme south-east Queensland to Tasmania, western Victoria and south-east South Australia) and south-west Western Australia. In NSW it occupies open forests and woodlands from the coast to the inland slopes (Higgins & Peter 2002). Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains.

The Scarlet Robin breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within 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. The Scarlet Robin builds an open cup nest of plant fibres and cobwebs, sited in the fork of tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (Higgins & Peter 2002).

9.3 Varied Sitella

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west (Higgins & Peter 2002; Royal Australian Ornithologists Union 2003). It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland and scrubby parks and gardens (Pizzey & Knight 1997). 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 (Debus, S. & Soderquist 2008).

In north-eastern NSW Varied Sittellas occur in sedentary groups or clans holding weakly-defended territories of 13-20 ha (Noske 1998).

The Varied Sittella was found to be relatively common within the Greater Southern Sydney Region in which the investigation area is located and has a fair amount of habitat within protected areas however it is likely to have declined significantly on the Cumberland Plain (Department of Environment and Climate Change 2007b, 2007c).

A flock of approximately five Varied Sittellas was recorded in the investigation area in the vicinity of Browns Rd feeding in mature trees in an otherwise cleared paddock to the north of Bringelly Road.

9.4 Specific impacts

The 33.6 ha of woodland affected by the proposal may be used as a foraging habitat by the Scarlet Robin on an occasional basis or seasonal basis but is unlikely to be used as breeding habitat by this species.

The Varied Sittella was observed foraging in the investigation area in remnant trees within otherwise cleared and grazed paddocks and may also breed there. This partially cleared habitat is abundant in the locality and the proposal will only affect a small proportion of habitat available for the species there.

9.5 Threats

Recognised threats to the Scarlet Robin and Varied Sittella include:

- Historical habitat clearing and degradation.
- Habitat modification due to overgrazing.
- Reduction of size of remnant patches.
- Reduction in the structural complexity of habitat, including reductions in canopy cover, shrub cover, ground cover, logs, fallen branches and leaf litter.
- Reduction of the native ground cover in favour of exotic grasses.
- Loss of nest sites, food sources and foraging sites, such as standing dead timber, logs and coarse woody debris from depletion by grazing, firewood collection and 'tidying up' of rough pasture.
- Predation by over-abundant populations of Pied Currawong (*Strepera graculina*) which are supported by planted exotic berry-producing shrubs; this pressure, is addition to that from other native and exotic predators, may be a potentially severe threat to the breeding success of Scarlet Robin populations.
- Predation by feral cats (*Felis cattus*).
- Dominance of Noisy Miners in woodland patches
- Robbing of nests and predation of fledglings by rats.
- Isolation of patches of habitat, particularly where these patches are smaller than 30 ha, and in landscapes where clearing has been heavy or where remnants are surrounded by cropping or stock grazing.
- Habitat for the Scarlet Robin may become unsuitable if dense regeneration occurs after bushfires or other disturbances (Department of Environment Climate Change and Water 2010b).

9.6 Recovery

No recovery plans have been developed for these species and no priority actions have been identified their recovery to date, however the following are identified in the Threatened species profiles for the Scarlet Robin and Varied Sittella as being necessary for the recovery of the species (Department of Environment Climate Change and Water 2010b):

- Retain existing forest, woodland and remnant grassland vegetation, including paddock trees.
- Retain dead timber on the ground in open forest and woodland areas.
- Enhance potential habitat through regeneration by reducing the intensity and duration of grazing.
- Fence remnants to protect from long-term, intense grazing.
- Increase the size of existing remnants, by planting trees and establishing buffer zones of un-modified, uncultivated pasture around woodland remnants.
- Keep domestic cats indoors at night; desex domestic cats; assess the appropriateness of cat ownership in new subdivisions adjacent to Scarlet Robin habitat.
- Avoid the use of exotic berry-producing shrubs in landscape and garden plantings in areas adjacent to Scarlet Robin habitats.

Threatened species profiles are yet to be produced for the Varied Sitella.

