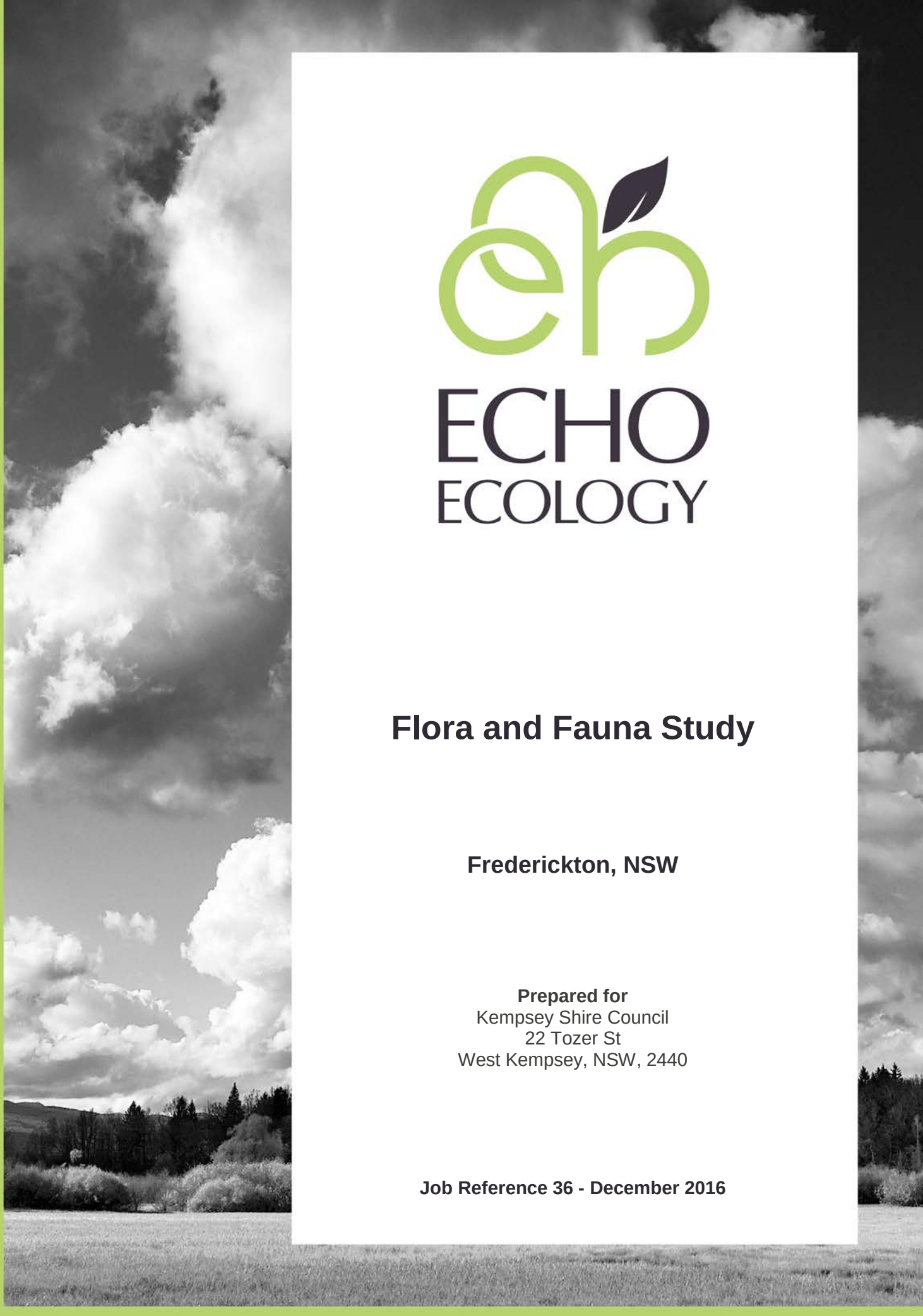

ECHO ECOLOGY

Flora and Fauna Study

Frederickton, NSW

Prepared for
Kempsey Shire Council
22 Tozer St
West Kempsey, NSW, 2440

Job Reference 36 - December 2016

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Certification

As the principal author, I, Anna McConville make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the site;
- Commonwealth, state and local government policies and guidelines formed the basis of project surveying methodology, or where the survey work has been undertaken with specified departures from industry standard guidelines, details of which are discussed and justified in Section 2;
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the *Animal Research Act 1995*, *National Parks and Wildlife Act 1974* and the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*.

Signature of Principal Author and Certifier:

Dr Anna McConville (PhD, B.Env.Sc.)
Ecologist / Director

Executive Summary

Introduction

Echo Ecology Pty Ltd has been engaged by Kempsey Council, hereafter referred to as 'Council', to undertake a flora and fauna survey to inform the future land-use planning of Frederickton, NSW, hereafter referred to as the 'study area' (Figure 1-1). This report provides the findings of a literature review, database searches, field survey and addresses relevant statutory considerations associated with the ecological constraints and opportunities to the future land-use of the study area.

The objectives of this assessment include the following:

- An ecological assessment of the study area with regards to the provisions of the *Threatened Species Conservation Act 1995*, Section 5a of the *Environment Planning and Assessment Act 1979* and the *Environmental Protection and Biodiversity Act 1979*. The survey and assessment is to be carried out in consideration of the draft *Threatened Species Survey and Assessment – Guidelines for Developments and Activities* (DEC 2004) and the *Threatened Species Assessment Guidelines – Assessment of Significance* (DECC 2007).
- An assessment of the study area identifying areas of significant habitat and any Endangered Ecological Communities. The study is also to identify any possible habitat corridor linkages and connectivity over the study area.
- An assessment of compliance with the Kempsey Shire Council Comprehensive Koala Plan of Management is to be undertaken.
- An assessment of the impacts on any remnant habitat and surrounding habitat and EECs from the proposed re-zoning and future development of the proposed development areas
- Identify any possible biodiversity offsets that may be required or koala habitat offsets that may be required to achieve compliance with the Kempsey Shire Council Comprehensive Koala Plan of Management (KSC 2011).

Methods

In order to determine the ecological constraints and opportunities to future urban expansion within the study area, we combined a literature review and database searches with field surveys and habitat assessment.

We undertook the following survey methods within the study area:

- Hollow-bearing tree survey and assessment;
- Flora survey
  - Flora survey (quadrats, random meander);
  - Vegetation community mapping;
- Habitat assessment
- Fauna survey
  - Diurnal bird survey;
  - Nocturnal

        - Call playback
        - Spotlighting
        - Stagwatching
    - Trapping
        - Terrestrial Elliott A
        - Arboreal Elliott B
        - Cage
        - Camera
    - Ultrasonic recording (bats);
    - Acoustic recording (owls, vocal mammals);
    - Koala scat searches (SAT plots); and
    - Grass owl nest searches.

Results

Hollow-bearing tree survey

A total of 82 hollow-bearing trees (HBTs) were recorded within the subject site as shown in Figure 3-4. A total of four large (> 20 cm), 19 medium (10 - 20 cm), 18 small (5 - 10 cm) and 14 tiny (3 - 5 cm) hollows were recorded within the study area. Of the 82 HBTs recorded within the study area, eight (9.8 %) had fire scars, 42 (51.2 %) had termitaria, 30 (36.6 %) were stags (dead standing trees) and 30 (36.6 %) had cracks.

Vegetation Communities

The vegetation communities recorded within the study area were:

1. Spotted Gum - Grey Ironbark open forest;
2. Tallowwood - Small-fruited Grey Gum open forest;
3. Blackbutt - Tallowwood open forest;
4. Blackbutt - Pink Bloodwood open forest;
5. Swamp Oak forest;
6. Paperbark swamp forest;
7. *Juncus* rushland / *Polygonum* forbland;

Endangered Ecological Communities

The following EECs were detected in the study area:

- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Threatened Flora Species

Threatened flora species considered likely to occur (moderate or greater chance) or recorded (in **bold**) within the study area are:

- *Maundia triglochinoides*;

- ***Persicaria elatior*** **(Knotweed);**

Fauna

A total of five amphibian, 66 bird, 24 mammal and two reptile species were recorded within the study area during surveys.

Threatened Fauna Species

Threatened fauna species considered likely to occur (moderate or greater chance) or recorded (in **bold**) within the study area are:

- *Litoria brevipalmata* (Green-thighed Frog);
- *Ephippiorhynchus asiaticus* (Black-necked Stork);
- *Botaurus poiciloptilus* (Australasian Bittern);
- *Lophoictinia isura* (Square-tailed Kite);
- *Pandion cristatus* (Eastern Osprey);
- *Irediparra gallinacea* (Comb-crested Jacana);
- *Rostratula australis* (Australian Painted Snipe);
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Lathamus discolor* (Swift Parrot);
- ***Ninox strenua*** **(Powerful Owl);**
- *Tyto novaehollandiae* (Masked Owl);
- *Tyto longimembris* (Eastern Grass Owl);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Dasyurus maculatus* (Spotted-tailed Quoll);
- *Phascogale tapoatafa* (Brush-tailed Phascogale);
- *Phascolarctos cinereus* (Koala);
- *Petaurus australis* (Yellow-bellied Glider);
- ***Petaurus norfolcensis*** **(Squirrel Glider);**
- ***Mormopterus norfolkensis*** **(East Coast Freetail-bat);**
- *Chalinolobus nigrogriseus* (Hoary Wattled Bat);
- ***Miniopterus australis*** **(Little Bentwing-bat);**
- ***Miniopterus schreibersii oceanensis*** **(Eastern Bentwing-bat);**
- *Myotis macropus* (Southern Myotis);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);
- ***Pteropus poliocephalus*** **(Grey-headed Flying-fox).**

Ecological Constraints Mapping

We combined the potential ecological constraints with areas that may benefit from ecological enhancement to identify opportunities for future urban expansion.

The ecological constraints mapping included the following classifications:

- Riparian buffers;
- Corridor and enhancement areas;
- Hollow-bearing trees and buffers;

- Endangered Ecological Communities;
- Moderate conservation value vegetation; and
- Low conservation value vegetation.

Potential Impacts

The key direct impacts associated with increased urbanisation within the study area is clearing and modification of native vegetation and the loss of hollow-bearing trees. The following vegetation will be removed or modified as a result of the rezoning proposal:

- R1 Residential - 1.64 ha
- R5 Rural Residential - 48.27 ha
- IN1 Industrial - 9.02 ha

Potential indirect impacts include:

- Increased habitat fragmentation and edge effects;
- Competition and predation by exotic animals and domestic pets;
- Competition from urban-adapted fauna species;
- Street light pollution;
- Weed invasion;
- Decreased water quality and alteration to hydrology;
- Road mortality;
- Disease transmission;
- Altered fire frequency; and
- Contribution to climate change.

Cumulative impacts from urbanisation in the local area and region may also occur.

Recommendations

Housing density

- Consider meeting housing needs with standard R1 Residential zones, rather than large R5 Rural Residential zones that have a larger ecological footprint;

Water quality and hydrology

- Potential impacts on water quality and hydrology arising from the rezoning proposals need to be carefully considered with strict mitigation measures put in place to minimise potential impacts to this receiving environment.

Riparian buffers

- For final riparian buffers, use a qualified surveyor to accurately locate the top of bank.

EEC buffers and Candidate EEC areas

- Revise EEC buffers as appropriate, particularly in the southern parts of the study area (area mapped as Candidate EEC Unsurveyed) following any detailed vegetation surveys of the floodplain.

Corridors

- Dedicated biodiversity corridors should not remain in private property to ensure enhancement works are appropriate and to minimise fauna mortality from domestic pets.
- Corridors should be managed under a Vegetation Management Plan to oversee revegetation and weed control
- Consider installing a street tree corridor along Raymond's Lane to facilitate bird and arboreal mammal movement east-west.
- If services or infrastructure cannot be located outside of a riparian corridor, then they should be located within a disturbed area of the riparian corridor and positioned to avoid sensitive ecological features. The advice of an appropriately qualified ecologist should be sought to guide this.

Further targeted surveys

- Microbat survey (harp trapping and bat detector) - Spring / Summer

Conclusion

In its current form, without the provision of any conservation zonings, habitat retention proposals or the provision of compensatory habitat (offsets), we have found that the R5 Rural Residential and IN1 Industrial rezoning areas are likely to have a significant impact on two threatened arboreal mammal species and three threatened hollow-dependent microbat species listed under the *Threatened Species Conservation Act 1995*. We recommend the preparation of a Species Impact Statement to further investigate these potential impacts and / or the redesign of the proposal to incorporate these ecological constraints.

Abbreviations and Definitions

EEC endangered ecological community

EPBC Act Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

FWW Freshwater Wetlands EEC

GIS geographic information system

Kempsey CKPoM The Kempsey Comprehensive Koala Plan of Management (Kempsey Shire Council 2011)

KTP key threatening process listed under NSW *Threatened Species Conservation Act 1995*

NPWS NSW National Parks and Wildlife Service

NV Act NSW *Native Vegetation Act 2003*

OEH NSW Office of Environment and Heritage

SEPP NSW State Environmental Planning Policy

sp. species (singular)

spp. species (plural)

subsp. subspecies

SOFF Swamp Oak Floodplain Forest EEC

SSF Swamp Sclerophyll Forest EEC

threatened a term used to describe a species, population or community listed under the *NSW Threatened Species Conservation Act 1995* and / or *Commonwealth Environment Protection Biodiversity Conservation Act 1999*

TSC Act NSW *Threatened Species Conservation Act 1995*

Definitions

Direct impacts those that directly affect the habitat, individual plants and animals.

Indirect impacts those that affect species, populations or ecological communities in a manner other than through direct loss or disturbance. These can usually be avoided or mitigated.

Local population
As defined under the TSC Act, a local population is "the population that occurs in the study area". The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions:

- The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.
- The local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
- The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time.

In cases where multiple populations occur in the study area, each population should be assessed separately.

Locality the area within a 10 km x 10 km square centred of the study area (Figure 1-1)

Study area is the broader Frederickton area that was assessed (Figure 1-1)

Subject site is the areas investigated for rezoning (R1, IN1 and R5) as shown in (Figure 1-1)

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1.0 INTRODUCTION

Echo Ecology Pty Ltd has been engaged by Kempsey Council, hereafter referred to as 'Council', to undertake a flora and fauna survey to inform the future land-use planning of Frederickton, NSW, hereafter referred to as the 'study area' (Figure 1-1). This report provides the findings of a literature review, database searches, field survey and addresses relevant statutory considerations associated with the ecological constraints and opportunities to the future land-use of the study area.

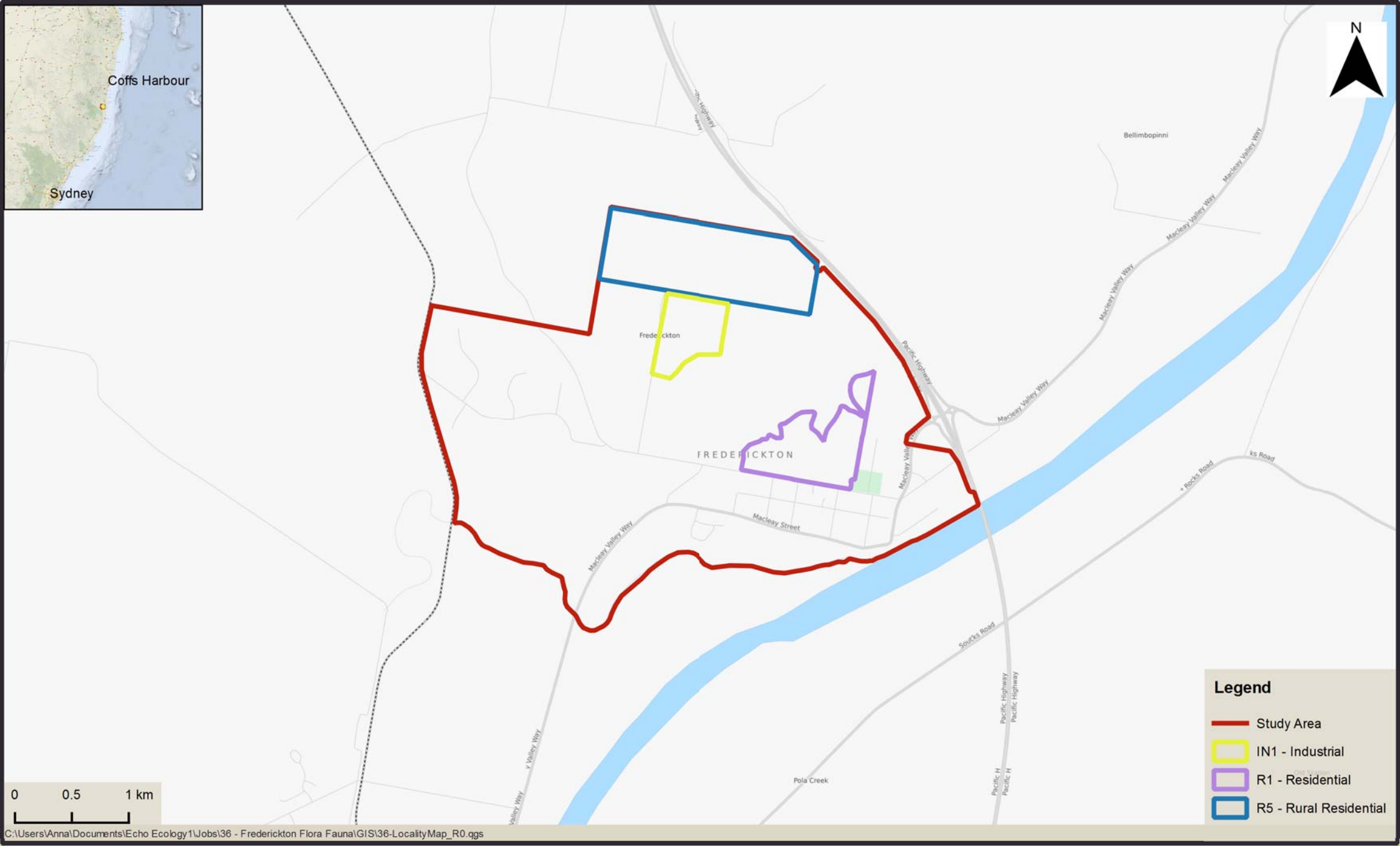
1.1 Study Area

The study area is shown in Figure 1-1 and relevant study area details are provided in Table 1-1.

Table 1-1: Study area description

Item	Description
Locality	Frederickton, NSW
Local Government Area	Kempsey
Address	Various lots across Frederickton
Area	Study Area - 812.5 ha Subject Site (rezoning areas): IN1 Industrial - 24.4 ha R5 Rural Residential - 85.4 ha R1 Residential - 39.6 ha
Boundaries	The site is bounded to the east by the new Pacific Highway, to the south by Christmas Creek. Large patches of remnant vegetation form much of the northern and western boundary of the study area.
Current Land-use	The study area contains agricultural land (mostly grazing), undeveloped bushland, rural residential land-uses and the village of Frederickton.
Soils	The residual Kundabung soil landscape occurs across most of the study area, with smaller areas of the erosional Euroka soil landscape occurring adjacent (Atkinson 1999). Alluvial soil landscapes occur central drainage line and along the Macleay River and Christmas Creek floodplains.

Item	Description
Topography	The study area is gently undulating falling away to the Macleay River and Christmas Creek floodplains in the south of the study area. A smaller low-lying drainage line also occurs through the central portion of the study area.
Vegetation	The study area contains a mosaic of remnant native vegetation, retained canopy species over a maintained understorey and heavily cleared pastures used for grazing. Remnant dry forest and riparian native vegetation patches with understorey present occur as bush patches in the central portion of the study area.



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Frederickton Flora and Fauna Survey

Client: Kempsey Shire Council

Job No. 36

Rev. 0

Date 23 December 2016

SOURCE
Aerial Photo - Google Earth Pro
© 2013 Onew Spot Image, DigitalGlobe
Sinclair Knight Menz

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GPS locations recorded at > 5 m accuracy

Figure 1-1
Locality Map

1.1.1 Soil Landscapes

The residual Kundabung soil landscape occurs across most of the study area, with smaller areas of the erosional Euroka soil landscape occurring adjacent (Atkinson 1999). Small areas of the Cairncross transferral soil landscape occur in the north and central parts of the study area. The alluvial Christmas Creek soil landscape occurs along the central creekline and adjacent to Christmas Creek in the south-west of the study area. Other alluvial soil landscapes also occur along the Macleay floodplain including the Maria River, Austral Eden and Gladstone Eden soil landscapes. Soil landscapes within the study area have been mapped at 1:100,000 scale (Atkinson 1999) and they are shown in Figure 1-2.

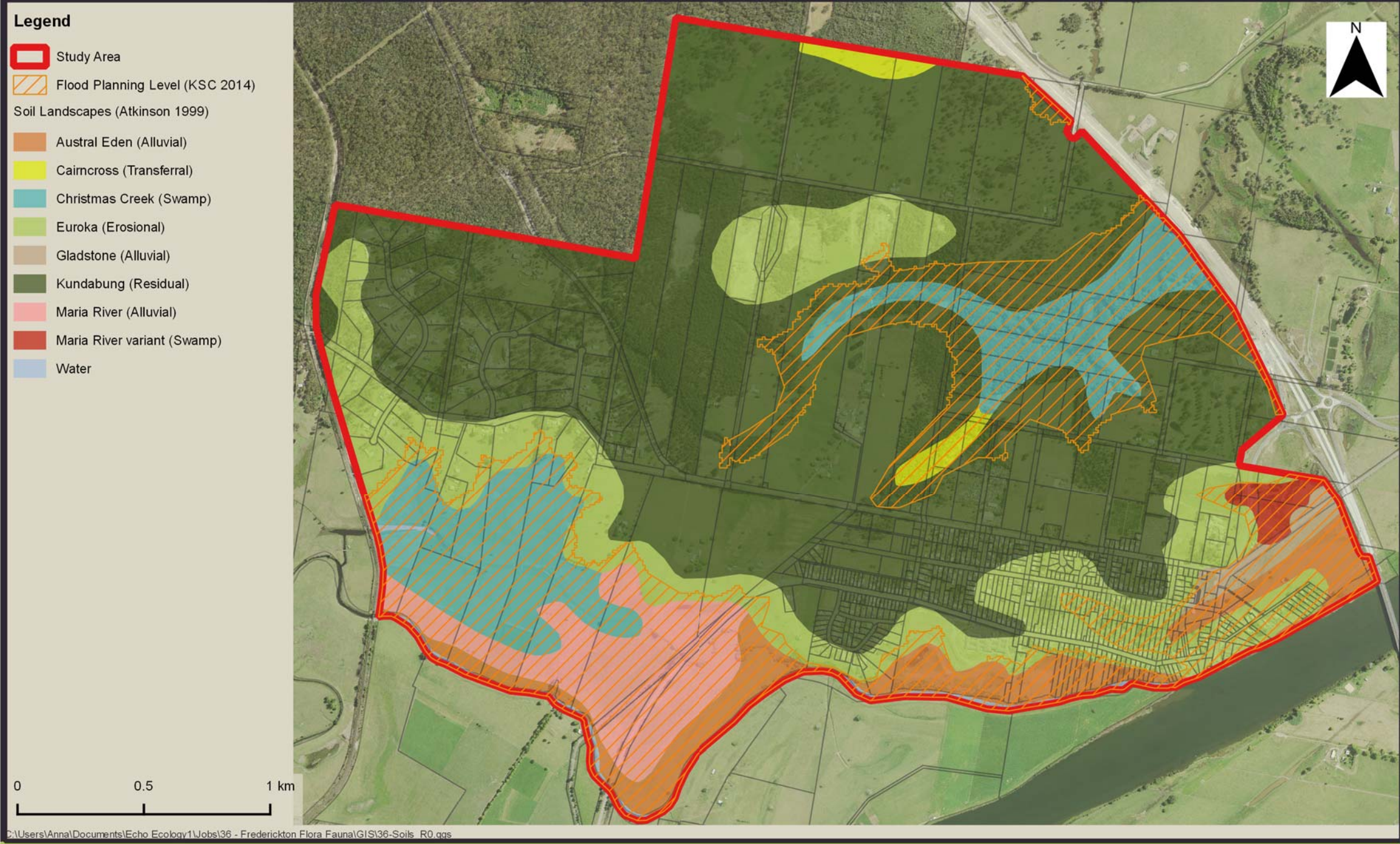
1.1.2 Geology

As shown in Figure 1-3, the study area is mapped at 1:100,000 scale as being underlain by mostly bedrock, being Carboniferous and Permian sedimentary geology (including coal measures) and minor volcanic rocks (Hashimoto and Troedson 2007). There is an area of alluvial geology along the central drainage line that has been mapped as Quaternary valley fill (silt, clay, fluvial sand and gravel) and Holocene backswamp (organic mud, peat, silt, clay) (Hashimoto and Troedson 2007). A small area of Quaternary alluvial and colluvial fan (silt, clay, fluvial sand, gravel) occurs to the north of Raymond's lane.

In the south of the study area along the Macleay River and Christmas Creek floodplain there is a large area mapped as Holocene levee (fluvial sand, silt, clay), with smaller areas of Holocene alluvial palaeochannel fill and inter-levee swale (organic mud, peat, clay, silt, fluvial sand) and Holocene backswamp (organic mud, peat, silt, clay) (Figure 1-3).

1.1.3 Flood Mapping

The study area is within the Macleay River catchment and the flood level supplied by Council, based on in-house knowledge of historic flood events, historic flood height data, LiDAR data and flood model data for the study area is shown in Figure 1-2.



Frederickton Flora and Fauna Study

Client: Kempsey Shire Council

Job No. 36

Rev. 0

Date 15 September 2016

Aerial Photo - © Land and Property Information (2016)
Cadastre & Study Area Boundaries -© Kempsey Shire Council (2016)
Soils - Atkinson, G. (1999) Soil Landscapes of the Kempsey-Korogoro Point 1:100,000 map

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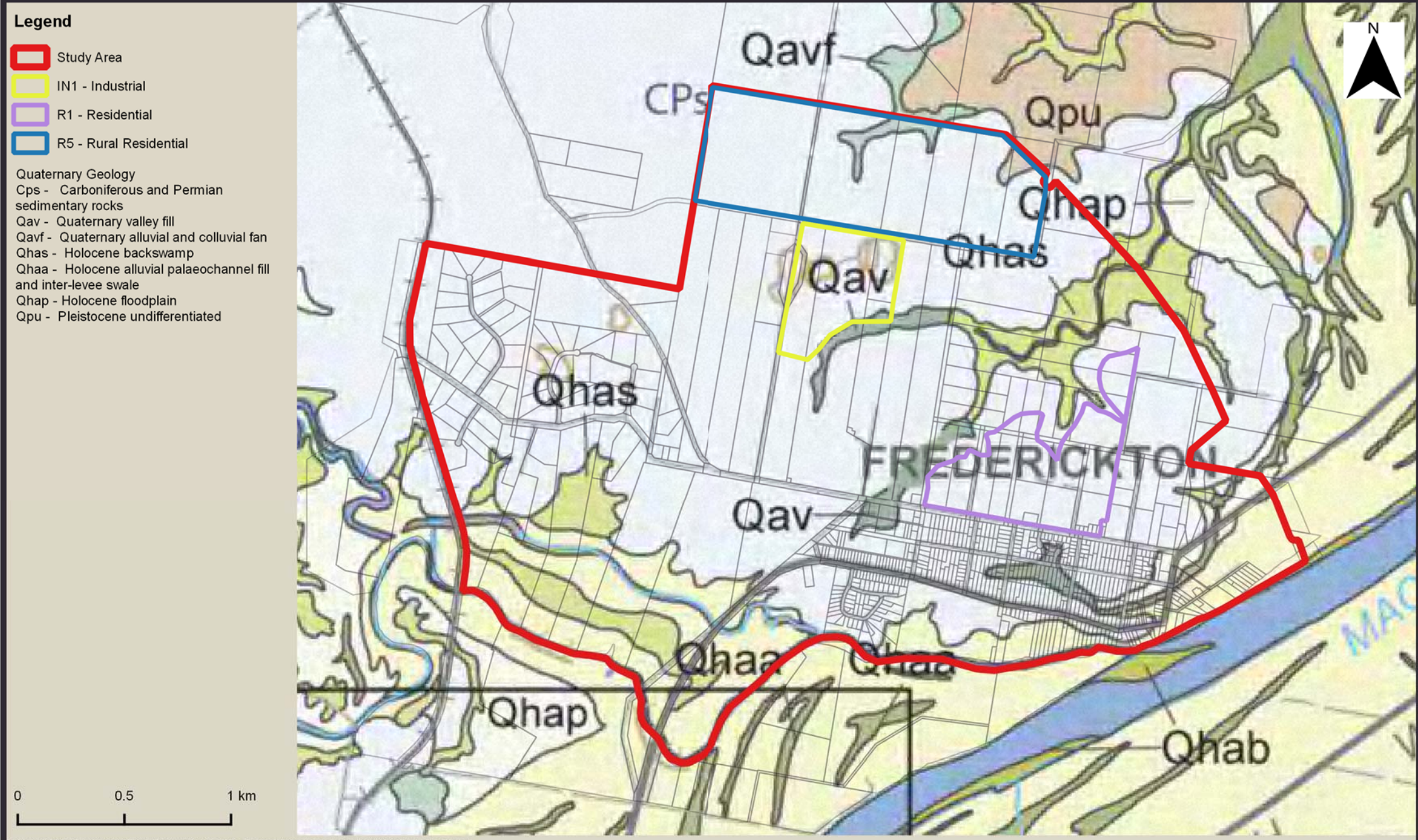
Figure 1-2
Soil Landscapes



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Rev. 0

Date 15 September 2016

Aerial Photo - © Land and Property Information (2016)
Cadastre & Study Area Boundaries - © Kempsey Shire Council (2016)
Geology - Hashimoto, T. R. and A. L. Troedson (2007). Kempsey 1:100 000 and 1:25 000, Coastal Quaternary Geology Map Series. Geological Survey of NSW, Maitland.

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Figure 1-3
Quaternary Geology

1.2 Description of the Proposal

Council is currently undertaking a review of the land use zones in an area centred on the Frederickton village. Three new rezoning areas are being considered: R1 Residential, R5 Rural Residential; and IN1 Industrial. Initial investigations have revealed the presence of significant stands of remnant native vegetation and areas of permanent or semi-permanent wetlands in various stages of modification and/or condition.

1.3 Scope of the Study

The objectives of this assessment include the following:

- An ecological assessment of the study area with regards to the provisions of the *Threatened Species Conservation Act 1995*, Section 5a of the *Environment Planning and Assessment Act 1979* and the *Environmental Protection and Biodiversity Act 1979*. The survey and assessment is to be carried out in consideration of the draft *Threatened Species Survey and Assessment – Guidelines for Developments and Activities* (DEC 2004) and the *Threatened Species Assessment Guidelines – Assessment of Significance* (DECC 2007).
- An assessment of the study area identifying areas of significant habitat and any Endangered Ecological Communities. The study is also to identify any possible habitat corridor linkages and connectivity over the study area.
- An assessment of compliance with the Kempsey Shire Council Comprehensive Koala Plan of Management is to be undertaken.
- An assessment of the impacts on any remnant habitat and surrounding habitat and EECs from the proposed re-zoning and future development of the proposed development areas
- Identify any possible biodiversity offsets that may be required or koala habitat offsets that may be required to achieve compliance with the Kempsey Shire Council Comprehensive Koala Plan of Management (KSC 2011).

1.4 Legislative Context

1.4.1 Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act 1999

The main Commonwealth environmental law is the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the EPBC Act any action that is likely to have a significant impact on a matter of national environmental significance or Commonwealth land is required to be referred to the Federal Environment Minister and may be designated as a 'controlled action'. Controlled actions require approval of the minister.

Matters of national environmental significance under the EPBC Act include:

- World Heritage sites;
- National Heritage places;
- Nationally protected wetlands (Ramsar wetlands);
- Nationally listed threatened species and ecological communities;
- Listed migratory species;
- Nuclear actions (including uranium mines);
- Commonwealth marine areas;
- Land owned by the Commonwealth; and
- Activities by Commonwealth agencies.

Some exemptions apply to the requirement for approval under the EPBC Act, including:

- Prior authorisation and continuing use exemptions;
- Approved bilateral agreements between the Commonwealth and the States;
- Ministerial declarations;
- Regional forest agreements; and
- *Great Barrier Reef Marine Park Act 1975*.

NSW bilateral agreement

Controlled actions which take place in NSW and which are assessed in the manner specified by the bilateral agreement do not require assessment under the EPBC Act.

1.4.2 NSW Legislation

Environmental Planning and Assessment Act 1979

The principal planning legislation in NSW is the *Environmental Planning and Assessment Act 1979* (EP&A Act). It provides a framework for the overall environmental planning and assessment of development proposals and requires consideration be given to the potential impacts of development proposals on biodiversity. Clause 5A of the EP&A Act provides an outline of the ecological matters that must 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.

Threatened Species Conservation Act 1995

The NSW *Threatened Species Conservation Act 1995* (TSC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The TSC Act is integrated with the EP&A Act and requires consideration of whether a development (Part 4 of the EP&A Act) or an activity (Part 5 of the EP&A Act) is likely to significantly affect threatened species, populations and ecological communities or their habitat.

The potential impact of proposals on threatened species, populations or communities listed under the TSC Act is assessed under Section 5A of the EP&A Act, the assessment of significance (also known as the 'seven-part test'). If the impacts are found to be

'significant', a Species Impact Statement (SIS) and concurrence from the Director General of the Office of Environment and Heritage (OEH) is required.

Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act) aims to conserve and manage native vegetation through regulation of native vegetation clearing in non-urban areas. The clearing of native vegetation (other than regrowth) in certain areas and for certain purposes requires consent under the NV Act, with Local Land Services being the consent authority.

Under section 6 the NV Act, 'native vegetation' is defined as:

- trees (including any sapling or shrub, or any scrub);
- understorey plants;
- groundcover (being any type of herbaceous vegetation); and
- plants occurring in a wetland.

Vegetation is indigenous if it is of a species of vegetation, or if it comprises species of vegetation, that existed in NSW before European settlement. For the purposes of the NV Act, native vegetation does not include any mangroves, seagrasses or any other type of marine vegetation to which section 205 of the *Fisheries Management Act 1994* applies.

The NV Act does not apply to the following land:

- the land described or referred to in Part 1 of Schedule 1 (National park estate and other conservation areas);
- the land described or referred to in Part 2 of Schedule 1 (State forestry land);
- the land described or referred to in Part 3 of Schedule 1 (Urban areas); and
- biodiversity certified land (within the meaning of Part 7AA of the TSC Act).

Clearing of native vegetation may be undertaken, if the following apply:

- a development consent has been granted in accordance with the NV Act;
- a Property Vegetation Plan (PVP) has been prepared for the site;
- the activity is classified as a Routine Agricultural Management Activity (RAMA) pursuant to S11 of the NV Act;
- the clearing is of regrowth vegetation, which is defined as native vegetation that has regrown since the earlier of the following dates:
    - 1 January 1983 in the case of land in the Western Division and 1 January 1990 in the case of other land; or
    - the date specified in a PVP for the purposes of this definition (in exceptional circumstances being a date based on existing rotational farming practices).

It should be noted that regrowth vegetation does not include any native vegetation that has regrown following unlawful clearing of remnant native vegetation or following clearing of remnant native vegetation caused by bushfire, flood, drought or other natural cause.

Water Management Act 2000

Controlled activities carried out in, on or under waterfront land and riparian corridors are regulated by the Water Management Act 2000 (WM Act). A controlled activity approval may be required from the NSW Government if works are undertaken within waterfront land or riparian corridors. The WM Act recommends Vegetated Riparian Zones for all watercourses, with the width depending on the Strahler System of ordering watercourses. Vegetated Riparian Zones are measured from the top of the highest bank on both sides of the watercourse. The recommended riparian corridor widths are outlined in Table 1-2 below.

Table 1-2: Water Management Act Riparian Corridor Widths

Watercourse type	Vegetated Riparian Zone width (each side of watercourse)	Total Riparian Corridor width
1st order	10 m	20 m + channel width
2nd order	20 m	40 m + channel width
3rd order	30 m	60 m + channel width
4th order and greater	40 m	80 m + channel width

State Environmental Planning Policy No. 14 - Coastal Wetlands

The *State Environmental Planning Policy No. 14 – Coastal Wetlands* (SEPP 14) aims to ensure that coastal wetlands are preserved and protected. Under SEPP 14, a person must not clear land, construct a levee, drain land or fill land which is covered by SEPP 14 (or within 100 m) except with the consent of the local council and the concurrence (agreement) of the Director-General of Planning. A copy of all development applications for such activities must also be forwarded by the local council to the Director of National Parks and Wildlife within 7 days.

On review of the SEPP 14 spatial data layer, we found that the Macleay River to the south-east of the study area is an estuarine wetland under SEPP 14.

State Environmental Planning Policy No. 26 - Littoral Rainforest

The *State Environmental Planning Policy No. 26 – Littoral Rainforest* (SEPP 26) provides a mechanism for the preservation of littoral rainforest in a natural state. Under SEPP 26, proposals require development consent from Council to use a littoral rainforest (or within 100m) for any purpose, except for:

- ordinary course of residential occupation of the land;
- controlling native flora declared to be noxious under the Noxious Weeds Act 1993; and
- removal of leaf litter, shed bark or cured grasses for the purpose of reducing the risk of bushfire.

Activities under SEPP 26 are deemed to be designated development, which means the development application must be accompanied by an environmental impact statement and be placed on public exhibition for public comment. The local council remains the consent authority for developments applying to SEPP 26 littoral rainforests and the concurrence (agreement) of the Director-General of the Department of Planning is also required.

The study area is not in close proximity to the coast, no littoral rainforests were found to be present within or adjacent to the study area during vegetation survey.

State Environmental Planning Policy No. 44 - Koala Habitat Protection

The *State Environmental Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) applies to all LGAs listed on Schedule 2 of the policy, except land dedicated under the *National Parks and Wildlife Act 1974* or the *Forestry Act 1916*. Potential Koala Habitat is defined as areas where koala feed tree species listed under Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. An area of land to which the policy applies must be at least one hectare in area (includes the total area of adjoining land in the same ownership). If potential koala habitat is present then it must be further assessed to determine whether it represents core koala habitat. Core Koala habitat is defined as 'an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'. The policy requires the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, encourages the identification of areas of core koala habitat, and encourages the inclusion of areas of core koala habitat in environment protection zones.

The Kempsey Comprehensive Koala Plan of Management (Kempsey CKPoM) was prepared in 2011 in accordance with SEPP 44. The Kempsey CKPoM removes the need for each new development to prepare an individual Koala Plan of Management under SEPP 44.

The primary aims of the Kempsey CKPoM are to ensure to the maximum extent possible that the extent of habitat currently being occupied by koalas is not reduced further on land to which the plan can be effectively applied, and that processes currently working to limit an increase in occupancy rate and/or population size are mitigated. These tasks are reflected by way of the following objectives:

i. Minimising the potential for adverse impact within current and future areas of core koala habitat;
ii. Ensuring that preferred koala food trees are effectively managed and conserved across all land to which the plan can be effectively applied;
iii. Establishment of a number of KMAs over some of the land to which the plan applies, within which the management of koalas and their habitat is a primary focus; and

iv. Ensuring that all future koala habitat assessments undertaken on land to which the plan applies are done to a minimum standard and assessment criteria as determined by Council so as to best inform future planning decisions.

As the study area occurs within the Kempsey CKPoM management area, it applies to the proposal and its provisions have been considered throughout this report.

1.5 Scientific Licensing and Ethics

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence SL101055 (Valid 30 November 2016);
- Animal Research Authority (Trim File No: 1294891) issued by NSW Agriculture (Valid 8 October 2016); and
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 12/4801) issued by NSW Agriculture (Valid 8 October 2016).

2.0 METHODS

2.1 Literature and Database Review

The literature review included the following information sources:

- OEH Atlas of NSW Wildlife (http://www.bionet.nsw.gov.au) - 10 km search centred on the study area, accessed 14 June and 13 July 2016;
- EPBC Act Protected Matters Search (http://www.environment.gov.au/epbc/) - 10 km buffer search, accessed 13 and 30 July 2016;
- OEH Threatened Species Profile Database (http://www.threatenedspecies.environment.nsw.gov.au/tsprofile);
- Threatened species recovery or threat abatement plans (http://www.environment.nsw.gov.au/threatenedspecies/).
- Existing vegetation mapping was reviewed to develop a draft vegetation map and was used as a basis for the development of a final vegetation map of the study area including:
    a) GHD (2007). Report for Vegetation Mapping for Western Portion Kempsey LGA, for Kempsey Shire Council
    b) Telfer, D. and P. Kendall (2006). Native Vegetation and Candidate Endangered Ecological Community Mapping Report: Kempsey LGA East, for Kempsey Shire Council .
- Kempsey Comprehensive Koala Plan of Management and Koala habitat mapping

a) Kempsey Shire Council (2011). Comprehensive Koala Plan of Management for Eastern Portion of Kempsey Shire LGA Volume 1 Working Provisions, Kempsey Shire Council.
b) Biolink (2009). Comprehensive Koala Plan of Management for Eastern Portion of Kempsey Shire LGA Volume II - Resource Study.

- Previous ecological assessment reports undertaken within the study area:
    a) Parsons Brinckerhoff (2006). Project Application Report Supporting Information Ecological Assessment: Kempsey to Eungai Upgrading the Pacific Highway. Sydney, NSW, for NSW Roads and Traffic Authority.
- Aerial photography
    a) 2014 30cm aerial imagery (Land and Property Information, supplied by Council);
    b) Spatial Information Exchange (https://maps.six.nsw.gov.au/)
    c) Google Earth Pro
- Nectar resources mapping and methodology (Eby and Law 2008)

The literature and database review was used to create a list of potentially occurring threatened flora, fauna and ecological communities (Appendix E).

2.2 Hollow-bearing Tree Survey and Assessment

2.2.1 Detailed hollow-bearing tree survey (subject site)

All trees within the subject site (potential rezoning areas) were visually assessed from the ground to determine whether hollows that may be used by native fauna were present. We defined a hollow as a hole, gap or crack that appears to form a cavity that a vertebrate animal may shelter in. This can be quite small. But as numerous tiny microbats listed as threatened under TSC Act are hollow-dependent, these small hollows are still valuable. Trees with termitaria, a termite mound located on the trunk or branches of a tree, were also included in our definition of a hollow-bearing tree regardless of whether any other hollows were visible.

We also collected the following information to describe the characteristics of each hollow-bearing tree:

- Tree species
- Diameter at breast height
- GPS coordinates
- Tree status (alive or dead)
- Number of hollows
- Hollow location
    a) fire scar (basal trunk hollow)
    b) trunk
    c) large branch (> 20 cm diameter)
    d) medium branch (10 - 20 cm diameter)

e) small branch (5 - 10 cm diameter)

- Hollow-size
    a) large (> 20 cm diameter)
    b) medium (10 - 20 cm diameter)
    c) small (5 - 10 cm diameter)
    d) tiny (3 - 5 cm diameter)
    e) cracks
- Termitaria - termite mound on the trunk or branches

We searched the entire subject site for hollow-bearing trees. Tree locations were recorded with a hand-held GPS and trees were tagged with small numbered aluminium tags that were placed on the north-facing side of the trunk (as far as possible).

2.2.2 Growth stage hollow classification (study area)

While the detailed hollow-bearing tree survey was limited to the subject site, we also collected information to inform tree hollow density across the remainder of the study area during the flora survey. The observed range of growth stages of trees within vegetation communities was used as a surrogate for tree hollow occurrence to help understand the likely distribution of hollows across the broader study area.