These strategies primarily relate to research, education and policy development and are of limited relevance to the proposal.

Measures designed to minimise clearing of vegetation and fauna habitat and revegetation activities are considered to be consistent with these strategies.

The proposal is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies.

9.7 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 Scarlet Robin usually breeds in forest and woodland, often on ridges and slopes and migrates to more open country outside of the breeding season. The Scarlet Robin species is considered likely to forage in the investigation area outside the breeding season but is considered unlikely to breed there.

The Varied Sittella is a sedentary species which may breed in the locality. 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 (Debus, S. & Soderquist 2008). Substantial occurrences of mature and rough-barked trees are almost exclusively found along the roadways of the investigation area. These areas are subject to noise and disturbance from passing traffic and are considered less likely to be used for nesting than trees located in paddocks in the broader locality. Given the ability of the species to utilise partially cleared habitat, and the relatively large home range of individual birds and family groups, the proposal is unlikely to significantly affect the local southern Sydney population of the species.

Neither of these species are likely to have their life cycles significantly impacted by the proposal.

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:

a) 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

b) 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:

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

b) 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

c) 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

27.4 ha of woodland would be cleared which may be used as a foraging habitat by these species.

The habitat of the investigation area is already fragmented and the additional fragmentation as a result of the proposal is unlikely to alter the value of the remaining habitat for these species in the investigation area.

The foraging habitat that the species would lose is considered to be of only moderate importance to the local occurrence of 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 this species.

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 (refer Section 9.5).

9.8 Conclusion

The Varied Sittella and Scarlet Robin are listed as Vulnerable species under the TSC Act.

These woodland birds are unlikely to be significantly impacted by effects of the proposal on either certified or non-certified areas or of the combined impact in these areas.

The effects of the proposal are considered unlikely to cause a significant impact on these species and hence the preparation of a Species Impact Statement is not required.

Appendix D2

Commonwealth impact assessments

1. Assessment criteria

1.1 Critically endangered and endangered ecological communities

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community.
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.
- Adversely affect habitat critical to the survival of an ecological community.
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to; assisting invasive species, that are harmful to the listed ecological community, to become established, or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.
- Interfere with the recovery of an ecological community (Department of the Environment and Heritage 2006).

1.2 Endangered species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species (Department of the Environment and Heritage 2006).

1.3 Vulnerable species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species.
- Reduce the area of occupancy of an important population.
- Fragment an existing important population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of an important population.
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere substantially with the recovery of the species (Department of the Environment and Heritage 2006).

2. Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest

2.1 Status

Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest is listed as a Critically Endangered ecological community under the EPBC Act and has been identified in the investigation area.

2.2 Description

Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest is listed as a Critically Endangered ecological community under the EPBC Act. Unlike the TSC Act listing of Cumberland Plain Woodland, the EPBC Act listing of Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest excludes very small patches of vegetation (<0.5ha in size) and vegetation patches that do not meet other condition thresholds outlined by the Threatened Species Scientific Committee (2009) (refer Table 4.8 in main body of report).

2.3 Specific impacts

Some patches of vegetation within the investigation area meet the condition thresholds of Category A and C and consequently are considered to form part of the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest Critically Endangered ecological community as listed under the EPBC Act.

The proposal may require the removal of approximately 0.9 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest vegetation and as such, an impact assessment has been completed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment and Heritage 2006) for assessment under the EPBC Act.

2.4 Significance of impacts

Under the EPBC Act, an action is likely to have a significant impact on a critically endangered or endangered community if there is a real chance or possibility that it will result in one or more of the following factors considered below.

Reduce the extent of an ecological community

Development of the Bringelly Road will result in the loss of approximately 0.9 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest within certified lands. The areas of this vegetation affected in the vicinity of the North Avenue intersection are the most intact examples of this vegetation within the investigation area and have been mapped as 'core habitat' in the NPWS conservation significance assessment mapping conservation significance assessment class (NSW National Parks and Wildlife Service 2002b).These patches are considered to be of condition categories A and C described by the Threatened Species Scientific Committee (2009).These areas are likely to contribute significantly to the viability of the community in the locality. Loss of this vegetation is considered to significantly reduce the extent of the community.

Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.

Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest within and surrounding the investigation area consists of relatively small, fragmented patches that are subject to edge effects. Development of the Bringelly road Upgrade will contribute to further fragmentation of high condition patches of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest.

Adversely affect habitat critical to the survival of an ecological community
No critical habitat has been listed for Cumberland Plain Shale Woodlands under the EPBC Act. The habitat within the investigation area is not considered to be critical to the existence of the community.

Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.

The proposal will adversely modify the soil profile in the areas that require clearing of vegetation within the construction footprint. The proposal may also significantly modify abiotic factors such as the soil profile, groundwater levels of surface water drainage patterns necessary to the survival of remaining Cumberland Plain Shale Woodland surrounding the proposal footprint.

Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.

The proposal may result in an adverse change of species composition to the remaining Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest surrounding the site due to fragmentation and associated edge effects such as weed invasion. Routine clearing of vegetation may also be required to protect road users and relocated services such as powerlines. The proposal does not involve actions that would significantly change the existing disturbance regime such as the intensity or frequency of fires, the intensity or frequency floods.

Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to assisting invasive species, that are harmful to the listed ecological community, to become established; or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.

The proposal has potential to result in increases in the establishment, density or diversity of exotic species of plant (weeds). However, weed control will be monitored and managed through the proposal Environmental Management Plan. The proposal does not involve other processes that are likely to reduce the quality or integrity of Cumberland Plain Shale Woodlands other than those described above.

Interfere with the recovery of an ecological community.

A final recovery plan has not been prepared for Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest in accordance with the requirements of the *EPBC Act.*

A draft recovery plan has been prepared for vegetation communities on the Cumberland Plain under the *Threatened Species and Conservation Act 1995* and the EPBC Act (Department of Environment Climate Change and Water 2009). This draft plan includes reference to Cumberland Plain Shale Woodlands. The proposed upgrade will not interfere with the recovery actions identified in this plan.

2.5 Assessment Conclusion

Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest is listed as a Critically Endangered community under the EPBC Act.

The proposal will result in the loss of approximately 0.9 ha of the Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest within certified lands in the investigation area. The community does not occur in non-certified lands. This impact will occur across a small area of a landscape that is already highly modified as a result of past land management practices. The patches of the ecological community that will be cleared although small are considered to be of significance to the survival of the ecological community as a whole. As such, the proposal may result in a significant impact to the Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest.

The impact assessment under the EPBC Act concluded that the proposal is likely to have a significant impact on Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest. Consequently, a referral to SEWPAC would be required for the proposal.

3. Threatened species of animal

An important population of a vulnerable species is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

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

3.1 Grey-headed Flying-fox

3.1.1 Status

The Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act.

3.1.2 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 (Parry-Jones & Augee 1991). 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 (Parry-Jones & Augee 1991).

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 (Eby 1991).

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 (Churchill 2008).

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 (Parry-Jones & Augee 1991; Parry-Jones & Augee 1992; Spencer *et al.* 1991).

3.1.3 Specific impacts

Grey-headed Flying-fox have been previously recorded in the locality and a single individual was recorded flying over the investigation area during field surveys.

The approximately 33.6 ha of woodland affected is likely to be used as a foraging habitat by this species on a seasonal basis when the dominant eucalypt species are flowering heavily.

3.1.4 Significance assessment

Grey-headed Flying-foxes that occur within the subject site would not be considered to be an important population because the site is not at the limit of the species range, habitats within the site are likely to be used a marginal foraging area on a seasonal basis and these habitats or adjacent areas do not contain known breeding camps for this species. As such, the site is not considered to contain an important population.

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

Not applicable.

Would the action reduce the area of occupancy of an important population?

Not applicable.

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

Not applicable.

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

No critical habitat has been listed for this species to date. The land within the subject site is highly fragmented and does not contain significant foraging or breeding habitat for this species of bat. As such this area is unlikely to be critical to the survival of this species.