The commencement of formation of tree hollows in eucalypts and ecologically similar trees typically commences at the end of the mature growth phase, which is marked by the loss of major lower limbs. Hollows are initially small and infrequent, but become more frequent throughout the late mature growth stage and the formation of larger hollows then proceeds via termites, fire and decay (Jacobs 1955, RACAC 1996).

Where hollows are mapped as ‘small’ they are typically infrequent; where they are mapped as ‘large and small’ large hollows are typically infrequent but small hollows are more common. These classifications were applied to all areas of mapped vegetation within the study area.

As the overall density of tree hollows will usually be lower in areas that have been partly cleared, tree hollow mapping should be considered in conjunction with the forest cover mapping.

2.3 Flora Survey

2.3.1 Vegetation community mapping

Field survey initially utilised long transects to empirically classify vegetation to Biometric vegetation types, locate community boundaries, identify areas with trees likely to contain hollows and prepare the vegetation map.

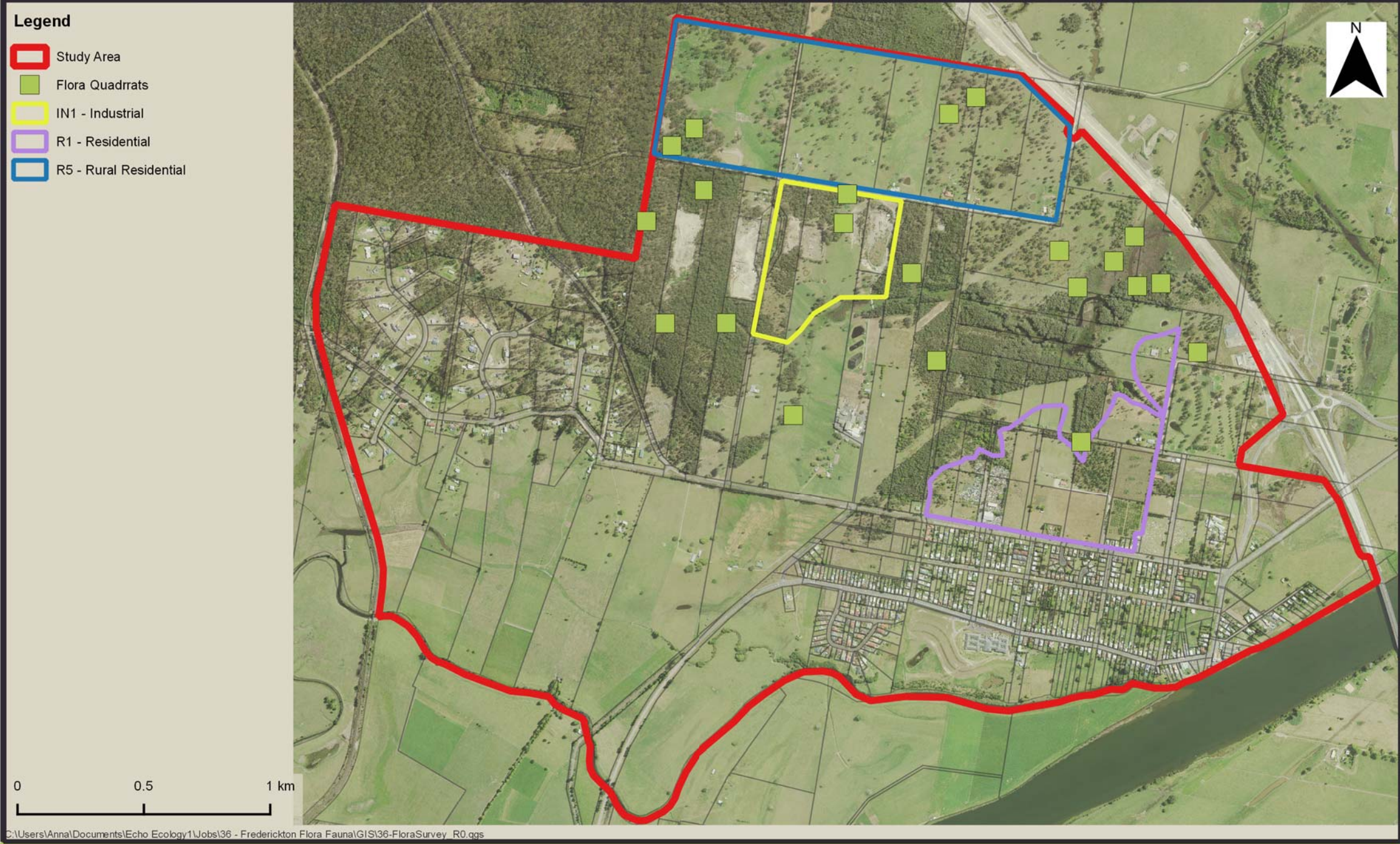
2.3.2 Flora survey

The flora field survey was undertaken during June and July 2016. After native vegetation communities were identified to type, comprehensive 0.04ha vegetation survey quadrats were undertaken within representative areas of each type to record the vegetation structure, floristics and disturbance impacts in areas representative of the type.

An assessment of forest cover, Koala habitat and hollow tree availability was undertaken over approximately 1 hectare centred on the survey quadrat. Each survey quadrat was also the starting point for a random meander search for flora of conservation significance. Plant species not reliably identified in the field were collected for identification in the laboratory.

2.3.3 Data analysis and vegetation classification

In order to examine the adequacy of the classification of quadrat data into vegetation communities, a cluster analysis of native flora cover/abundance was undertaken using the Kulczynski measure of association, unweighted pair-group mean averaging and beta value of -0.1 (Belbin 1994).



Frederickton Flora and Fauna Study

Job No. 36

Rev. 0

Date 15 September 2016

Client: Kempsey Shire Council

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GPS locations recorded at > 5 m accuracy

Figure 2-1
Flora Survey Sites

2.4 Habitat Assessment

Habitat assessments were undertaken at each of the flora survey sites. The habitat assessment included recording the quality and presence of habitat for threatened fauna including:

- evidence of disturbance such as fire, weeds, feral animals, dumping, erosion and logging;
- presence of fallen timber and logs;
- presence of stumps and stags;
- presence of groundcover features such as rock, leaf litter, grasses, logs, boulder, soil and lichen;
- presence of dieback and / or insect attack;
- mistletoe presence;
- fallen and loose bark;
- vegetation strata and composition;
- nectar and seed producing trees and shrubs (particularly, winter flowering plants);
- presence of other specific feed tree species (such as for cockatoos and honeyeaters); and
- presence of hollow-bearing trees.

2.4.1 Nectar Resource Mapping

We applied the nectar reliability and productivity rankings of Eby and Law (2008) to our vegetation community mapping to create a nectar resource map for the study area. We did this by noting the final rankings of similar vegetation communities used by Eby and Law (2008).

2.4.2 Koala Habitat Mapping

We revised the Koala habitat mapping for the study area by applying the criteria used by the Comprehensive Koala Plan of Management (Kempsey Shire Council 2011) to our revised vegetation mapping.

'Preferred koala habitat' includes any area identified as either Primary, Secondary A or Secondary B koala habitat as defined below:

Primary

Vegetation communities and/or associations wherein primary food tree species comprise the dominant or co-dominant (i.e. 50%) overstorey tree species.

Secondary A

Vegetation communities and/or associations wherein Primary food tree species are sub-dominant components of the overstorey tree species and usually (but not always) growing in association with one or more secondary food tree species.

Secondary B

Vegetation communities and/or associations wherein Primary food tree species are absent, habitat containing secondary and supplementary food tree species only.

Primary food tree species

- Tallowwood *Eucalyptus microcorys*
- Forest Red Gum *Eucalyptus. tereticornis*
- Swamp Mahogany *Eucalyptus robusta*

Secondary/supplementary food tree species

- Grey Gum *Eucalyptus propinqua*
- White Stringybark *Eucalyptus globoidea*
- Stringybark *Eucalyptus tindaliae*

The relative abundance of koala food tree species was recorded during the flora survey plots and then the Koala habitat classifications above were applied to each vegetation community recorded within the study area.

2.5 Fauna Survey

The fauna survey methodology was developed with reference to the NSW threatened biodiversity survey guidelines (DEC 2004) for the subject site (potential rezoning areas). Supplementary surveys were undertaken within the broader study area to add contextual information. The particular survey methods used were selected to target the threatened fauna species identified from the literature review with the potential to occur within the study area. We did deviate from the recommended survey effort in some instances due to unsuitable survey conditions (e.g. cooler seasons for frogs, microbats and reptiles and call playback due to owl breeding season). However, we have addressed these limitations by either recommending further targeted surveys during appropriate weather conditions or by using additional survey methods or periods to increase our chances of detecting our target threatened species. We take into account the various survey limitations by combining the results of surveys, onsite habitat assessment and local records when considering the likelihood of occurrence of threatened species (Appendix E). A summary of the fauna survey effort undertaken within the study area is given in Table 2-1.

Table 2-1: Fauna survey effort

Report Section	Survey Method	Survey Effort	Target Species	Total Survey Effort	Date(s)	Comments
2.5.1	Diurnal Bird Survey	0.5 hrs x 4 sites x 2 days 1.75 hrs x 1 site x 1 day 1.25 hrs x 2 sites x 1 day	Diurnal Birds incl. Swift Parrot	8.25 hours	27 June - 1 July 2016	

Report Section	Survey Method	Survey Effort	Target Species	Total Survey Effort	Date(s)	Comments
2.5.2	Call Playback	2 nights x 3 sites	Masked Owl, Powerful Owl, Sooty Owl, Eastern Grass Owl, Koala, Yellow-bellied Glider	2 nights	29 & 30 June 2016	
2.5.2	Spotlighting	2 - 4 people over 3 nights	Nocturnal mammals, owls, reptiles, amphibians	20 person hours spread over three consecutive nights	28 - 30 June 2016	
2.5.2	Stagwatching	2 - 3 people x 1 hour x 2 nights	Hollow-dwelling fauna (microbats, owls, arboreal mammals)	5 hours	29 & 30 June 2016	
2.5.3	Terrestrial Elliott A traps	2 traplines x 25 traps x 4 nights	Terrestrial Mammals (Common Planigale, Eastern Chestnut Mouse)	200 trap nights	27 June - 1 July 2016	
2.5.3	Arboreal Elliott B traps	3 traplines x 10 traps x 4 nights	Squirrel Glider, Brush-tailed Phascogale	120 trap nights	27 June - 1 July 2016	
2.5.3	Cage Traps	2 traplines x 2 cage traps x 3 - 4 nights	Spotted-tailed Quoll	14 trap nights	27 June - 1 July 2016	
2.5.4	Camera Traps	21 survey sites x 1 camera x 7 nights	Squirrel Glider, Brush-tailed Phascogale, Spotted-tailed Quoll, Koala	147 trap nights	23 June - 29 July 2016	Cameras set on tree trunks and on ground
2.5.5	Ultrasonic Recording	6 x Anabat sites x 1 Anabat x 2 - 5 entire nights	Microbats	16 entire nights	27 June - 4 July 2016	Marginal survey conditions for microbats (winter)

Report Section	Survey Method	Survey Effort	Target Species	Total Survey Effort	Date(s)	Comments
2.5.5	Acoustic Recording	6 x Song Meter sites x 1 Song Meter x 7 entire nights acoustic recording	Owls Vocal Mammals Birds Amphibians	42 nights	7 July - 6 Aug 2016	
2.5.7	Reptile Search	Nil	Reptiles	Nil	NA	Marginal survey conditions in winter
NA	Frog survey	Nil	Frogs	Nil	NA	Unsuitable survey conditions in winter for target species.
2.5.8	Koala SAT plots	10 SAT plots	Koala	10 SAT plots, 300 trees	1 - 2 September 2016	
2.5.9	Eastern Grass Owl nest searches	Along the edge of wetlands in grassy areas	Eastern Grass Owl	8 hours	27 June - 1 July 2016	Targeting areas within and adjacent to subject site

2.5.1 Diurnal Bird Survey

Opportunistic and formal bird surveys were undertaken across the study area. Each trap line was surveyed for birds for 30 minutes on two mornings. Observers wandered through vegetation surrounding the point and recording all bird species observed or heard. An additional four bird survey sites (long transects) were surveyed on one occasion each for 1.25 - 1.75 hrs. For diurnal surveys, emphasis was placed on peak activity periods, i.e. dawn and dusk, to maximise chances of species encountered. Birds were identified by direct observation, by recognition of calls or distinctive features such as nests, feathers etc.

Whenever other survey work was conducted, during both diurnal and nocturnal periods, opportunistic observations of those bird species encountered were recorded.

A total of 8.25 hours of dedicated bird survey was undertaken within the site during the survey. See Figure 2-2 for bird survey sites.

2.5.2 Nocturnal Survey

Call Playback

Pre-recorded calls of fauna species with the potential to occur within the site were broadcast in an effort to elicit vocal responses or to attract animals to the playback site. The calls were broadcast through an amplification system (loud haler) designed to project the sound. The call of each species was broadcast for five minutes, followed by five minutes of listening, and stationary spotlighting. Following the final broadcast a 10 minute quiet listening period was undertaken and then the area was spotlighted on foot.

Species broadcast were:

- *Ninox strenua* (Powerful Owl) which also targeted the *Petaurus australis* (Yellow-bellied Glider);
- *Tyto novaehollandiae* (Masked Owl);
- *Tyto tenebricosa* (Sooty Owl);
- *Tyto longimembris* (Eastern Grass Owl); and
- *Phascolarctos cinereus* (Koala).

Two nights of call playback were undertaken within the study area at three survey sites on 29 and 30 June 2016. The call playback sites were positioned on ridgetops to maximise coverage of the broadcast call and were separated by at least 700 m. Call playback sites are shown in Figure 2-2. We supplemented the two nights of call playback with passive acoustic recording during the night using Song Meter recorders to further sample any owl species present within the study area (see Section 2.5.4).

Stagwatching

Five hollow-bearing trees were watched for animals leaving hollows for approximately one hour (30 mins before dusk and 30 mins after dusk) until poor visibility occurred. We selected hollow-bearing trees which would have a good silhouette of the hollow(s) after dusk. Observers sat silently and used spotlights and headlamps as little as possible to minimise disturbance to any fauna species in the area.

Spotlighting

Spotlighting was undertaken on foot via the use of 75 Watt hand-held spotlights and bright LED head torches with adjustable dimmers. Spotlighting was undertaken to target owls and threatened terrestrial, arboreal and flying mammals. Two to four people undertook spotlighting each night for three nights (28 - 30 June 2016), resulting in a total of 20 person hours of spotlighting undertaken within the study area.

2.5.3 Mammal Trapping

Arboreal Elliott Trapping

A total of four arboreal trap lines were set for four nights 27 June - 1 July 2016. Trap lines consisted of 10 Elliot B traps mounted on tree trunks 2 - 3 m above the ground and spaced at approximately 30 m intervals. Traps were baited with a mix of peanut butter, rolled oats

and honey and a piece of honey-soaked paper. To protect animals from inclement weather, synthetic insulative material (holofil) was placed inside each trap and traps were wrapped in plastic bags. Tree trunks were liberally sprayed with honey each morning to act as a lure.

Arboreal traps were set to target threatened arboreal mammals including Squirrel Glider (*Petaurus norfolcensis*) and Brush-tailed Phascogale (*Phascogale tapoatafa*) and a total of 120 arboreal trap nights were undertaken within the study area.

Terrestrial Elliott Trapping

A total of two terrestrial trap lines were set for four nights 27 June - 1 July 2016. Trap lines consisted of 25 Elliot 'A' traps placed on the ground. Traps were baited with a mix of peanut butter and rolled oats. To protect animals from inclement weather, synthetic insulative material (holofil) was placed inside each trap and traps were wrapped in plastic bags.

Terrestrial traps were set to target threatened small mammals including Common planigale (*Planigale maculata*) and Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*). A total of 200 terrestrial Elliott 'A' trap nights were undertaken within the study area.

Cage Trapping

A total of four large cage traps were set for 3 - 4 nights 27 June - 1 July 2016. Two traps were set at each of the terrestrial trap lines. Traps were set along run-ways, covered with a hessian bag and baited with chicken necks. A total of 14 cage trap nights were undertaken within the study area.

2.5.4 Camera Traps

Motion-triggered cameras with infrared flashes (Scoutguard 550V) were set to remotely record fauna within the study area 24 June - 27 July 2016. Cameras were either set on tree trunks or on the ground. Cameras set on tree trunks had a lure of peanut butter, oats and honey-soaked paper placed approximately 0.75 m down the tree trunk from the camera. Cameras aimed at the ground were mounted onto small trees and aimed at a lure (peanut butter and oats) that was placed approximately 1.5 m from the camera. The lure was hung on a short metal stake at a height of approximately 30 cm. Lures were placed in secure holders (tea-strainer) so that animals could not access the baits. Cameras were set to record either video or still photographs when triggered. Masking tape was placed over the flash of some cameras to reduce the brightness of the camera flash in photographs.

A total of 147 camera trap nights were undertaken during the survey and camera locations are shown in Figure 2-2.

2.5.5 Ultrasonic Recording

Bat detectors (Anabat SD1, Titley Electronics) were used to record the high frequency echolocation calls made by insectivorous bats. The bat detector microphones were attached to an extension cable and placed within a protective PVC pipe. One bat detector was placed at each of six ultrasonic recording sites and left to record for 2 - 5 full nights.

A total of 16 ultrasonic recording nights were undertaken within the study area. The ultrasonic bat call recordings were identified as detailed in Appendix D.

2.5.6 Acoustic Recording

Song Meter recording devices (SM2+, Wildlife Acoustics) were set to sample acoustic sounds during the night. The acoustic microphone recorded audible sounds made by animals (birds, vocal mammals, frogs, etc.) from one hour before sunset until one hour after sunrise each night for 7 days (7 July - 6 Aug 2016).

A total of 42 acoustic recording nights were undertaken within the study area.

Acoustic recordings were run through the automated call identification software, Song Scope (Wildlife Acoustics) using the following recognisers developed by Echo Ecology:

- Powerful Owl;
- Masked Owl;
- Grass Owl;
- Sooty Owl
- Yellow-bellied Glider; and
- Koala.

Any vocalisations triggering the recogniser (above predetermined thresholds) were manually validated by visualising the acoustic spectrogram in Song Scope and listening to the audio.

2.5.7 Reptile Searches

The cooler weather experienced during surveys made reptile searches difficult and so targeted reptile surveys were not undertaken.

2.5.8 Koala SAT plots

We applied the methodology outlined in the Kempsey CKPoM for undertaking a Koala habitat assessment to each rezoning area. This involved the use of the Spot Assessment Technique (SAT) specified in Appendix I of Volume II of the Kempsey CKPoM. We first used our updated Koala habitat mapping (see Section 2.5) to determine whether potential Koala habitat existed. Then the following grids were then placed over the rezoning areas as per the SAT sampling intensities required by the Kempsey CKPoM for each rezoning area (Table 2-2):

- Industrial - total area 24.4 ha - 125 m grid - initial sampling every 250 m
- Rural Residential - total area 85.4 ha - 175 m grid - initial sampling every 350 m
- Residential - no potential Koala habitat present.

Table 2-2: SAT sampling intensities required by Kempsey CKPoM

Area of Land	Initial SAT Sampling intensity	High SAT sampling intensity
< 15 ha	Every 150 m	Every 75 m
15 - 50 ha	Every 250 m	Every 125 m
> 50 ha	Every 350 m	Every 175 m

The rezoning areas were overlaid with a square grid at intervals specified by the High SAT sampling intensity applicable to the area of land (Table 2-2). We then undertook sampling at each grid point specified under the Initial SAT Sampling Intensity using the SAT methodology (Appendix 1 of Volume II of the CKPoM). Grid points that fell outside areas of potential Koala habitat were either moved slightly to be within potential Koala habitat or if no potential Koala habitat was nearby, they were not sampled. The intention was that where 'significant Koala activity' (see below for definition) was recorded at a SAT site, then the surrounding high sampling intensity SAT sites were also sampled. However, no 'significant Koala activity' was recorded.

A total of 10 SAT plots were undertaken within the subject site, their locations are shown in Figure 2-2.

SAT methodology

The SAT involves an assessment of Koala activity within the immediate area surrounding a tree of any species that is known to have been utilised by a Koala or otherwise considered to be of some importance for Koala conservation and / or habitat assessment purposes. In order of decreasing priority, selection of the centre tree for a SAT should be based on one or more of the following criteria:

1. A tree of any species beneath which one or more Koala faecal pellets have been observed; and/or
2. A tree in which a Koala has been observed; and / or
3. Any other tree known or considered to be potentially important for Koalas, or of interest for other assessment purposes.

A minimum of 30 trees are sampled at each SAT site. For assessment purposes, a tree is defined as *"a live woody stem of any plant species (excepting palms, cycads, tree ferns and grass trees) which has a diameter at breast height (DBH) of 100 mm or greater"*. In the case of multi-stemmed trees, at least one of the live stems must have a DBH of 100 mm or greater.

The steps of applying the SAT are as follows:

1. Locate and uniquely mark with flagging tape a tree (the centre tree) that meets one or more of the abovementioned selection criteria;
2. Differentially flag the 29 nearest trees to that identified in Step 1;
3. Undertake a search for Koala faecal pellets beneath each of the marked trees based on a cursory inspection of the undisturbed ground surface within 100 cm of from the base of each tree, followed (if no faecal pellets are initially detected) by a more thorough inspection involving disturbance of the leaf litter and ground cover within the prescribed search area.

An average of approximately two person minutes per tree were dedicated to the faecal pellet search. More time was spent searching beneath larger trees than smaller trees. The search was concluded once a single koala faecal pellet was detected or when the maximum search time has expired, whichever happens first. This process was repeated until each of the 30 trees in the site had been assessed. Where the location of faecal pellets falls within overlapping search areas due to two or more trees growing in close proximity to each other, both were positively scored for pellets.

The location of each SAT site (the centre tree) was recorded using a handheld GPS and the selection criteria, tree species assessed, tree DBH and the total radial area searched (measured from the centre tree) was also recorded.

The Koala activity levels were calculated for each SAT site and classified according to the Koala activity categories specified in the Kempsey CKPoM (Table 2-3). The activity level for a SAT site was calculated as follows: No. trees with faecal pellets / Total No. trees searched * 100. “Significant Koala activity” under the Kempsey CKPoM included any medium - high activity categories (Table 2-3).

Table 2-3: Koala activity categories (adapted from Kempsey CKPoM)

Area (density)	Soil landscape type	Activity Category		
		Low Use	Medium (normal) use	High use
East Coast (low)	Erosional or residual	< 9.47 %	9.47 - 12.59 %	> 12.59 %
East Coast (med - high)	Alluvial	< 22.52 %	22.52 - 32.84 %	> 32.84 %

Core Koala Habitat Classification

All SAT sample sites wherein ‘significant Koala activity’ was recorded became the central point of a grid cell, the size of which was commensurate with sampling intensity as follows:

- For 75m sampling intersections, the grid cell size will be 75m x 75m (0.56ha)
- For 125m sampling intersections, the grid cell size will be 125m x 125m (1.56ha)
- For 175m sampling intersections, the grid cell size will be 175 x 175m (3.06ha)

Each of these grid cells where significant Koala activity was recorded were then mapped as Core Koala Habitat under the Kempsey CKPoM.

2.5.9 Eastern Grass Owl Searches

Searches of low-lying grassy areas adjacent to wetlands were made for *Tyto longimembris* (Eastern Grass Owl) nests and in an attempt to flush individuals. Not all suitable habitat could be searched, but we selected areas of suitable habitat (ungrazed or lightly grazed and overgrown grassland) within or adjacent to the subject site. An observer walked through the area in a zig-zag fashion in order to cover as much habitat as possible and searched for potential nesting sites or individuals flushed from ground cover.

2.5.10 Opportunistic Observations, Scats, Signs and Traces

Opportunistic observations were recorded during all aspects of field work, including the comprehensive hollow-bearing tree survey. In particular, the following signs were taken note of:

- chewed Allocasuarina cones indicative of *Calyptorhynchus lathami* (Glossy Black-Cockatoo) foraging activity;
- flying-fox camps as evidenced by smell and noise;
- koala scats and characteristic scratches on tree trunks;
- other distinctive scats left by mammals. Any scats unable to be positively identified or scats of predator species containing fur or bones were sent to an expert (Barbara Triggs) for identification and analysis;
- owl regurgitation pellets indicative of an owl roost;
- raptor nests;
- quoll latrine sites near fallen logs, rocks etc.;
- burrows and diggings;
- searches of tree canopies for resting koalas (during the hollow-bearing tree survey);
- scratch marks made by various types of arboreal animals; and
- feeding scars on eucalypts made by gliders.

Legend

- Study Area

Fauna Survey Sites

- Anabat
- Cage Trap
- Camera (Arboreal)
- Camera (Ground)
- Call playback
- Song Meter
- Stagwatch
- Additional Bird Survey Site
- Koala SAT centre tree
- Koala SAT extent
- Spotlighting Transect
- Grass Owl Transect
- Trapline (Arboreal)
- Trapline (Arboreal and Ground)

N

0 0.5 1 km

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Frederickton Flora and Fauna Study

Client: Kempsey Shire Council

Job No. 36

Rev. 0

Date 15 September 2016

SOURCE
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All boundaries, scale and points are approximate only
GPS locations recorded at > 5 m accuracy

Figure 2-2
Fauna Survey Effort

2.6 Mapping

Maps for this report were prepared using QGIS, a geographic information system (version 2.6.1; QGIS Development Team 2015).

2.7 Ecological Constraints Mapping

We created an overall ecological constraints map that combined the key ecological features for the study area.

2.7.1 Riparian buffers

We created riparian buffers by applying the buffers recommended by the *Water Management Act 2000 guidelines for riparian corridors on waterfront land*.

2.7.2 Hollow-bearing trees

The loss of hollow-bearing trees is a key threatening process under the TSC Act and as such, the removal of hollow-bearing trees should be minimised as far as possible. We have shown hollow-bearing trees with a 10 m buffer to roughly indicate the drip zone of trees. Consideration will need to be given to offsetting hollow-bearing tree loss through the conservation of areas of high hollow-bearing tree density, compensatory recruitment trees protection and nest box installation (maintained and managed under a nest box management plan).

2.7.3 Endangered Ecological Community

EECs have been mapped with the following buffers recommended by Port Macquarie - Hastings Council in Development Control Plan 2013:

- Freshwater Wetland - 100 m
- Swamp Oak Floodplain Forest and Swamp Sclerophyll Forest - 35 m

The areas mapped in the south of the study area as candidate EEC (unsurveyed) were given a 100 m buffer. This is considered to be a worst-case scenario if Freshwater Wetland EEC occurs close to the edge of the mapped area. This may be reduced following vegetation surveys within the candidate EEC area.

2.7.4 Vegetation conservation value rankings

Moderate conservation value

Areas mapped as of moderate conservation value are somewhat degraded, such as lacking an understorey, regrowth vegetation or have high weed infestation. However, they also contain important habitat features such as a high density of mature and hollow-bearing trees and / or linkage to other remnant patches. These areas may be suitable for some limited urban development (requiring the provision of suitable offsets), as part of

open space zonings or as offsets for the development of other areas. It should be noted that not all areas of moderate conservation value will be suitable for use as offsets. Important offset considerations will be condition, fragmentation, linkage, size and vegetation type. As these areas are often disturbed (most frequently lacking a native understorey and canopy recruitment), they will be more difficult to rehabilitate. Areas for use as offsets would be most suitable where they conserve important hollow-bearing trees or strengthen corridors and remnant fragments with enhancement activities.

Low conservation value
Areas of low conservation value include heavily cleared areas with no overstorey, regenerating dry forest vegetation (that is not an EEC, has little connectivity and with very few hollow-bearing trees) and isolated paddock trees. While some offsetting may still be required for specific habitat attributes (such as hollow-bearing trees), these areas appear to be the least ecologically constrained.

2.8 Limitations

All ecological surveys are limited in their ability to fully document all flora and fauna species that occur within a particular area. Our surveys are designed to collect a representative sample of the species assemblage that occurs within a site and are particularly aimed towards detecting threatened species. We also rely heavily on habitat assessment that we undertake during surveys to determine the likelihood of occurrence of threatened species, populations and communities listed under TSC Act and/or EPBC Act. We use this combination of field survey and habitat assessment to determine the ecological values of the site and the potential for threatened species, populations and communities to occur (Appendix E).

Areas where native trees were absent and that were dominated by exotic grasses, in particular a large expanse of farmland on the floodplain in the south-western part of the study area, were not surveyed. Some of these areas are likely to contain remnant wetland plant species but because they have been subject to a long period of disturbance including drainage, cultivation, pasture improvement, slashing and grazing, are not detectable on aerial photographs and could not be mapped. This is not considered to be a significant limitation because these areas are not proposed for rezoning, are remote from areas likely to be impacted by rezoning and will continue to be managed under the current legislative settings.

Because the survey occurred in winter and parts of the study area had been heavily grazed, some plant species did not carry fertile material and could not be identified. As these plants were confined to areas not expected to support threatened flora, this is not considered to be a significant limitation.

The winter survey period also resulted in poor sampling of microbats, reptiles and amphibians. However, we have used habitat assessment to determine the likelihood of

3.0 RESULTS

3.1 Weather Conditions

Daily rainfall, minimum and maximum temperatures during surveys sourced from the Bureau of Meteorology weather station located at Kempsey Airport (station 059007) is shown in Figure 3-1 and Figure 3-2.

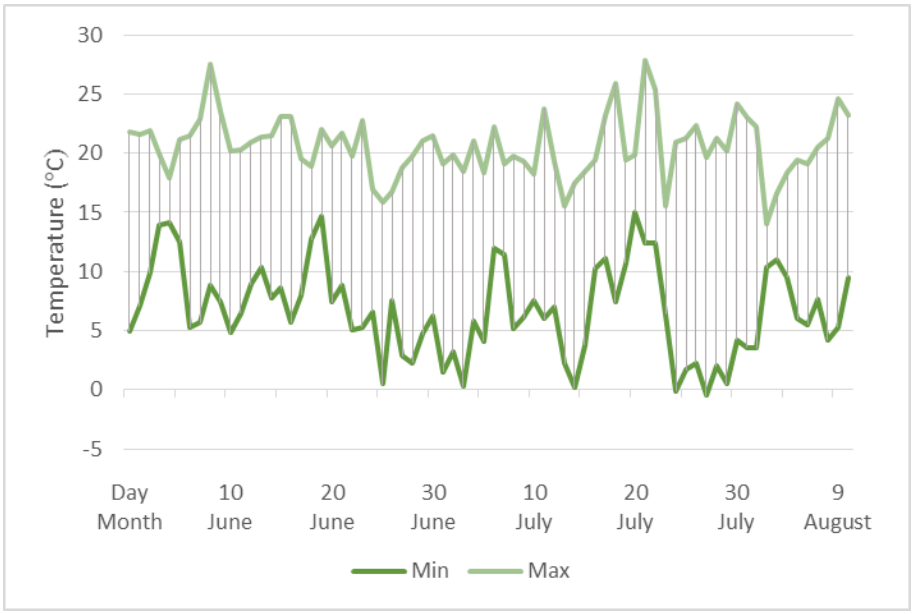

Figure 3-1: Temperature recorded before, during and after field surveys (Bureau of Meteorology)

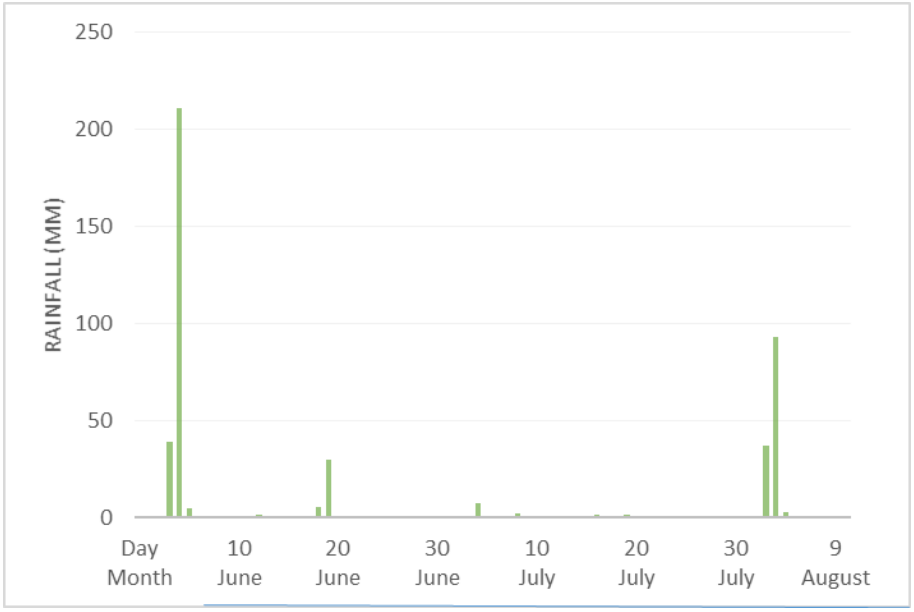

Figure 3-2: Rainfall recorded before, during and after field surveys (Bureau of Meteorology)

3.2 Hollow-bearing Tree Survey

3.2.1 Detailed hollow-bearing tree survey (subject site)

A total of 82 hollow-bearing trees (HBTs) were recorded within the subject site as shown in Figure 3-4. A total of four large (> 20 cm), 19 medium (10 - 20 cm), 18 small (5 - 10 cm) and 14 tiny (3 - 5 cm) hollows were recorded within the subject site. Of the 82 HBTs recorded within the subject site, eight (9.8 %) had fire scars, 42 (51.2 %) had termitaria, 30 (36.6 %) were stags (dead standing trees) and 30 (36.6 %) had cracks. The tree species composition of hollow-bearing trees recorded within the subject site is shown in Figure 3-3.

The HBT data has been provided to Council in the form of an excel spreadsheet and GIS layer. The data can be interrogated to produce maps of where key hollow resources are located. For example, maps of potential owl nest trees may be produced based on the location of trees with large hollows.

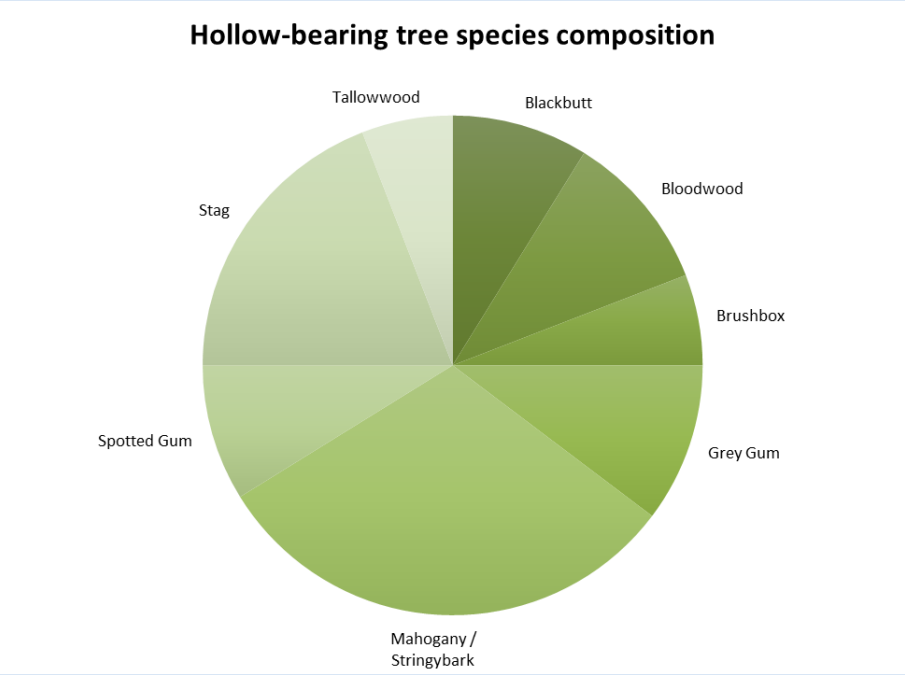

Figure 3-3: Proportion of hollow-bearing tree species (species that had two or less trees were omitted)

3.2.2 Growth stage hollow classification (study area)

A total of 62.7 ha of vegetation classified as containing ‘small’ hollows and 85.1 ha of vegetation classified as containing ‘large and small’ hollows occurs within the study area based on tree growth stage data collected during the flora survey (Figure 3-4).

Legend

Study Area

Hollow-bearing trees recorded

- Tiny Tree Hollows (3-5 cm) and Cracks
- Small Tree Hollows (5-10 cm)
- Medium Tree Hollows (10-20 cm)
- Termitaria only
- Large Tree Hollows (> 20 cm)

Growth stage hollow classification

- Large and Small
- Small

N

0 0.5 1 km

C:\Users\Anna\Documents\Echo Ecology1\Jobs\36 - Frederickton Flora Fauna\GIS\36-HBT_R0.qgs

Frederickton Flora and Fauna Study

Client: Kempsey Shire Council

Job No. 36

Rev. 0

Date 15 September 2016

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Figure 3-4
Hollow-bearing Trees

3.3 Habitat

3.3.1 General Habitat Description

Fauna habitat within the study area includes open forest with grassy understorey in the central elevated parts of the study area; riparian swamp oak and paperbark forest with varying amounts of groundcover; permanent pools and swamp along the central creekline; permanent water at farm dams; paddock trees over a grazed pasture understorey in the rural areas north of Raymond's Lane; and open pasture along the low-lying floodplain areas in the south of the study area.

Riparian areas
The receiving environment of the subject site is primarily the unnamed watercourse that drains the catchment in which the proposed new R1 Residential and IN1 Industrial areas are located. Open water in the watercourse immediately downstream of the existing abattoir was covered by a thick layer of algae, which indicates eutrophic conditions (Appendix C - Photograph 23 – 'eutrophic watercourse near Plot 10). The nutrients from settlement ponds and waste water disposal associated with the nearby abattoir are likely to be the main contributor to this eutrophication.

Areas further downstream that had been recently inundated following a major storm event had a strong smell that I associated with decomposing organic matter that is high in nutrients especially nitrogen. The presence of large quantities of the noxious weed Water hyacinth in this part of the watercourse may indicate persistently elevated nutrient levels. Other weedy exotic species with high levels of vegetation cover including Knotweed *Polygonum strigosum* and the annual grass *Panicum bisulcatum* also occurred in this area.

The proposed R1 residential zone has been cleared of most native vegetation, occupied by exotic plants and grazed by cattle. Part is also currently utilised for an industrial use (storage of wrecked motor vehicles). These activities may have been a minor contributor to hydrological impacts observed downstream. There was no indication that the watercourse might be unduly sensitive to the impacts of the proposed rezoning to R1 Residential.

Approximately half of the proposed IN1 Industrial zone has been cleared of native vegetation, occupied by exotic plants and grazed by cattle or quarried for road base. One quarry is also currently utilised for an industrial use (truck depot). These activities may have been a minor contributor to hydrological impacts observed downstream along the central drainage line. There was no indication that the watercourse might be unduly sensitive to the impacts of the proposed rezoning to IN1.

The proposed R5 Rural Residential zone has been partly cleared of vegetation, with understorey vegetation cleared, replaced by exotic grasses and grazed. As the proposed R5 zone is part of a separate catchment to the central drainage line these activities would

not have contributed to the hydrological impacts observed in the R1 Residential and IN1 Industrial catchment. No hydrological impacts were observed in the drainage depressions draining this area and there is no indication that the receiving environment would be unduly sensitive to the impacts of the proposed rezoning to R5.

The Macleay River and Christmas Creek are heavily modified. The banks of the Macleay River on the south-east edge of the study area have constructed levees to reduce flooding and very little fringing vegetation remains. Christmas Creek has also been heavily modified by historical land clearing and ongoing rural activities. However, the Christmas Creek floodplain appears to contain wetland vegetation despite ongoing grazing and slashing activity.

Dams are scattered across the study area and range from having very little to moderate aquatic and fringing vegetation. These farm dams are likely to provide breeding habitat for a variety of frog species and a permanent water source for birds and mammals.

Disturbance and Weed Invasion

The main disturbance experienced within the study area is historical land-clearing for grazing. Large areas of native vegetation have been cleared in the north and south of the study area. Ongoing vegetation maintenance activities have resulted in the removal of the understorey in rural residential areas. This has created a parkland vegetation structure with canopy trees occurring over a maintained grassy or a planted garden understorey. Along Raymond's Lane this parkland structure occurs as a result of grazing, with remnant scattered paddock trees. Removal of mature trees across the study area appears to continue due to safety, maintenance or aesthetic reasons.

The remnant bushland areas show evidence of recent thinning and minor firewood collection. The IN1 Industrial rezoning area has a high level of weed invasion, including *Lantana camara* (Lantana) and *Solanum mauritianum* (Wild tobacco), particularly along Quarry Rd. *Lantana camara* (Lantana) also occurred along the western end of the central drainage line. *Cinnamomum camphora* (Camphor laurel) was scattered throughout the study area and was recorded in every vegetation community except for the rushland.

Rural areas used for grazing contained a mixture of exotic grasses and herbs, in particular the western end of Raymond's Lane had a high level of weed invasion.

Bushrock

There was very little bushrock observed within the study area.

Ground cover, leaf litter and fallen timber

The remnant forest patches in the IN1 Industrial and R1 Residential rezoning areas provide some fallen timber and low to moderate leaf litter coverage (5 - 15 cm deep). Fallen timber was mostly small to medium logs and branches. The remnant forest patches had a moderate to high coverage of *Lomandra* spp. and other grasses which are likely to provide shelter opportunities for a range of terrestrial reptiles and small mammals.

Large piles of recently cleared timber were present at a number of properties within the study area and these are likely to provide temporary shelter sites for fauna such as reptiles and small mammals. However, this recent clearing activity has removed much of the understorey and leaf litter layer reducing habitat for small terrestrial fauna. Most of the rural and rural residential areas had very little leaf litter cover or fallen timber providing few shelter opportunities for fauna species.

Friable soils suitable for diggings occurred along creeklines and lower-lying areas across the study area.

The hollow-bearing tree habitat resource is discussed above in Section 3.2.

Den and burrows
No potential dens or burrows were observed during the field surveys.

Ecotonal (edge) areas
Forest edges, boundaries of open and dense forest and regenerating vegetation all form edge habitats that are preferred by some species. Edges are used by many open habitat-adapted fauna species to hunt for insect or vertebrate prey common in forests, without entering the denser vegetation. Edge habitats occur throughout the study area where remnant patches of vegetation adjoin more cleared areas.

Shrubs and grasses
Grasses provide foraging habitat for some birds and terrestrial herbivorous mammals. Understorey vegetation provides shelter and foraging habitat for frogs, reptiles, small birds and terrestrial mammals. Large tracts of the study area has been heavily cleared for grazing or has a maintained understorey with only canopy trees remaining. These areas provide very little shelter for native fauna, but may still provide grassy foraging opportunities to mobile species such as *Platycercus eximius* (Common Eastern Rosella). Some properties along Raymond's Lane are subject to only light grazing and contain regenerating native vegetation and long grasses and provide shelter opportunities for small terrestrial fauna, despite historical land-clearing.

The remnant bushland patches within the study area have a variable understorey, depending on disturbance history. The more intact bushland remnants contain mixtures of shrub and grasses, providing good shelter and foraging opportunities to a range of terrestrial fauna species.