Would the action disrupt the breeding cycle of an important population?

Not applicable.

Would 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 approximately 33.6 ha of marginal quality, chiefly immature to semi-mature regrowth woodland habitat that would be removed is not considered to be significant habitat for the Grey-headed Flying-fox. This species is highly mobile and forages over a large area on resources that are widely available in the proposal locality.

The action would not result in significant isolation or fragmentation of habitat for this species which is a wide-ranging species capable of foraging in highly fragmented landscapes including urban areas.

The action would not remove significant habitat or result in isolation of habitat. As such, the proposal is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in vulnerable species habitat.

Would the action interfere substantially with the recovery of the species?

The habitat within the subject site is predominantly cleared and disturbed or relatively young regrowth and as such does not provide significant feeding resources for nectivorous animals. Neither the subject site nor surrounding habitats contain known breeding camps for the species. As such, the habitat within the site would not be important to the long-term survival o the Grey-headed Flying-fox.

The action is unlikely to interfere with the recovery of the species.

Conclusion

The Grey-headed Flying Fox is listed as a Vulnerable species under the EPBC Act.

The Grey-headed Flying Fox is unlikely to be significantly impacted by the effects of the proposal on potential habitat in either certified or non-certified areas or of the combined impact in these areas.

A referral is not recommended on the basis of impacts to this species.

3.2 Migratory nectarivorous birds

The following two bird species are Endangered migratory or nomadic nectar-feeding species which are only likely to utilise the investigation area on a seasonal or sporadic basis in response to the flowering of the dominant eucalypt species.

3.2.1 Status

The Swift Parrot and Regent Honeyeater are listed as Endangered species under the EPBC Act.

3.2.2 Swift Parrot

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 coast's 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).

3.2.3 Regent Honeyeater

Occurs mostly in box-ironbark forests and woodland and prefers the 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. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), E. melliodora (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett & Crowley 2000).

Regent Honeyeaters are highly mobile, rarely remaining long in one place unless breeding. Even then, they usually depart as soon as their young are independent. During winter, Regent Honeyeaters disperse widely in small groups. In spring they concentrate into the main breeding areas around Chiltern and Benalla in Victoria and Capertee Valley and Bundarra District in NSW. Other sites regularly visited include Canberra and the Warrumbungles, Mudgee and Gosford areas in New South Wales (Garnett & Crowley 2000).

The species also utilises the woodland communities of the Cumberland Plain.

3.2.4 Specific impacts

The approximately 33.6 ha of woodland affected may be used as a foraging habitat by these species on a seasonal or sporadic basis when the dominant eucalypt species are flowering heavily.

3.2.5 Significance assessment

Would the action lead to a long-term decrease in the size of a population?

The loss of approximate 33.6 ha of largely marginal potential habitat for these species is unlikely to lead to a long-term decrease in the size of a population as this habitat is only likely to be used as a foraging habitat by these species on a sporadic basis when the dominant eucalypt species are flowering heavily.

Would the action reduce the area of occupancy of the species?

The habitat surrounding the subject site is likely to remain available to these species after construction of the proposal and their area of occupancy is unlikely to be significantly impacted.

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

As these species are highly mobile it is unlikely that they would be significantly affected by the additional habitat fragmentation that would occur as a result of the proposal. Any existing population is unlikely to be split.

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

No critical habitat has been listed for this species to date. Potential foraging habitat for these species is likely to be relatively abundant in the locality. The foraging habitat that the species would lose is likely to be of only moderate importance to the local occurrence of these species. As such this area is unlikely to be critical to the survival of the species.

Would the action disrupt the breeding cycle of a population?

The Swift Parrot only breeds in Tasmania. The Regent Honeyeater chiefly breeds in several main breeding areas and is unlikely to breed in the disturbed habitat of the investigation area. No significant impact on the lifecycle of these species is likely to occur as result of the proposal.