Fruit Resources
Very few rainforest tree and shrub species were recorded within the study area during flora surveys. These trees or shrubs bear fleshy fruit that may be consumed by bird and mammal frugivores as part of their larger home range or nomadic behaviour. The study area appears to provide very little fleshy fruiting resources for fauna.

The study area does contain large stands of *Allocasuarina littoralis* and *Allocasuarina torrulosa* as a mid-storey plant in the dry forest vegetation types. These areas provide suitable foraging habitat for *Calyptorhynchus lathami* (Glossy Black-cockatoo). However, no chewed *Allocasuarina* spp. cones, evidence of *Calyptorhynchus lathami* (Glossy Black-cockatoo) foraging, were observed within the study area during surveys.

Critical Habitat
No critical habitat listed under the TSC Act occurs within 10 km of the study area.

3.3.2 Nectar Resources

We reviewed the *Pteropus poliocephalus* (Grey-headed Flying-fox) foraging habitat mapping layer (Eby and Law 2008) and found that most eucalypt vegetation within the study area was ranked as either 1 or 2 (the two highest rankings), meaning that the forest type contained high bimonthly nectar scores. This mapping not only classifies foraging habitat for *Pteropus poliocephalus* (Grey-headed Flying-fox), but for many other nectarivorous threatened fauna species that consume nectar such as *Petaurus australis* (Yellow-bellied Glider), *Petaurus norfolkensis* (Squirrel Glider), *Glossopsitta pusilla* (Little Lorikeet), *Lathamus discolor* (Swift Parrot) and *Anthochaera phrygia* (Regent Honeyeater). We applied the ranking system of Eby and Law (2008) to our vegetation to illustrate the distribution of these nectar resources (Figure 3-5)

Within the study area, important nectar-producing trees are tall *Eucalyptus pilularis* (Blackbutt), *Corymbia intermedia* (Pink Bloodwood), *Eucalyptus siderophloia* (Grey Ironbark), *Syncarpia glomulifera* (Turpentine), tall *Eucalyptus tereticornis* (Forest Red Gum) and *Lophostemon confertus* (Brushbox) (Eby and Law 2008).

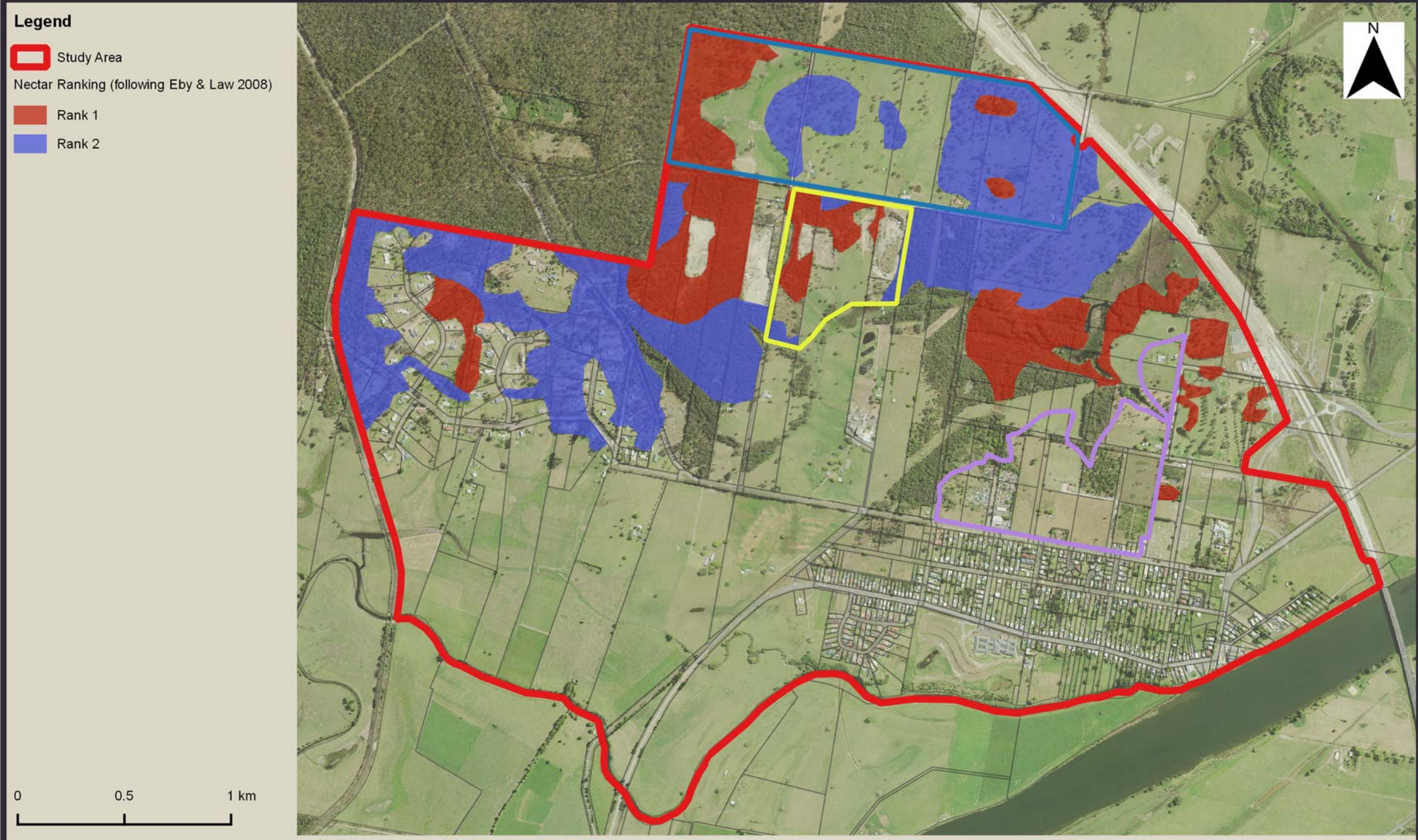
Mistletoe was uncommon within the study area.

The flowering phenology of tree species recorded within the study area is shown in Table 3-1.

Table 3-1: Flowering phenology, nectar productivity and reliability of tree species listed in Eby and Law (2008) and recorded within the study area. Higher nectar productivity and reliability scores indicate higher productivity and reliability respectively. Adapted from Eby and Law (2008) using lower north-east NSW data.

Scientific Name	Common Name	D-J	F-M	A-M	J-J	A-S	O-N	Flowering Duration (Months)	Nectar Productivity	Nectar Reliability
Corymbia gummifera	Red Bloodwood	X	X					2	0.91	0.45
Corymbia intermedia	Pink Bloodwood	X	X					2	1	0.60
Corymbia maculata	Spotted Gum	A	AB	B				≥ 3	0.91	0.30
Eucalyptus pilularis†	Blackbutt	X	X					2	0.47 - 0.80	0.45
Eucalyptus propinqua	Small-fruited Grey Gum	X	X					2	0.47	0.15
Eucalyptus siderophloia	Northern Grey Ironbark	X					X	2	0.91	0.60
Eucalyptus tereticornis†	Forest Red Gum	DE	E			C	CD	2	0.54 - 0.91	0.15 - 0.80
Lophostemon confertus	Brush Box	X					X	1	0.41	0.80
Melaleuca quinquenervia	Broad-leaved Paperbark		FG	FG	F			≥ 3	0.91	0.80
Syncarpia glomulifera	Turpentine					X	X	2	0.59	0.60

* sourced from Brooker and Kleinig (2006); † These species have two values for productivity and nectar reliability with the higher value being for taller trees and the lower for shorter trees; NA - Not Available; C - coastal lowlands; D - inland low altitude; E - high altitude



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Nectar Rankings from Eby & Law 2008 applied to the vegetation types recorded within the study area

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Figure 3-5
Nectar Resources

3.3.3 Koala Habitat Mapping

Primary Koala tree species occurring in the study area were *Eucalyptus microcorys* (Tallowwood) and *Eucalyptus tereticornis* (Forest Red Gum); Secondary tree species were *Eucalyptus propinqua* (Small-fruited Grey Gum) and *Eucalyptus globoidea* (White Stringybark). Most Koala habitat in the study area is Secondary A that has been partly cleared; there are smaller areas of Secondary A and Secondary B (Figure 3-6). No core Koala habitat was found to occur as no Koala scats were recorded during SAT surveys.

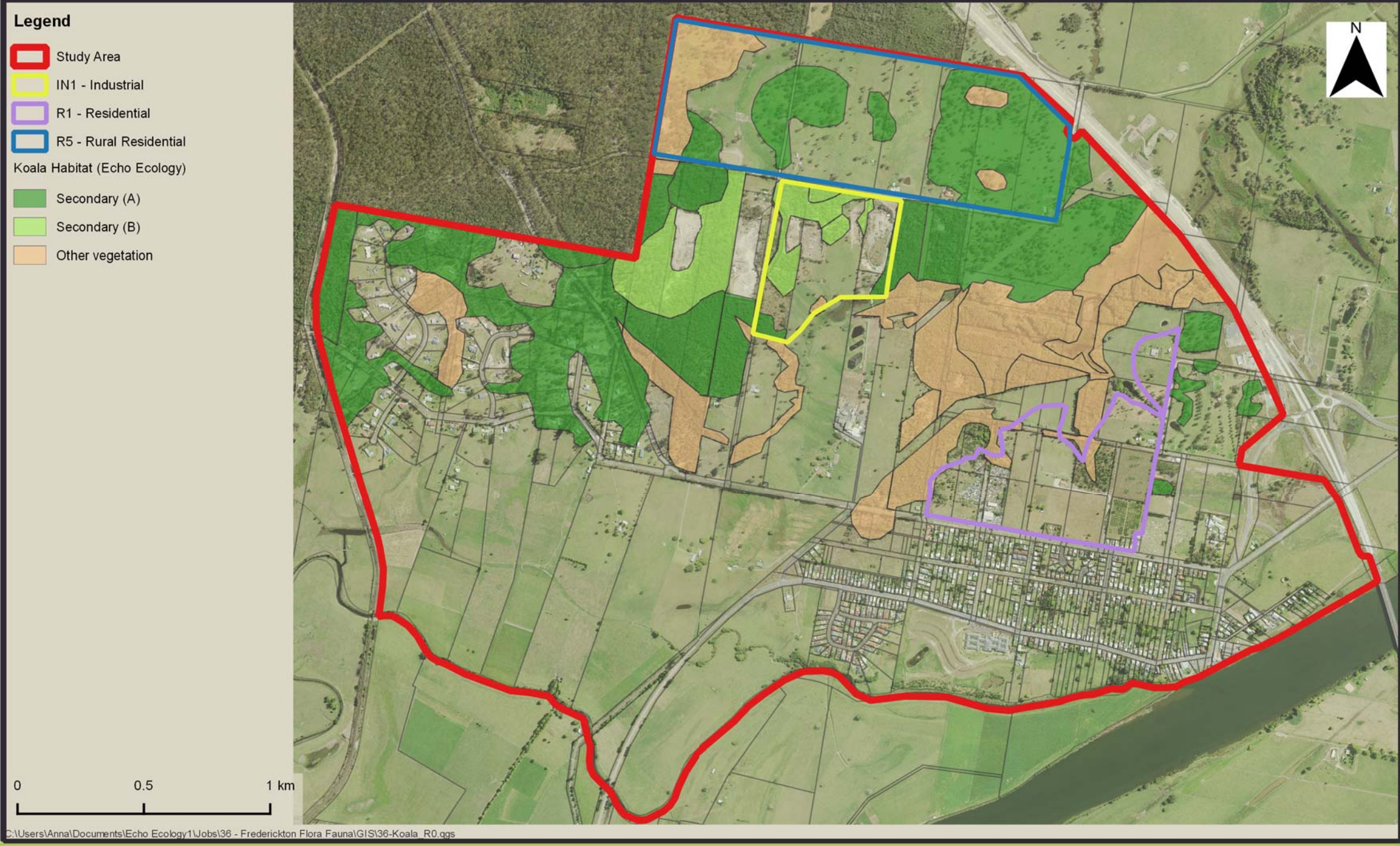

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Figure 3-6
Koala Habitat

3.4 Flora

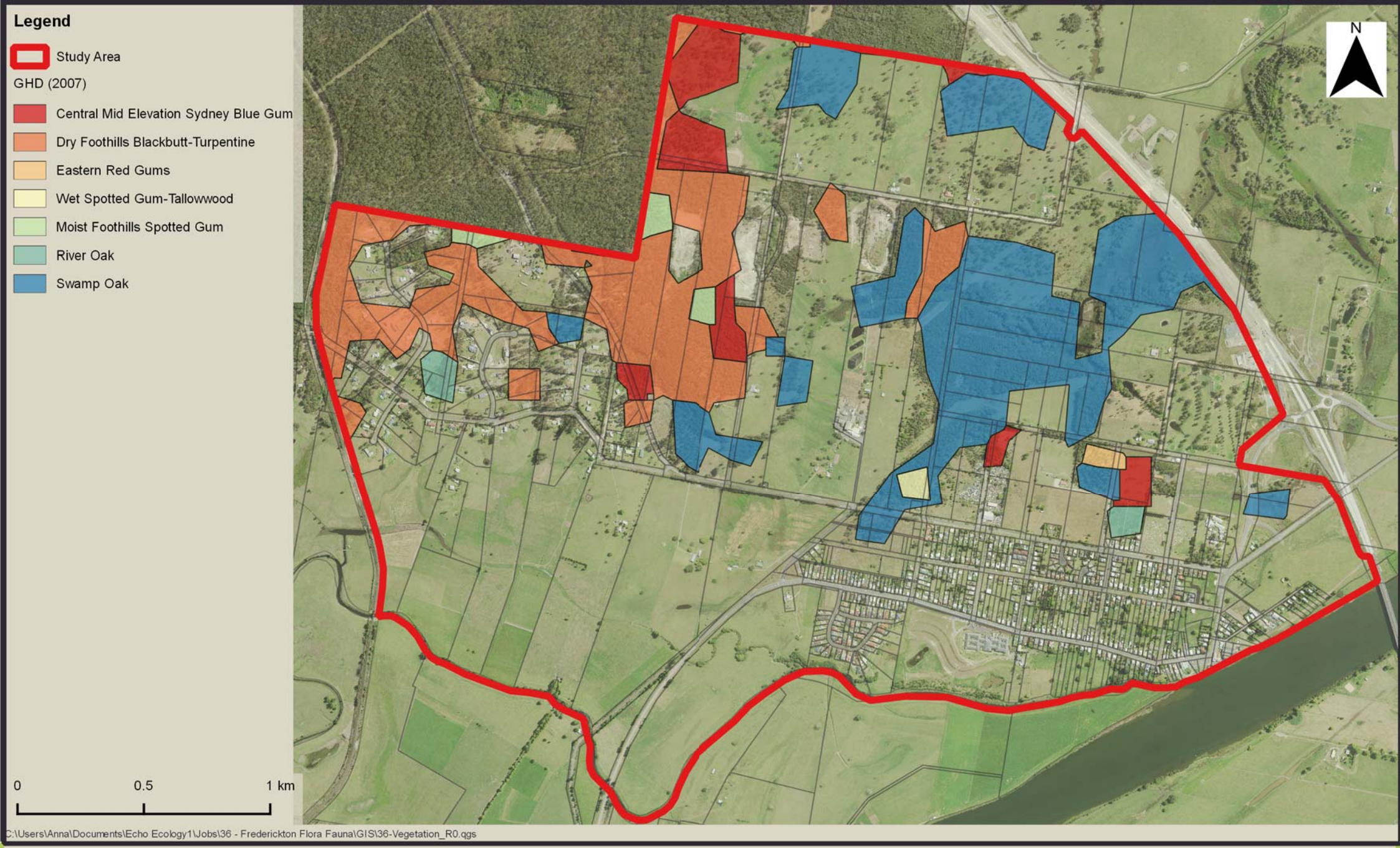
3.4.1 Previous vegetation mapping

GHD (2007) mapped the following seven vegetation communities as occurring within the study area (Figure 3-7), with polygons delineated coarsely:

- Central Mid Elevation Sydney Blue Gum Forest
- Dry Foothills Blackbutt - Turpentine Forest
- Eastern Red Gums
- Moist Foothills Spotted Gum Forest
- River Oak
- Swamp Oak
- Wet Spotted Gum - Tallowwood Forest

Telfer and Kendall (2006) mapped the following 16 vegetation communities as occurring within the study area (Figure 3-8):

- Dry Grassy Blackbutt - Tallowwood
- Dry Grassy Tallowwood - Grey Gum
- Grey Gum - Grey Ironbark - Mahogany Complex
- Hardwood Plantations
- Isolated or Individual Fig Trees
- Low relief Coastal Blackbutt
- Lowlands Scribbly Gum
- Macleay Lowland Spotted Gum
- Moist Coastal Complex
- Paperbark
- Rainforest
- River Oak
- Scribbly Gums
- Sedgeland
- Swamp
- Swamp Oak



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SOURCE
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Vegetation - GHD (2007). Report for Vegetation Mapping for Western Portion Kempsey LGA. KSC

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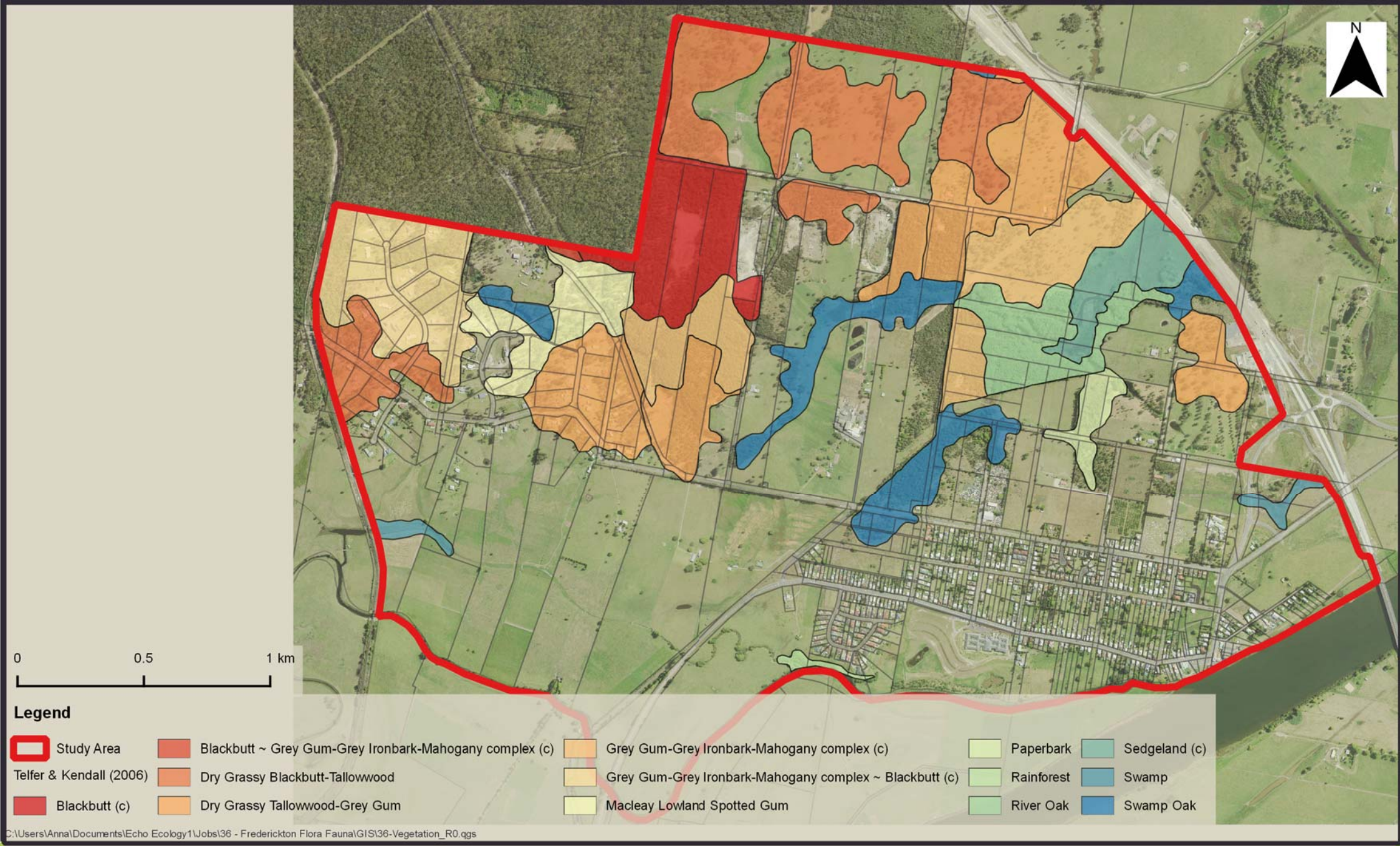
Figure 3-7
Kempsey West Vegetation (GHD 2007)



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Aerial Photo - © Land and Property Information (2016)
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Vegetation - Telfer, D. and P. Kendall (2006) Native Vegetation and Candidate Endangered Ecological Community Mapping Report: Kempsey LGA East.

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Figure 3-8
Kempsey East Vegetation (Telfer & Kendall 2006)

3.4.2 Vegetation Communities

Eight vegetation types were identified in the field. They included a dry sclerophyll forest occurring on crests and elevated slopes, three wet sclerophyll forests occurring on mid-slopes, two forested wetlands on lower slopes and flats and two freshwater wetland types in open depressions. Seven vegetation communities were mapped (Figure 3-9) because the freshwater wetland types occurred as a complex mosaic that could not be reliably separated and were therefore mapped and sampled as a single community.

The vegetation communities recorded within the study area were:

1. Spotted Gum - Grey Ironbark open forest;
2. Tallowwood - Small-fruited Grey Gum open forest;
3. Blackbutt - Tallowwood open forest;
4. Blackbutt - Pink Bloodwood open forest;
5. Swamp Oak forest;
6. Paperbark swamp forest;
7. *Juncus* rushland / *Polygonum* forbland;

1. Spotted Gum - Grey Ironbark open forest

Structure and floristics

A tall open forest dominated by Spotted gum *Corymbia maculata* and White mahogany *Eucalyptus carnea*. Associated species often include Grey ironbark *E. siderophloia*, and occasionally Small-fruited grey gum *E. propinqua,* Tallowwood *E. microcorys* and White Stringybark *E. globoidea*.

There may be a sparse midstratum of Black oak *Allocasuarina littoralis*.

The ground layer is typically a dense and diverse cover of grasses and forbs with occasional rushes, sedges, twiners and small ferns. Shrubs are rare or absent.

Ecology and disturbance

This community occurs on the crests and upper slopes of the more elevated parts in the north-west of the study area. Soils appear to be shallow and stony and significant areas within this community have been quarried for road base.

Selective logging probably occurred more than 50 years ago, but much of the evidence has been lost to fires, some of which were of moderate to high intensity as indicated by basal fire scars. More recently, fires have been infrequent and of low intensity. Except for a small patch on the Miles property with older trees where hollows are common (Figure 3-9), most trees are in the early mature and mature growth stages and tree hollows are uncommon and typically small.

There is evidence of low- intensity cattle grazing in the form of barbed-wire fencing and cattle tracks but only a small part of the community shows evidence of recent grazing.

Weeds are uncommon, being mostly occasional exotic grasses, Lantana and Camphor laurel.

Classification and conservation status

This community falls within the vegetation class *Hunter-Macleay Dry Sclerophyll Forests* (Keith 2004) and is classified as the Biometric vegetation type *NR247 - Spotted Gum - Grey Ironbark open forest of the Macleay Valley lowlands of the North Coast*. This vegetation type is estimated as 35% cleared in the Northern Rivers CMA region and is not of conservation concern.

2. Tallowwood - Small-fruited Grey Gum open forest

Structure and floristics

A tall open forest with a variable composition; dominant trees may include some or all of Tallowwood, Small-fruited grey gum, Grey ironbark, White stringybark and Pink bloodwood *Corymbia intermedia*. Associated species may include White mahogany, which occurs mostly on ridgelines; Brush box *Lophostemon confertus*, which occurs mostly on mid-slopes in the east of the study area, and Forest Red Gum *E. tereticornis*, which tends to replace Grey gum on lower slopes in the north of the study area.

There is often a sparse midstratum of Forest oak *Allocasuarina torrulosa* or Brush box. Paperbarks occur occasionally in moister areas that have been disturbed by partial clearing. Midstratum is generally absent from areas that have been partly cleared and under scrubbed.

The ground layer ranges from dense to very sparse and is typically dominated by Blady grass *Imperata cylindrica* or Wire grass *Entolasia stricta.* Forbs, rushes and twiners are common. Exotic grasses are common in areas that have been partly cleared and under scrubbed.

Ecology and disturbance

This community is extensive in the northern half of the study area and occurs from upper slopes through to lower slopes. Soils appear to be deeper and more fertile, especially on lower slopes enriched by colluvium.

Most of this community in the study area has been partly cleared and under scrubbed, either for grazing in the eastern and central parts of the study area or for large lot residential development in the west of the study area. Tree cover has typically been reduced to less than 50% of normal and the understorey cleared and suppressed by grazing or mowing. Because of the diversity of management regimes across the different properties trees occur in the regrowth, early mature and mature growth stages, with occasional late mature trees; tree hollows are uncommon and typically small but there are occasional large hollows.

Except for parts of the area north-west of Raymond's Lane that have been heavily fertilised and sown to exotic grasses, ground layer vegetation typically has a substantial component

of native perennial grasses and forbs, indicating that the soil has not been subject to significant cultivation or fertilisation.

The community has fewer weed species than any other eucalypt forest in the study area, indicating relatively infertile soils and relatively low impacts from grazing.

Classification and conservation status

This community falls within the vegetation class *Northern Hinterland Wet Sclerophyll Forests* (Keith 2004) and is classified as the Biometric vegetation type *NR263 - Tallowwood - Small-fruited Grey Gum dry grassy open forest of the foothills of North Coast* This vegetation type is estimated as 30% cleared in the Northern Rivers CMA region and is not of conservation concern.

3. Blackbutt - Tallowwood open forest

Structure and floristics

A tall open forest dominated by Blackbutt *E. pilularis* and Tallowwood. Associated species may include occasional Brush box, Grey ironbark, Small-fruited grey gum and Pink bloodwood, with one record of Red bloodwood in the south-eastern part of the study area.

There may be a sparse midstratum of Black oak *Allocasuarina littoralis*.

The ground layer is mid-dense and is typically dominated by Blady grass and Wire grass.

Ecology and disturbance

This community occurs in a few small patches in the study area and typically in midslope positions.

In the study area much of this community has been subjected to selective logging, which has retained some large old trees of no particular use as timber and facilitated the recruitment of several new generations of trees. The remainder consists of isolated mature and late mature trees that have been retained on the Frederickton golf course. Most trees are in the regrowth, early mature or mature growth stages with occasional late mature trees; tree hollows are uncommon and typically small but there are occasional large hollows.

In the distant past there have been moderate to high intensity fires as indicated by basal fire scars. There is some evidence of more recent and frequent fire of low intensity.

There is a diverse suite of weed species including pasture grasses, woody weeds and the declared noxious weed Tropical soda apple *Solanum viarum*. The community has the highest weed flora diversity of any other study area community, indicating relatively fertile soils and/or relatively high disturbance impacts associated with fire, logging and grazing.

Classification and conservation status

This community falls within the vegetation class *Northern Hinterland Wet Sclerophyll Forests* (Keith 2004) and is classified as the Biometric vegetation type *NR119 - Blackbutt - Tallowwood dry grassy open forest of the central parts North Coast.* This vegetation type is estimated as 55% cleared in the Northern Rivers CMA region and is not of conservation concern.

4. Blackbutt - Pink Bloodwood open forest

Structure and floristics

A tall open forest dominated by Blackbutt. The associated species is Pink Bloodwood. At the two locations where this community adjoins the Tallowwood –Grey gum community there is usually a zone of Scribbly gum *E. signata* but as this zone is less than 50m wide it has not been mapped or sampled.

There may be a sparse upper midstratum of Black oak or Forest oak.

The ground layer is typically a mid-dense cover of exotic grasses and forbs. Shrubs are rare.

Ecology and disturbance

This community occurs in a few small patches in the north of the study area.

Most of this community in the study area has been partly cleared and under scrubbed, either for grazing in the eastern and central parts of the study area or for large lot residential development in the west of the study area. Tree cover has typically been reduced to less than 50% of normal and the understorey cleared and suppressed by grazing or mowing. Trees are usually in the early mature and mature growth stages, with occasional late mature trees in the small remaining area that has not been under scrubbed. Tree hollows are therefore uncommon and typically small.

There is a diverse suite of weed species including pasture grasses and the declared noxious shrub *Cestrum parqui.*

Classification and conservation status

This community falls within the vegetation class *North Coast Wet Sclerophyll Forests* (Keith 2004) and is classified as the Biometric vegetation type *NR117 - Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the North Coast.* This vegetation type is estimated as 50% cleared in the Northern Rivers CMA region and is not of conservation concern.

5. Swamp Oak forest

Structure and floristics

An open or closed forest dominated by Swamp oak *Casuarina glauca*. Associated species may include Broadleaved paperbark *Melaleuca quinquenervia*, and occasionally Pink bloodwood or Black oak.

Midstratum vegetation is usually absent, although stands of the shrubs Sago bush *Ozothamnus diosmifolius* and *Sannantha angusta* occur occasionally.

The ground layer is typically a dense cover of grasses with occasional forbs and rushes; there is often a substantial component of exotic pasture grasses such as Setaria, Broadleaved paspalum *P. mandiocanum* or Kikuyu *Pennisetum clandestinum.*

Ecology and disturbance

This community is the most extensive after Tallowwood-Grey gum and occurs on mid- to lower-slopes adjoining watercourses throughout the study area. It usually occurs on 'waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains' (Scientific Committee 17/12/04) but in parts of the study area occurs on land that is elevated well above the floodplain.

In the study area it usually occurs as dense stands that have probably developed in response to past clearing or burning to facilitate grazing because the community usually has a dense grassy groundcover highly valued for cattle. After clearing or fire Swamp oak regenerates vigorously from root suckers and wind-dispersed seed which, together with its drought tolerance and a more recent reduction in fire frequency and severity, have enabled its expansion into adjoining cleared areas upslope of its original distribution. This is indicated by the presence of many species that do not usually occur in the Swamp oak community but rather are characteristic of eucalypt dominated communities.

Because of the disturbance regime it is dominated by trees in the regrowth growth stage, hollow trees are usually absent (although occasionally present in the form of trunk splits) and weeds such as Lantana and Camphor laurel are common. Weed species diversity is second only to Blackbutt – Tallowwood in the study area, indicating relatively fertile soils and disturbance impacts associated with clearing and grazing.

Classification and conservation status

Much of the community falls within the vegetation class *Coastal Floodplain Wetlands* (Keith 2004) and is classified as the Biometric vegetation type *NR255 - Swamp Oak swamp forest of the coastal lowlands of the North Coast.* This vegetation type is estimated as 75% cleared in the Northern Rivers CMA region and is of conservation concern, being listed in NSW as the Endangered Ecological Community (EEC) *Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregion* (Scientific Committee 17/12/04a).

The parts of the community that are not on, or bordering, waterlogged or periodically inundated flats and drainage lines are classified as Swamp Oak forest and unlikely to form part of the EEC. As a guide, these areas are likely to be confined to areas located above the 1% AEP flood level and not on mapped alluvial or swamp soil landscapes.

6. Paperbark swamp forest

Structure and floristics

An open or closed forest dominated by Broadleaved paperbark *Melaleuca quinquenervia*. Associated species include occasional Swamp oak.

Midstratum vegetation is absent.

The ground layer ranges from a dense cover of grasses such as Common couch *Cynodon dactylon* in less inundated areas to a mid-dense cover dominated by the sedges *Carex spp*. The rush *Juncus polyanthemus* often forms a taller open ground layer. There are usually small forbs such as Centella, Native violet and *Enydra fluctuans* and the exotic Knotweed *Persicaria strigosa* is very common.

Ecology and disturbance

This community is confined to frequently inundated flats and shallow open depressions between Swamp oak forests and Rushland / land along waterways in the eastern part of the study area. These areas are inundated more deeply and for longer periods than the adjoining Swamp oak forests.

In the study area it usually occurs as dense stands that have probably developed after infrequent major disturbance associated with major flooding and probably also with windthrow. Some more elevated areas occupied by dense regrowth may have been cleared in the past for grazing; regrowth in more inundated areas may be a response to drainage activities or major droughts that have allowed Paperbarks to establish in areas normally to deeply inundated to allow their establishment.

There are often large numbers of over-mature trees in this community that are likely support numerous fissures and small hollows that are obscured by the bark and difficult to detect.

Except for the exotic Knotweed, weeds and pasture grasses are rare in this community, despite the very heavy grazing observed at the time of survey.

Classification and conservation status

This community falls within the vegetation class *Coastal Swamp Forests* (Keith 2004) and is classified as the Biometric vegetation type *NR217 - Paperbark swamp forest of the coastal lowlands of the North Coast.* This vegetation type is estimated as 75% cleared in the Northern Rivers CMA region and is of conservation concern, being listed in NSW as the EEC *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (Scientific Committee 17/12/04b).

7. *Juncus* rushland / *Polygonum* forbland

Structure and floristics

A mosaic of tall dense rushland dominated by *Juncus polyanthemus* and low open forbland dominated by the exotic creeping forb *Polygonum strigosum*.

Species associated with the *Juncus* tall rushland usually include *Polygonum strigosum,* the exotic annual grass *Panicum bisulcatum* (which is likely to be a dominant species in Summer) and less commonly, the forb *Ranunculus inundatus*.

A more diverse suite of species is associated with the *Polygonum* low forbland include including grasses (Common couch *Cynodon dactylon*, Matgrass *Hemarthria uncinata*, Water couch *Paspalum distichum*) and forbs (*Alternanthera, Centella, Enydra*). More inundated parts of this community merge into emergent aquatic vegetation dominated by the noxious weed Water hyacinth *Eichornia crassipes*, with occasional large emergent *Persicaria orientalis* (identified from dead material - none were alive at the time of survey).

There may be isolated emergent small trees of Paperbark or Swamp oak.

Ecology and disturbance

The *Juncus* rushland appears to occupy slightly less inundated areas than the *Polygonum* forbland. At the time of survey it had been avoided by grazing cattle, unlike the *Polygonum* forbland, which had been very heavily grazed and trampled.

Differential grazing may underlie the structural and floristic differences between these two communities. *Polygonum* forbland is closely grazed for its grasses as water levels recede in winter, and this grazing and trampling provides opportunities for establishment of herbaceous vegetation in spring. In contrast, *Juncus* rushland is probably grazed in summer at a lower intensity for the annual *Panicum* component, whilst the *Juncus* are avoided because they are unpalatable to cattle, and this allows the *Juncus* to dominate.
There are fewer weeds and pasture grasses in this community than in any other study area community, although the cover of the exotic *Persicaria strigosa* is far higher than that of any other exotic except for pasture grasses in a few areas of fertilised pasture.

Classification and conservation status

The freshwater wetland types occurred as a complex mosaic that could not be reliably separated and were therefore mapped and sampled as a single community.
The *Juncus* rushland part of the community falls within the vegetation class *Coastal Floodplain Wetlands* (Keith 2004) and is classified as *NR 149 - Coastal floodplain sedgelands, rushlands, and forblands.* It is estimated as being 80% cleared and is of conservation concern.

The *Polygonum* forbland part of the community falls within the vegetation class *Coastal Freshwater Lagoons* (Keith 2004) and is classified as *NR 150 - Coastal freshwater meadows and forblands of lagoons and wetlands.* It is estimated as being 40% cleared and is also of conservation concern.

Both parts of the community are listed in NSW as part of the EEC *Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (Scientific Committee 17/12/04c).

This community is also known habitat for the threatened flora species *Persicaria elatior* which was detected at one location in the study area (Quadrat 22); it is also potential habitat for the threatened flora species *Maundia triglochinoides*, last detected in the study area in 1987.

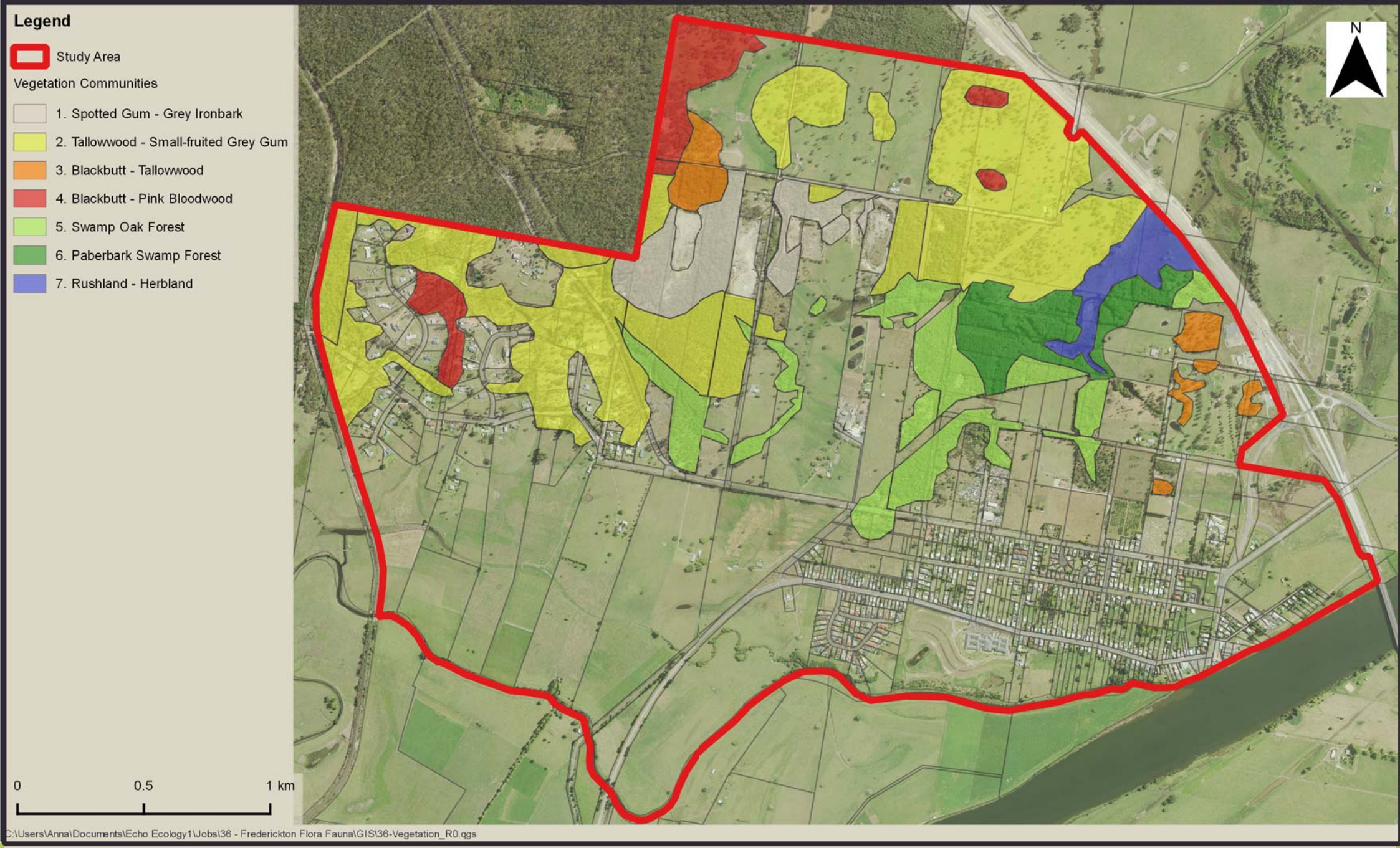

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Figure 3-9
Vegetation Communties

3.4.3 Data analysis and vegetation classification

Classification of the plot data (Figure 3-10) indicated that Spotted gum, Swamp Oak, Paperbark and Rushland - Herbland communities are floristically very distinctive and adequately classified for the purpose of vegetation mapping. On the other hand, Blackbutt-bloodwood, Blackbutt-tallowwood and Tallowwood-grey gum communities are not floristically very distinctive; boundaries between these communities are more gradual and indistinct than indicated by the lines on the vegetation map.

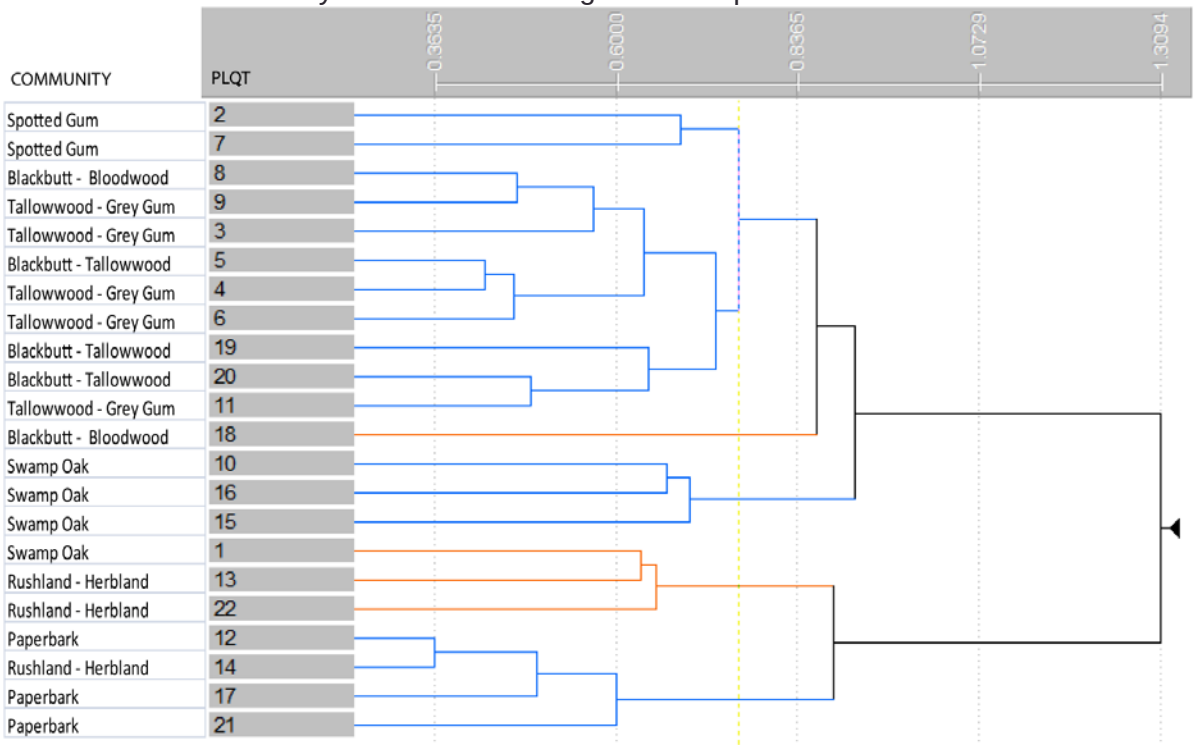

Figure 3-10: Vegetation classification dendrogram

3.4.4 Endangered Ecological Communities

The following EECs were detected in the study area (Figure 3-11):

- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions; and
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

A small area south-west of Frederickton mapped as Rainforest (Telfer and Kendall (2006) was found to be a mixture of sclerophyllous native vegetation and invasive exotic trees together with occasional mature native Fig trees *Ficus virens* and *Jagera pseudorhus* (Foambark) and as such does not constitute rainforest.