Would 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 approximately 33.6 ha of marginal quality, chiefly immature to semi-mature regrowth woodland habitat that would be removed is unlikely to be significant habitat for these species. These species are highly mobile and forage over a large area on resources that are widely available in the proposal locality.

The action would not result in significant isolation or fragmentation of habitat for this species which is a wide-ranging species capable of foraging in highly fragmented landscapes including urban areas.

The action would not remove significant habitat or result in isolation of habitat. As such, the proposal is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful an endangered species becoming established in the endangered species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in the habitat of these species.

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

The action is unlikely to result in disease introduction as it does not involve the movement of animals or other potential bird disease vectors into the area.

Would the action interfere with the recovery of the species?

The habitat within the subject site is predominantly cleared and disturbed or relatively young regrowth and as such does not provide significant feeding resources for nectivorous animals. Neither the subject site nor surrounding habitats contain known foraging habitat for the species. As such, the habitat within the site is not likely to be important to the recovery of the species in the locality.

3.2.6 Conclusion

The Swift Parrot is listed as an Endangered species under the EPBC Act. The Regent Honeyeater is currently listed as an Endangered species under the EPBC Act however a nomination to list the species as Critically Endangered is under consideration.

The Swift Parrot and Regent Honeyeater are unlikely to be significantly impacted by the effects of the proposal on potential habitat in either certified or non-certified areas or in these .

A referral is not recommended on the basis of impacts to these species.

4. Threatened species of plant

4.1 Vulnerable species

4.1.1 *Acacia pubescens*

Acacia pubescens is listed as a Vulnerable species under the EPBC Act.

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 2003b).

4.1.2 Specific impacts

Approximately 0.9 ha of high condition Cumberland Plain Woodland (canopy cover >10%) that is considered to be potential habitat for this species occurs within the subject site. A further 27.3 hectares of poor condition woodland that is considered to be marginal as habitat for this species is also found within the subject site (refer Figure 4.1, Figure 4.2). Of this poor condition habitat, 26 hectares of this marginal quality habitat is located in certified areas with the remaining 1.3 hectares in non-certified lands.

4.1.3 Significance assessment

Acacia pubescens was not recorded within or adjacent to the investigation area however it is possible that it may exist there as a soil-stored seedbank. If present it is likely to occur in low numbers and hence the investigation area is unlikely to contain an important population of this species.

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

Not applicable.

Would the action reduce the area of occupancy of an important population?

Not applicable.

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

Not applicable.

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

No critical habitat has been listed for this species to date. The land within the subject site is highly fragmented and of marginal suitability for the species. As such this area is unlikely to contain significant habitat for this species and unlikely to be important to the survival of this species.

Would the action disrupt the breeding cycle of an important population?

Not applicable.

Would 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 approximately 28.2 ha of largely marginal quality woodland habitat that would be removed is not likely to be significant habitat for the species.

The action would not result in a significant increase in the isolation or fragmentation of habitat for this species in the locality or result in the removal of significant habitat for the species. As such, the proposal is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in this Vulnerable species' habitat.

Would the action interfere substantially with the recovery of the species?

The habitat within the subject site is predominantly cleared and disturbed with moderate to high levels of weed infestation. The subject site does not contain a known occurrence of the species and is unlikely to contain in important population. As such, the habitat within the site would not be important to the long-term survival of *Acacia pubescens* The action is unlikely to interfere with the recovery of the species.

Conclusion

Acacia pubescens is listed as a Vulnerable species under the EPBC Act.

Acacia pubescens is unlikely to be significantly impacted by the effects of the proposal on potential habitat in either certified or non-certified areas or in these areas combined.

A referral is not recommended on the basis of impacts to this species.

4.2 Endangered species

4.2.1 Status

Pimelea spicata and *Cynanchum elegans* are listed as Endangered species under the EPBC Act.

4.2.2 Pimelea spicata

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 2000).

4.2.3 Cynanchum elegans

Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997; NSW National Parks and Wildlife Service 2002a).