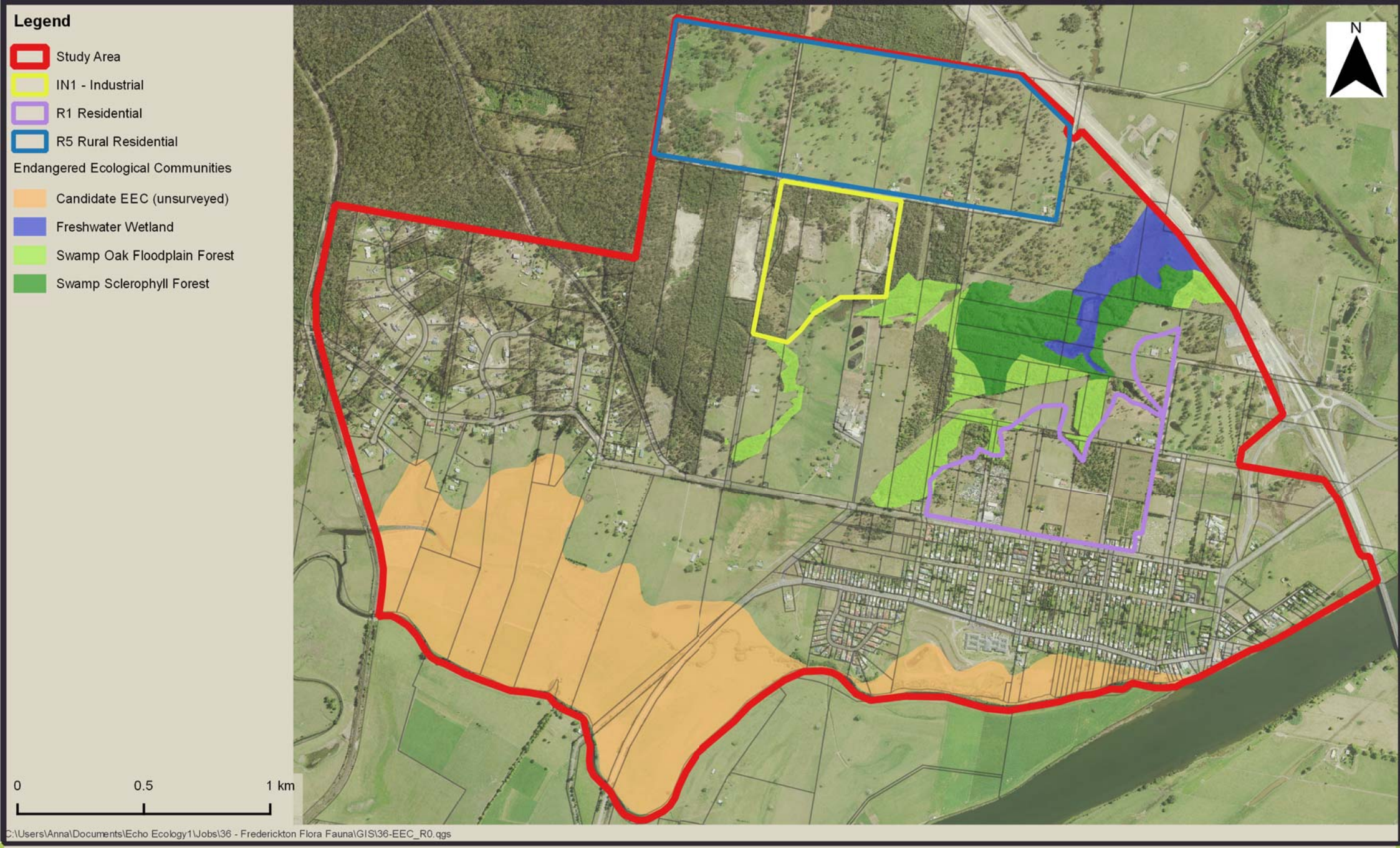

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Figure 3-11
Endangered Ecological Communities

3.4.5 Threatened Flora Species

Threatened flora species considered likely to occur (moderate or greater chance) or recorded (in **bold**) within the study area are:

- *Maundia triglochinoides*;
- ***Persicaria elatior*** **(Knotweed);**

There are 21 Wildlife Atlas records of one threatened flora species, *Maundia triglochinoides*, in the locality. *Maundia triglochinoides* is an emergent herbaceous aquatic species of swamps, lagoons and waterways. It is listed under the TSC Act as Vulnerable in NSW. Nineteen of these records are from 1987 or earlier. Two recent records from 2010, located about 6km north-west of the study area, were detected during studies for the Pacific Motorway (Parsons Brinckerhoff 2006).

Studies for the Pacific Motorway also detected a single plant of *Persicaria elatior* (Parsons Brinckerhoff 2006) which was subsequently removed during the construction of the motorway.

A single plant of *Persicaria elatior* was detected during the field survey approximately 200 metres south-west and upstream of this previous record. No other threatened flora were detected, and except for *Maundia triglochinoides*, none were assessed as likely to occur.

3.4.6 Forest cover mapping

This study identified two main variations in forest cover in the study area (Figure 3-12):

- Normal tree cover – the cover of tree crowns is approximately that of a mature forest that has not been significantly modified by disturbances such as clearing or logging and includes understorey vegetation typical of the type, and
- Partly cleared and under scrubbed - tree cover has been reduced to between 50% and 20% of ‘normal’ tree cover, which in the study area is typically associated with an understorey that has been cleared and is suppressed by grazing or mowing.

Forest cover of less than 20% of normal (less than about 10% tree cover) is not mapped as forest.

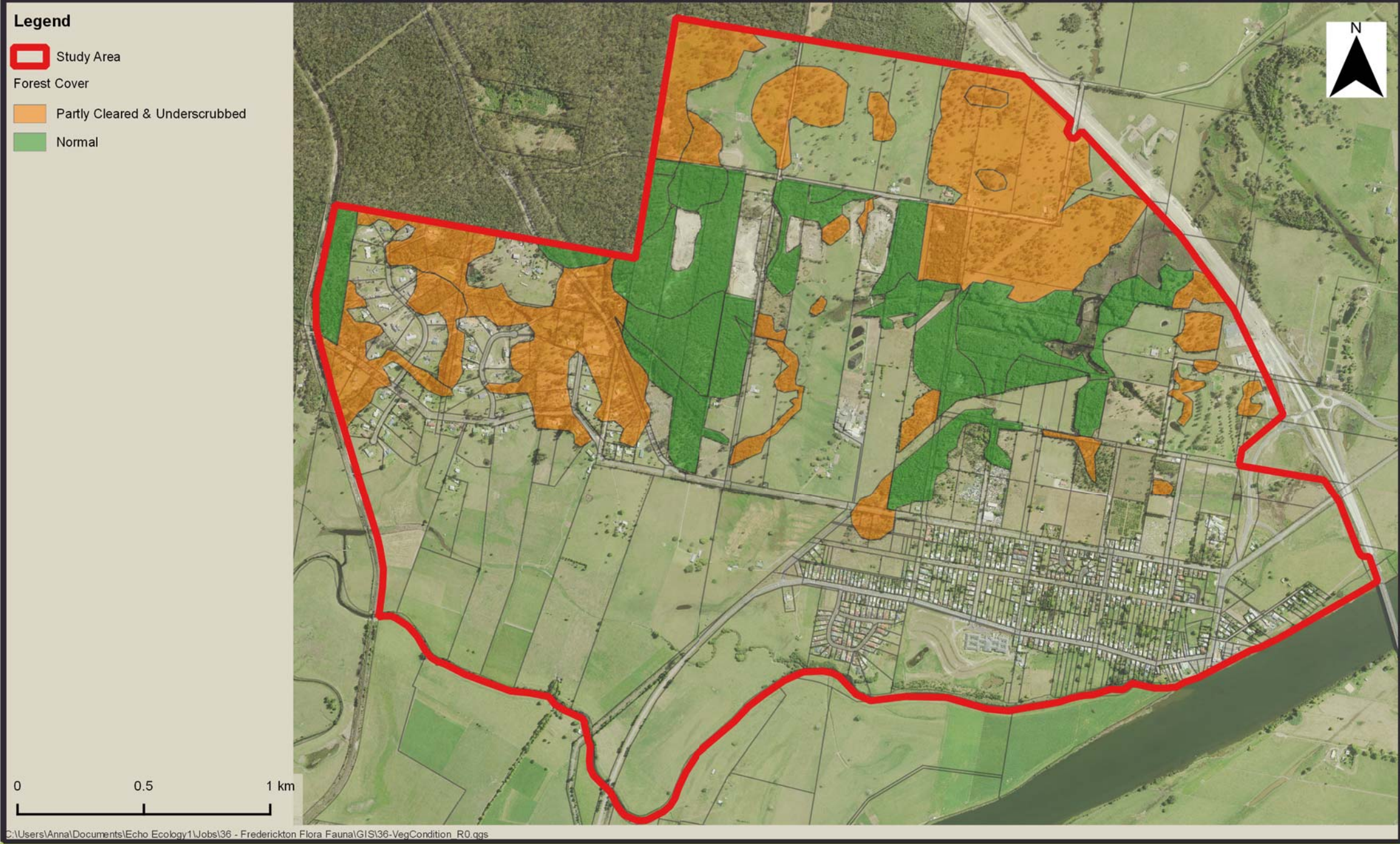

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Figure 3-12
Forest Cover

3.5 Fauna

3.5.1 Terrestrial Mammals

The most common terrestrial mammals encountered during surveys were *Macropus giganteus* (Eastern Grey Kangaroo) and *Macropus rufogriseus* (Red-necked Wallaby). Other macropods observed within the study area were *Wallabia bicolor* (Swamp Wallaby). All three macropod species were also recorded on cameras in the study area. Macropods forage in the grassland across the study area and shelter in the remnant bushland patches.

One male Brown Antechinus (*Antechinus stuartii*), was captured in a terrestrial Elliott A trap at Trapline 1. The Brown Antechinus (*Antechinus stuartii*) was also recorded on cameras in the south of the IN1 Industrial rezoning area.

A total of 18 captures of *Rattus rattus* (Black Rat) and eight *Mus musculus* (House Mouse) were made along trapline 3, mostly from the pine forest within the R1 Residential rezoning area. Few captures of these species were made within the Swamp Oak forest end of the trapline. The high density of *Rattus rattus* (Black Rat) and *Mus musculus* (House Mouse) in the pine forest may be due to the abundance of pine cones that these two introduced species are likely to be feeding on. One *Rattus rattus* (Black Rat) was also captured at Trapline 1 in the IN1 Industrial rezoning area.

Isoodon macrourus (Northern Brown Bandicoot) was captured in a cage trap at trapline 3 in Swamp Oak Forest and recorded on a camera trap (CAM4-2) in paperbark forest. Additionally, conical diggings indicative of bandicoot activity were observed within the IN1 Industrial rezoning area.

One domestic cat was captured in a cage trap at Trapline 1 in the IN1 Industrial rezoning area.

The introduced *Vulpes vulpes* (Fox) was recorded calling during spotlighting and was recorded on cameras at all camera trap locations, except for the eastern end of Raymond's Lane, but this is probably only due to the arboreal location of cameras at that site.

3.5.2 Arboreal Mammals

One mature adult male *Petaurus breviceps* (Sugar Glider) and one mature adult female *Petaurus norfolcensis* (Squirrel Glider) were captured from Trapline 4 (paddock tree property at the north-eastern end of Raymond's Lane). Additionally, two young male (probably 1st year) *Petaurus breviceps* (Sugar Glider) were captured in arboreal traps at Trapline 1 (IN1 Industrial rezoning area).

One *Petaurus norfolcensis* (Squirrel Glider) was observed exiting a tree hollow during spotlighting just after dusk in a paddock tree area to the east of Raymond's Lane. Three *Trichosurus vulpecula* (Common Brushtail Possum) were also recorded during spotlighting of the same area. One *Petaurus norfolcensis* (Squirrel Glider) was recorded on an Ironbark to the north-west of Raymond's Lane. The ironbark had a lot of sap and so the glider could have been feeding on sap or searching for insects.

One *Petaurus breviceps* (Sugar Glider) was recorded in an *Allocasuarina* tree to the south-west of Raymond's Lane during spotlighting and appeared to be eating a casuarina cone. *Petaurus breviceps* (Sugar Glider) were also recorded during spotlighting to the north of Frederickton Golf Course, near the R1 residential rezoning area, along Quarry Rd and along Raymond's Lane.

Two *Trichosurus vulpecula* (Common Brushtail Possum) were captured in a cage trap at Trapline 1 (IN1 Industrial rezoning area).

Koala

Despite spotlighting, camera trapping, song meter recording, opportunistic scat and scratch searches and visual searches of all mature tree canopies within proposed rezoning areas during the hollow-bearing tree survey, no evidence of *Phascolarctos cinereus* (Koala) was recorded within the study area.

Scat searches undertaken using the SAT methodology also failed to detect any *Phascolarctos cinereus* (Koala) within the subject site.

3.5.3 Bats

Insectivorous bats

A total of 3,087 call sequences were recorded, of which 2,644 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 1,536 call sequences (58 %) were able to be confidently identified (those classified as either definite or probable identifications) to species level. Species recorded confidently within the study area include:

- *Austronomus australis* (White-striped Free-tailed Bat)
- *Chalinolobus gouldii* (Gould's Wattled Bat)
- *Chalinolobus morio* (Chocolate Wattled Bat)
- *Miniopterus australis* (Little Bent-winged Bat)
- *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat)
- *Mormopterus norfolkensis* (Eastern coastal Free-tailed Bat)
- *Mormopterus ridei* (Ride's Free-tailed Bat)
- *Rhinolophus megaphyllus* (Eastern Horseshoe Bat)
- *Vespadelus pumilus* (Eastern Forest Bat)

Additionally, the following bat species potentially occurred within the study area, but could not be confidently identified (those calls classified as possible or as a species group):

- *Chalinolobus nigrogriseus* (Hoary Wattled Bat)
- *Falsistrellus tasmaniensis* (Eastern Falsistrelle)
- *Myotis macropus* (Large-footed Myotis)
- *Nyctophilus geoffroyi* (Lesser long-eared bat)
- *Nyctophilus gouldi* (Gould's long-eared bat)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Scotorepens* sp. (Parnaby's Broad-nosed Bat)
- *Scotorepens orion* (Eastern Broad-nosed Bat)
- *Vespadelus darlingtoni* (Large Forest Bat)
- *Vespadelus regulus* (Southern Forest Bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturnus* (Little Forest Bat)

Full details of the bat call identification are provided in Appendix D.

Flying-foxes

Pteropus poliocephalus (Grey-headed Flying-fox) was observed foraging within flowering eucalypts within the study area (Figure 3-13). We also recorded *Pteropus scapulatus* (Little Red Flying-fox) also foraging within the study area. Habitat occurs across much of the study area the form of flowering eucalypts. The closest known flying-fox camp occurs along the Macleay River at Kempsey (author's personal observation). Nectar and fruiting resources likely to be important for this species are discussed in Section 3.3 above.

3.5.4 Diurnal Birds

Commonly recorded bird species in the open pasture areas were *Dacelo novaeguineae* (Laughing Kookaburra), *Cracticus nigrogularis* (Pied Butcherbird), *Strepera graculina* (Pied Currawong), *Cacatua roseicapilla* (Galah), *Coracina novaehollandiae* (Black-faced Cuckoo-shrike), *Ocyphaps lophotes* (Crested Pigeon), *Corvus coronoides* (Australian Raven), *Corvus orru* (Torresian Crow), *Grallina cyanoleuca* (Magpie-lark) *Manorina melanocephala* (Noisy Miner), *Platycercus eximius* (Eastern Rosella) and *Rhipidura leucophrys* (Willie Wagtail). In addition, *Centropus phasianinus* (Pheasant Coucal) was recorded within the more open rural areas.

Nectarivorous bird species were recorded foraging in the canopy of remnant bushland areas and canopy trees in the rural residential areas. Common nectarivorous birds recorded included: *Acanthorhynchus tenuirostris* (Eastern Spinebill), *Caligavis chrysops* (Yellow-faced Honeyeater), *Myzomela sanguinolenta* (Scarlet Honeyeater), *Philemon corniculatus* (Noisy Friarbird), *Trichoglossus haematodus* (Rainbow Lorikeet) and *Glossopsitta concinna* (Musk Lorikeet).

Other forest birds recorded include: *Eopsaltria ausralis* (Eastern Yellow Robin), *Acanthiza lineata* (Striated Thornbill), *Acanthiza pusilla* (Brown Thornbill), *Pachycephala pectoralis* (Golden Whistler), *Colluricincla harmonica* (Grey Shrike-thrush) and *Rhipidura fuliginosa* (Grey Fantail). *Columba leucomela* (White-headed Pigeon) were commonly sighted and *Leucosarcia melanoleuca* (Wonga Pigeon) were captured on a camera within the study area.

Farm dams were frequented by *Chenonetta jubata* (Australian Wood Duck), *Anas castanea* (Chestnut Teal), *Anas superciliosa* (Pacific Black Duck). *Vanellus miles* (Masked Lapwing) were recorded from a number of locations throughout the study area and were regularly recorded calling on dusk.

A number of raptor species were recorded within the study area during surveys including: *Aviceda subcristata* (Pacific Baza), *Circus approximans* (Swamp Harrier), H*aliastur sphenurus* (Whistling Kite), *Aquila audax* (Wedge-tailed Eagle) and *Accipiter cirrocephalus* (Collared Sparrowhawk).

3.5.5 Nocturnal Birds

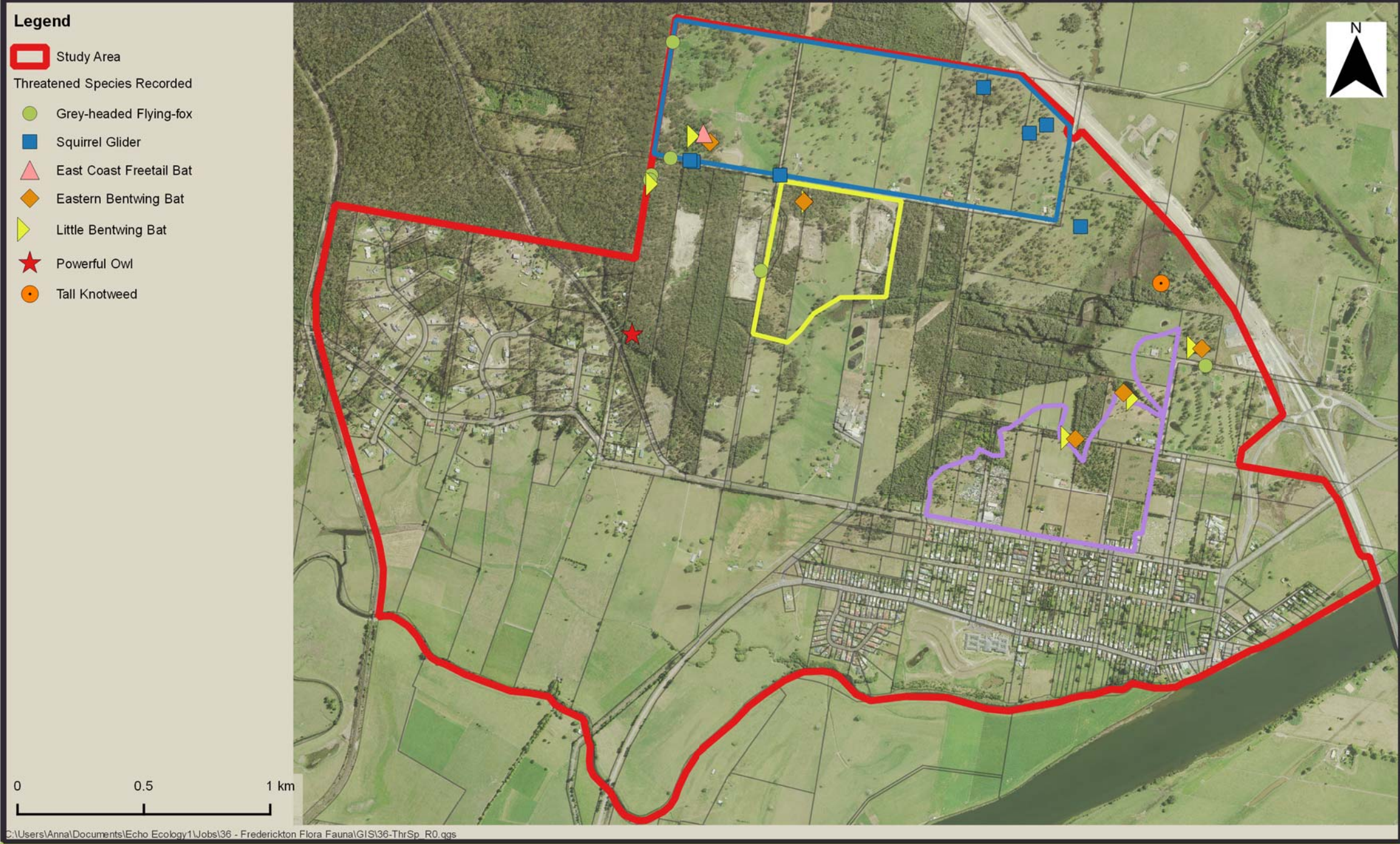
Podargus strigoides (Tawny Frogmouth) was recorded during spotlighting and two individuals were recorded roosting in foliage near Trapline 1. We recorded one *Ninox strenua* (Powerful Owl) call on the Song Meters (Site SM2-4). No owl pellets or other evidence of nesting was found within the subject site during the hollow-bearing tree survey and no response was elicited from our call playback survey.

3.5.6 Amphibians

As these surveys were undertaken during winter when many frog species are inactive, few amphibians were recorded. *Crinia signifera* (Common Eastern Froglet) was heard to call from a number of areas across the study area including: farm dams, creeklines and other waterlogged areas. We observed a tree frog, probably *Litoria tyleri* (Tyler's Tree Frog) in a tree during spotlighting and heard *Limnodynastes tasmaniensis* (Spotted Grass Frog) calling during spotlighting. We also recorded the calls of *Limnodynastes peronii* (Brown-striped Frog) and *Mixophyes fasciolatus* (Great Barred Frog) on Song Meters within the study area.