4.2.4 Specific impacts

Approximately 0.9 ha of high condition Cumberland Plain Woodland (canopy cover >10%) that is considered to be potential habitat for this species occurs within certified lands within the subject site. A further 27.3 hectares of poor condition woodland that is considered to be marginal as habitat for this species is also found within the subject site (refer Figure 4.1, Figure 4.2). Of this poor condition habitat, 26 hectares of this marginal quality habitat is located in certified areas with the remaining 1.3 hectares in non-certified lands.

4.2.5 Significance assessment

Would the action lead to a long-term decrease in the size of a population?

Neither of these species was recorded within the investigation area however it is possible that individuals of these species may be present in the form of a soil-stored seedbank. If present these individuals are likely to be present in low numbers and to represent a small proportion of any broader population. The potential loss of a small number of individuals would be unlikely to lead to a long term decrease in population size.

Would the action reduce the area of occupancy of the species?

Neither of these species was recorded within the investigation area however it is possible that individuals of these species may be present in the form of a soil-stored seedbank. If present these individuals are likely to occupy a small area representing a small proportion of an area potentially occupied by the species. The potential loss of a small proportion of the potential area of occupancy would be unlikely to lead to a long term significant decrease the species area of occupancy.

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

Neither of these species was recorded within the investigation area however it is possible that individuals of these species may be present in the form of a soil-stored seedbank. As the potential habitat for these species in the investigation area is already highly fragmented, it is unlikely that they would be significantly affected by the additional habitat fragmentation that would occur as a result of the proposal.

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

No critical habitat has been listed for these species to date. Neither of these species was recorded within the investigation area however it is possible that individuals of these species may be present in the form of a soil-stored seedbank. Any such occurrence is however likely to be small and as such this area is unlikely to be critical to the survival of the species.

Would the action disrupt the breeding cycle of a population?

Neither of these species was recorded within the investigation area however it is possible that individuals of these species may be present in the form of a soil-stored seedbank.

The proposal is unlikely to significantly affect processes such as pollination, seed dispersal and recruitment which could affect the breeding of any population in the investigation area.

No significant impact on the breeding cycle of these species is likely to occur as result of the proposal.

Would 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 approximately 28.2 ha of marginal quality, chiefly immature to semi-mature regrowth woodland habitat that would be removed is unlikely to be significant habitat for these species.

The action would not remove significant habitat or result in isolation of habitat. As such, the proposal is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful an endangered species becoming established in the endangered species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in vulnerable species habitat.

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

Mitigation measures provided would minimise the potential for the introduction of plant pathogens into adjacent areas of habitat and the introduction of disease is unlikely.

Would the action interfere with the recovery of the species?

Neither of these species was recorded within the investigation area however it is possible that individuals of these species may be present in the form of a soil-stored seedbank.

It is unknown whether a viable population of any of these species exists within the investigation area. The presence of a substantial population of any of these species with potential for long-term viability is unlikely as these species were not recorded on the site. If present, these species would exist as small, isolated populations.

As such, the habitat within the site is not likely to be important to the recovery of the species in the locality.

4.2.6 Conclusion

Cynanchum elegans and *Pimelea spicata* are listed as Endangered species under the EPBC Act.

Cynanchum elegans and *Pimelea spicata* are unlikely to be significantly impacted by the effects of the proposal on potential habitat in either certified or non-certified areas or in these areas combined

The proposal is unlikely to have significant impact on these Endangered plants and a referral for these species is not recommended.

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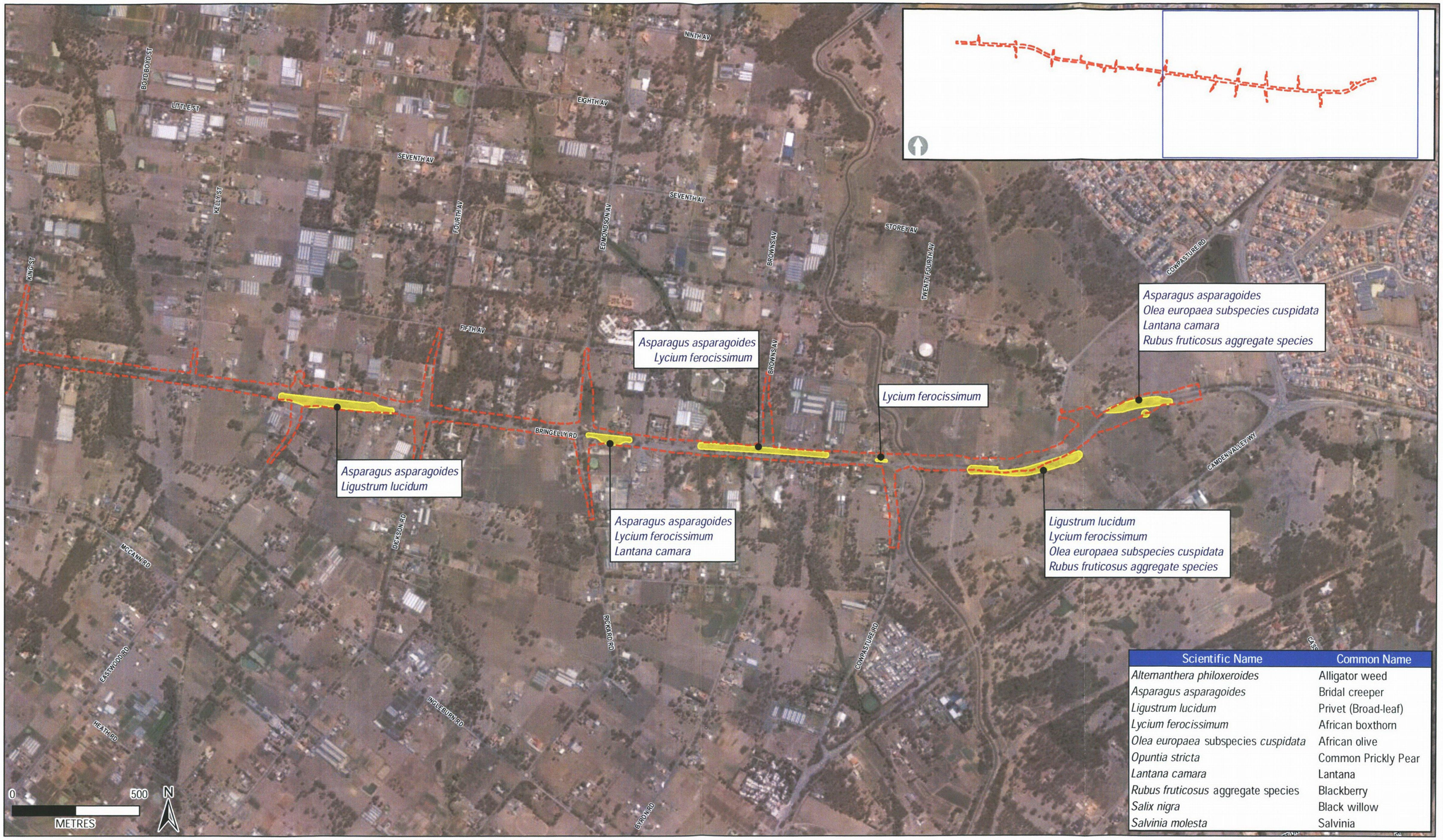
Appendix E

Noxious weed map

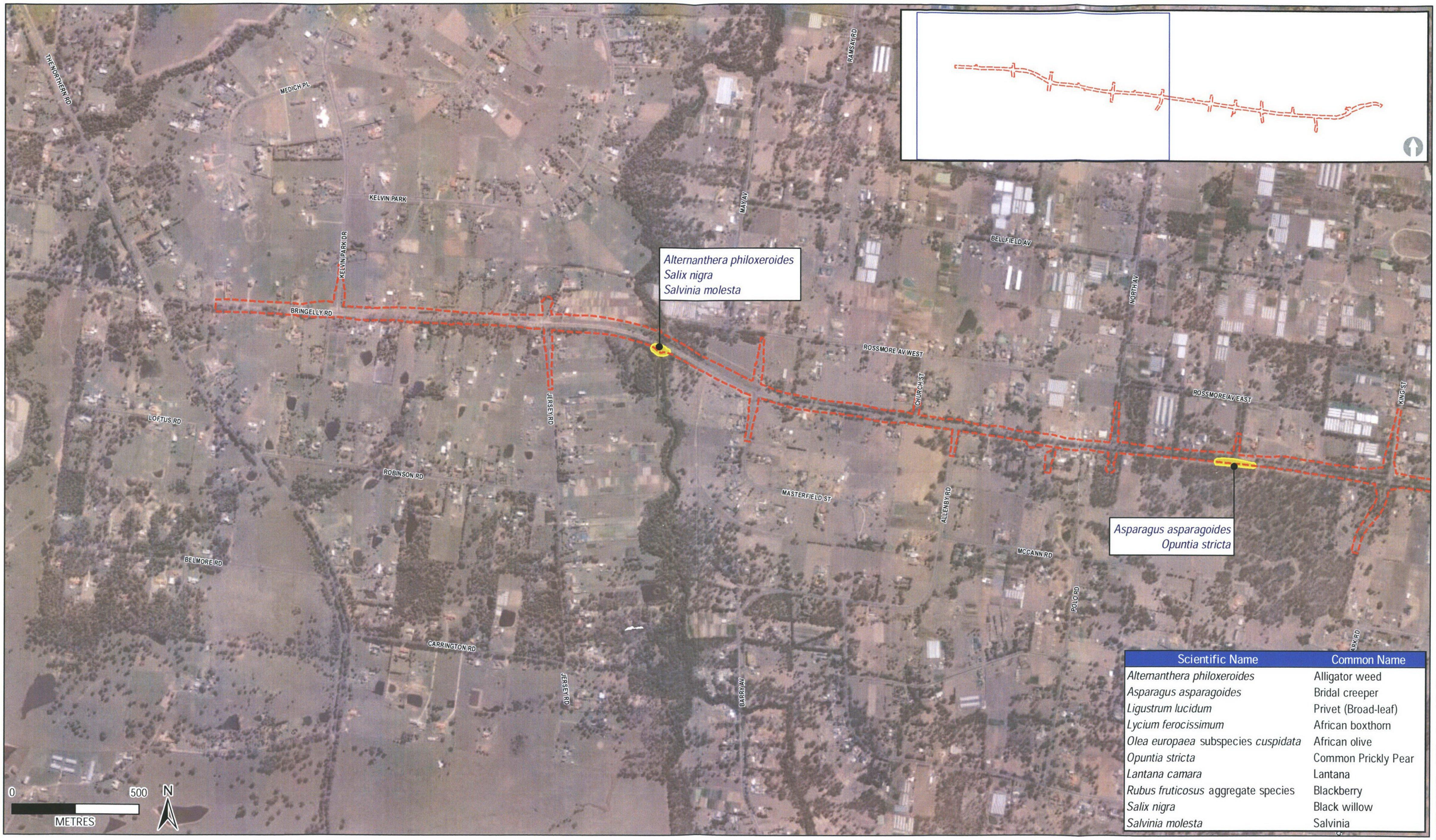


Scientific Name	Common Name
Alternanthera philoxeroides	Alligator weed
Asparagus asparagoides	Bridal creeper
Ligustrum lucidum	Privet (Broad-leaf)
Lycium ferocissimum	African boxthorn
Olea europaea subspecies *cuspidata*	African olive
Opuntia stricta	Common Prickly Pear
Lantana camara	Lantana
Rubus fruticosus aggregate species	Blackberry
Salix nigra	Black willow
Salvinia molesta	Salvinia

Project footprint

Location of noxious weeds

Figure E.1 Locations of noxious weeds
Map 1 / 2



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Project footprint

Location of noxious weeds

Figure E.2 Locations of noxious weeds
Map 2 / 2