3.5.7 Reptiles

Cool weather during surveys resulted in only two reptile species being observed during surveys, being *Lampropholis delicata* (Dark-flecked Garden Sunskink) and *Pseudechis porphyriacus* (Red-bellied Black Snake).



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Some threatened species records have been moved slightly to aid display

Figure 3-13
Threatened Species

3.5.8 Threatened Fauna Species

A total of 26 threatened fauna species were found to have at least a moderate chance of occurrence within the study area based on local records, habitat assessment and the results of our survey (see Appendix E for full assessment of likelihood of occurrence).

Threatened fauna species considered likely to occur (moderate or greater chance) or recorded (in **bold**) within the study area are:

- *Litoria brevipalmata* (Green-thighed Frog);
- *Ephippiorhynchus asiaticus* (Black-necked Stork);
- *Botaurus poiciloptilus* (Australasian Bittern);
- *Lophoictinia isura* (Square-tailed Kite);
- *Pandion cristatus* (Eastern Osprey);
- *Irediparra gallinacea* (Comb-crested Jacana);
- *Rostratula australis* (Australian Painted Snipe);
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Lathamus discolor* (Swift Parrot);
- ***Ninox strenua*** **(Powerful Owl);**
- *Tyto novaehollandiae* (Masked Owl);
- *Tyto longimembris* (Eastern Grass Owl);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Dasyurus maculatus* (Spotted-tailed Quoll);
- *Phascogale tapoatafa* (Brush-tailed Phascogale);
- *Phascolarctos cinereus* (Koala);
- *Petaurus australis* (Yellow-bellied Glider);
- ***Petaurus norfolcensis*** **(Squirrel Glider);**
- ***Mormopterus norfolkensis*** **(East Coast Freetail-bat);**
- *Chalinolobus nigrogriseus* (Hoary Wattled Bat);
- ***Miniopterus australis*** **(Little Bentwing-bat);**
- ***Miniopterus schreibersii oceanensis*** **(Eastern Bentwing-bat);**
- *Myotis macropus* (Southern Myotis);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);
- ***Pteropus poliocephalus*** **(Grey-headed Flying-fox).**

The potential impacts on these species arising from the proposed rezoning is discussed in Section 4.0 below.

3.6 Biodiversity Corridors

3.6.1 Riparian Corridors under WM Act

The riparian corridors recommended under the WM Act (see Section 1.4.2) have been illustrated in Figure 3-15. Where these corridors are in good condition they may function as fauna movement corridors.

3.6.2 NPWS Key Habitats and Corridors

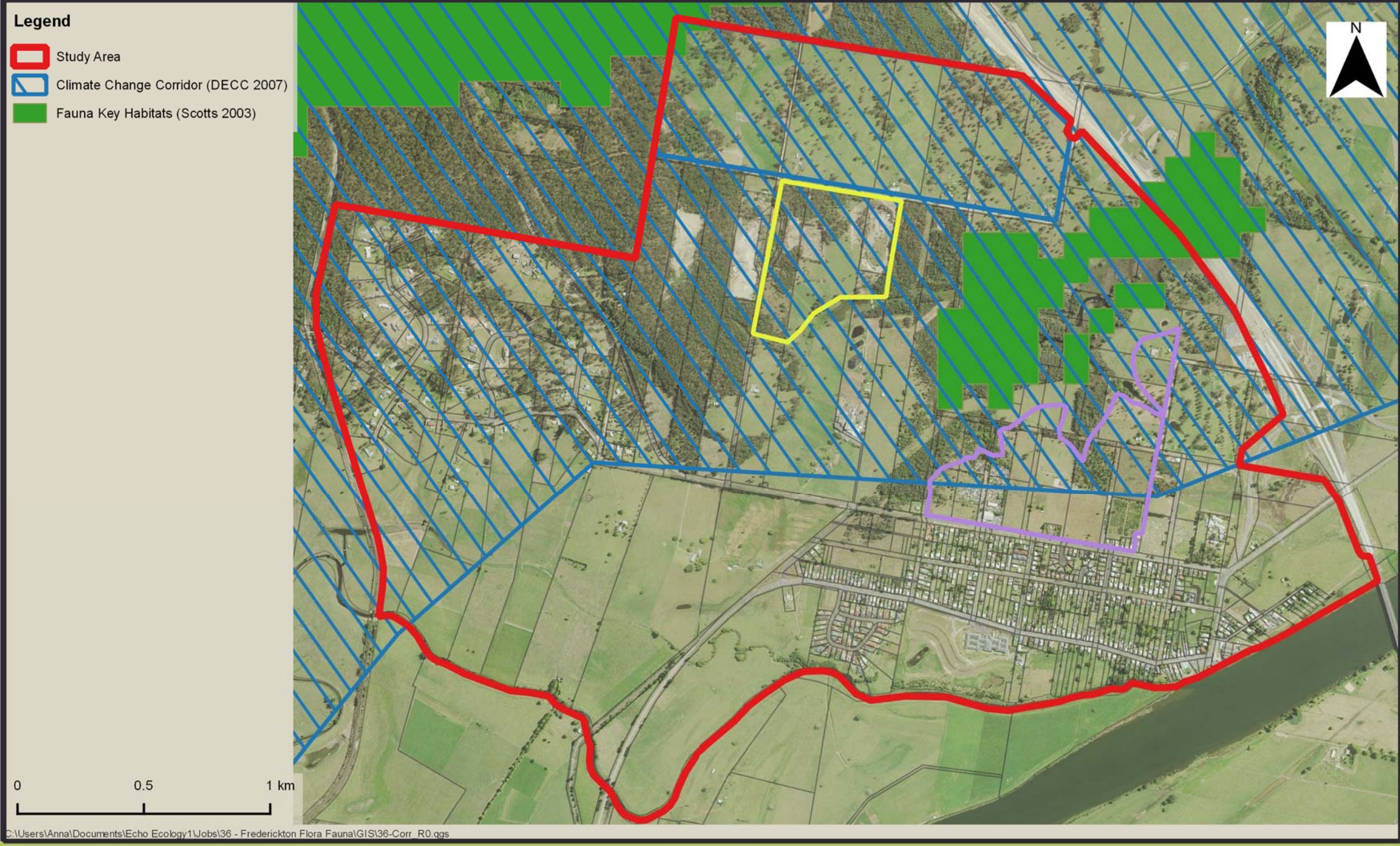
Fauna key habitats (Scotts 2003) are mapped through the wetland areas in the east of the study area and in the dry forest to the north-west of the study area (Figure 3-14). The Collombatti-Rail regional fauna corridor mapped by Scotts (2003) occurs approximately 1 km to the north-west of the study area.

The Nambucca - Macleay corridor is a coastal connector climate change corridor extending from the coast at Nambucca to just west of the study area (Department of Environment and Climate Change 2007) (Figure 3-14). It passes through the northern half of the study area and it targets *Syconycteris australis* (Common Blossom Bat) and *Pteropus poliocephalus* (Grey-headed Flying-fox).

3.6.3 Local Corridors

Immediately to the west of the study area is a large remnant of native vegetation. To the east of the study area occurs the recently completed Pacific Highway. A large underpass exists to allow some connectivity of wetland areas under the Pacific Highway. However, most vegetation to the east of the study area has been heavily modified with only disturbed wetland vegetation remaining. We reviewed the vegetation connectivity extending from the site and have marked some areas that are likely to function as corridors for wildlife movement at a local scale (Figure 3-15). The Frederickton Golf Course contains some large old trees which are part of a remnant patch of dry forest vegetation that occurs to the north. This patch is relatively isolated from other areas of dry forest. However, the riparian vegetation (Paperbark forest) may provide a movement corridor for fauna species and this link should be maintained. The partially cleared proposed R5 Rural Residential zone provides habitat for a number of arboreal mammals and birds that are also likely to use adjacent forested areas. Linkage through the proposed R5 Rural Residential zone should be encouraged through strategic revegetation to ensure that vegetation to the south of Raymond's Lane does not become isolated from more intact vegetation that occurs to the north and west as a result of the proposed rezoning. Similarly, east-west linkage along Raymond's Lane should be further enhanced. There already exists many large old trees within the road reserve of Raymond's Lane. These mature trees should be retained and this area might benefit from bush regeneration works along either side of Raymond's Lane. The drainage line that occurs through the central portion of the study area may also be a target for some future revegetation works. The central portion of this drainage line has been heavily cleared effectively severing the riparian vegetative corridor.

Enhancement works at this location would have benefit as a wet corridor link for local fauna movement.



Frederickton Flora and Fauna Study

Client: Kempsey Shire Council

Job No. 36

Rev. 0

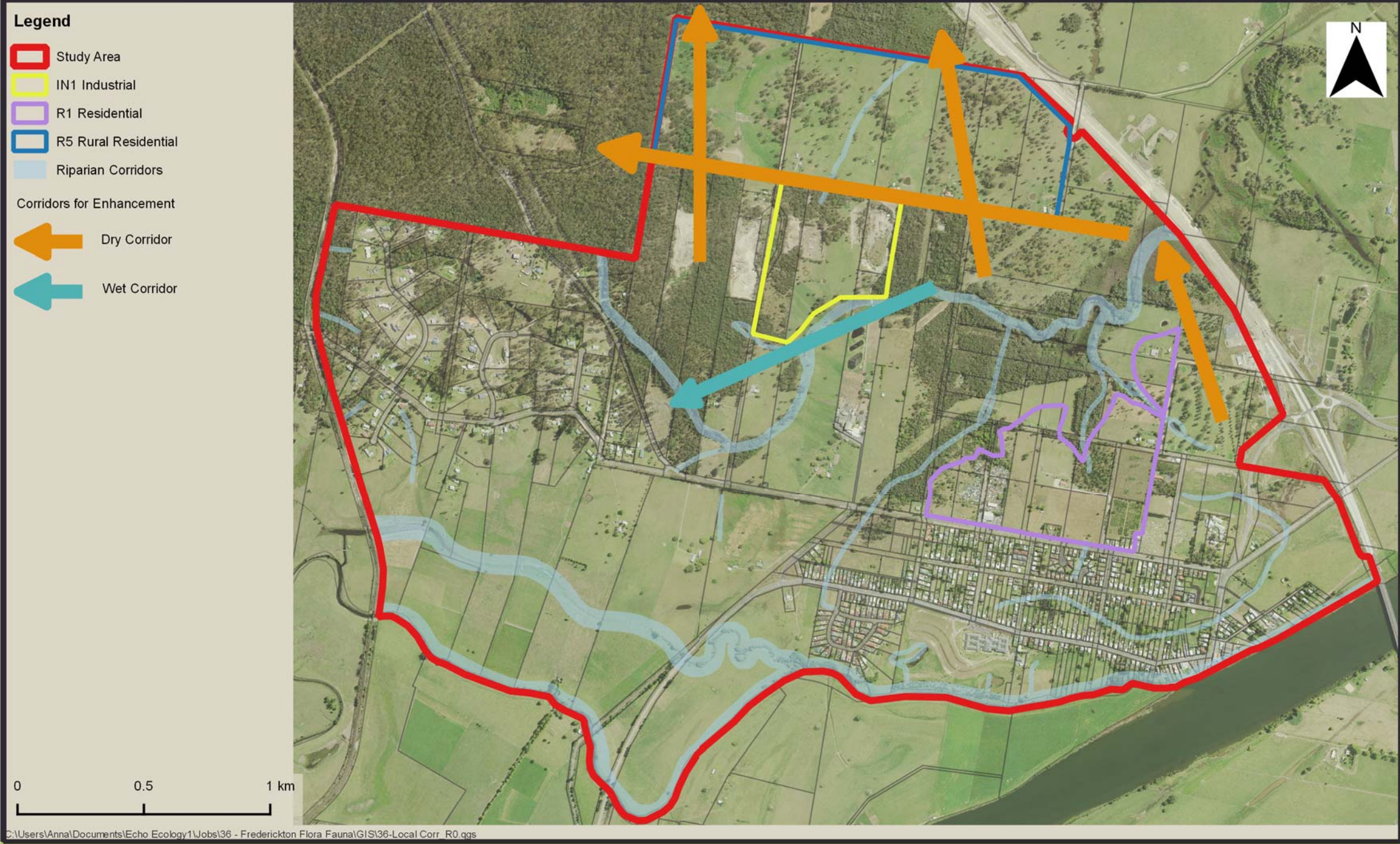
Date 21 September 2016

Aerial Photo - © Land and Property Information (2016)
Cadastre & Study Area Boundaries -© Kempsey Shire Council (2016)
DECC (2007). Landscape Selection Process: key altitudinal, latitudinal and coastal corridors for response to climate change.
Scotts, D. (2003). Key Habitats and Corridors for Forest Fauna, NPWS Occasional Paper.

ECHO ECOLOGY

DISCLAIMER:
Indicative only
All boundaries, scale and points are approximate only
GPS locations recorded at > 5 m accuracy

Figure 3-14
Regional and State Biodiversity Corridors



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ECHO ECOLOGY

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Figure 3-15
Local Biodiversity Corridors

4.0 DISCUSSION

4.1 Potential Impacts

The proposal is examining the rezoning of three areas of land as described in Table 4-1.

Table 4-1: Proposed rezoning description

Proposed Zoning	Current Zoning	Total Area	Description
R1 General Residential	IN1 General Industrial, RU5 Village and RU2 Rural Landscape	39.6 ha	The areas are largely cleared of native vegetation, with small areas of remnant and partly cleared Swamp oak and Blackbutt – Tallowwood forests
IN1 Industrial	RU1 Primary Production	24.4 ha	The area has significant remnant and partly cleared Spotted gum – Ironbark, Tallowwood – Grey gum and Swamp oak forests
R5 Large Lot Residential	RU1 Primary Production and RU2 Rural Landscape	85.4 ha	These areas have large partly cleared remnants of Tallowwood – Grey gum, Blackbutt – Bloodwood and Blackbutt – Tallowwood forest.

4.1.1 Extent of vegetation removal or modification

The areas of each vegetation community within the three areas proposed for rezoning are itemised in Table 4-2 below and their distribution can be seen in Figure 3-9. The area of preferred Koala habitat as defined by the Kempsey CKPoM within each of the proposed rezoning areas is given in Table 4-3 below.

Table 4-2: Area of vegetation within the proposed rezoning (subject site)

Vegetation Community	Area of vegetation (ha) within each rezoning		
	R1	R5	IN1
Spotted gum - Ironbark (intact)	-	-	5.24
Spotted gum - Ironbark (partly cleared)	-	-	1.29
Blackbutt - Tallowwood (intact)	-	-	-
Blackbutt - Tallowwood (partly cleared)	0.03	2.23	-
Blackbutt - Bloodwood (intact)	-	-	-
Blackbutt - Bloodwood (partly cleared)	-	12.10	-

Vegetation Community	Area of vegetation (ha) within each rezoning		
	R1	R5	IN1
Tallowwood – Grey gum (intact)	-	-	1.43
Tallowwood – Grey gum (partly cleared)	-	33.94	0.80
Swamp oak (intact)	0.79	-	0.01
Swamp Oak partly cleared	0.82	-	0.25
Total	**1.64**	**48.27**	**9.02**

Table 4-3: Area of preferred Koala habitat within the proposed rezoning (subject site)

Koala habitat type	Area of preferred Koala habitat (ha) within each rezoning		
	R1	R5	IN1
Secondary (A)	0.03	36.18	1.64
Secondary (B)	-	-	7.12
Total	**0.03**	**36.18**	**8.76**

The key direct impacts associated with increased urbanisation within the study area is clearing and modification of native vegetation and the loss of hollow-bearing trees.

Potential indirect impacts include:

- Increased habitat fragmentation and edge effects;
- Competition and predation by exotic animals and domestic pets;
- Competition from urban-adapted fauna species;
- Street light pollution;
- Weed invasion;
- Decreased water quality and alteration to hydrology;
- Road mortality;
- Disease transmission;
- Altered fire frequency; and
- Contribution to climate change.

The potential impacts for each of the rezoning areas is summarised in Table 4-4. Cumulative impacts from urbanisation in the local area and region may also occur. Each of these impacts are discussed in detail below.

Table 4-4: Potential impacts associated with each rezoning area

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
DIRECT IMPACTS			
Flora species			
Persicaria elatior	Nil	Nil	Nil
Maundia triglochinoides	Nil	Nil	Nil
EECs			
Freshwater Wetlands on Floodplain	Nil	Nil	Nil
Swamp Oak Floodplain Forest	Nil	Nil	Nil
Swamp Sclerophyll Forest on Floodplain	Nil	Nil	Nil
Fauna species			
Litoria brevipalmata Green-thighed Frog	Unlikely. No habitat within zone	Unlikely. No habitat within zone	Unlikely. No habitat within zone (low-lying areas dominated by grass which is unsuitable)

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Ephippiorhynchus asiaticus Black-necked Stork	Removal / modification of < 9 ha of low-lying pasture that may provide marginal foraging habitat after heavy rainfall. The species is unlikely to breed within the zone.	Removal / modification of < 10 ha of low-lying pasture that may provide marginal foraging habitat after heavy rainfall. The species is unlikely to breed within the zone.	Removal / modification of < 2.5 ha of low-lying pasture that may provide marginal foraging habitat after heavy rainfall. The species is unlikely to breed within the zone.
Botaurus poiciloptilus Australasian Bittern	Unlikely	Unlikely	Unlikely
Lophoictinia isura Square-tailed Kite	Removal / modification of approximately 1.64 ha of potential habitat	Removal / modification of approximately 48.27 ha of potential habitat	Removal / modification of approximately 9.02 ha of potential habitat
Pandion cristatus Eastern Osprey	Unlikely. Unlikely to forage or nest within zone.	Unlikely. Unlikely to forage or nest within zone.	Unlikely. Unlikely to forage or nest within zone.
Irediparra gallinacea Comb-crested Jacana	Unlikely	Some farm dams within this zone contain marginally suitable aquatic vegetation for this species. However, it is unlikely that farm dams will be removed as a result of the proposal.	Unlikely
Rostratula australis Australian Painted Snipe	Unlikely	Unlikely	Unlikely
Calyptorhynchus lathami Glossy Black-Cockatoo	Removal / modification of < 1.64 ha of potential foraging habitat and no potential nesting trees (eucalypts with large DBH with large hollows)	Removal / modification of < 1 ha of potential foraging habitat (only a few casuarina individuals recorded within this zone) and 1 potential nesting trees (eucalypts with large DBH with large hollows)	Removal / modification of < 9.02 ha of potential foraging habitat and 1 potential nesting trees (eucalypts with large DBH with large hollows)

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Glossopsitta pusilla Little Lorikeet	Removal / modification of approximately 0.03 ha of potential foraging habitat and two potential nesting trees (trees with small or tiny hollows)	Removal / modification of approximately 48.27 ha of potential foraging habitat and six potential nesting trees (trees with small or tiny hollows)	Removal / modification of approximately 8.76 ha of potential foraging habitat and 14 potential nesting trees (trees with small or tiny hollows)
Lathamus discolor Swift Parrot	Removal / modification of approximately 0.03 ha of potential foraging habitat. No breeding habitat occurs within the study area.	Removal / modification of approximately 48.27 ha of potential foraging habitat. No breeding habitat occurs within the study area.	Removal / modification of approximately 8.76 ha of potential foraging habitat. No breeding habitat occurs within the study area.
Ninox strenua Powerful Owl	Removal / modification of approximately 1.64 ha of foraging habitat and no potential nesting trees (eucalypts with large hollows)	Removal / modification of approximately 48.27 ha of foraging habitat and two potential nesting trees (eucalypts with large hollows).	Removal / modification of approximately 9.02 ha of foraging habitat and two potential nesting trees (eucalypts with large hollows).
Tyto longimembris Eastern Grass Owl	Removal / modification of approximately 39.6 ha of potential foraging habitat. No potential nesting habitat within zone.	Removal / modification of approximately 85.4 ha of potential foraging habitat. No potential nesting habitat within zone.	Removal / modification of approximately 24.4 ha of potential foraging habitat and approximately 1 ha of marginal potential nesting habitat (ungrazed grassland adjacent to wetland)
Tyto novaehollandiae Masked Owl	Removal / modification of approximately 39.6 ha of potential foraging habitat and no potential nesting trees (eucalypts with large hollows).	Removal / modification of approximately 85.4 ha of potential foraging habitat and two potential nesting trees (eucalypts with large hollows).	Removal / modification of approximately 34.4 ha of potential foraging habitat and two potential nesting trees (eucalypts with large hollows).
Daphoenositta chrysoptera Varied Sittella	Removal / modification of approximately 0.03 ha of potential eucalypt foraging and nesting habitat.	Removal / modification of approximately 48.27 ha of potential eucalypt foraging and nesting habitat.	Removal / modification of approximately 8.76 ha of potential eucalypt foraging and nesting habitat.

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Dasyurus maculatus Spotted-tailed Quoll	Removal / modification of approximately 1.64 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.	Removal / modification of approximately 48.27 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.	Removal / modification of approximately 9.02 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.
Phascogale tapoatafa Brush-tailed Phascogale	Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential den trees (trees with tiny or small hollows)	Removal / modification of approximately 48.27 ha of potential foraging habitat and six potential den trees (trees with tiny or small hollows).	Removal / modification of approximately 9.02 ha of potential foraging habitat and 14 potential den trees (trees with tiny or small hollows).
Phascolarctos cinereus Koala	Removal / modification of approximately 0.03 ha of Secondary (A) Koala habitat	Removal / modification of approximately 36.18 ha of Secondary (A) Koala habitat	Removal / modification of approximately 1.64 ha of Secondary (A) Koala habitat and approximately 7.12 ha of Secondary (B) Koala habitat
Petaurus australis Yellow-bellied Glider	Removal / modification of approximately 0.03 ha of marginal potential foraging habitat and one potential den trees (trees with medium hollows)	Removal / modification of approximately 48.27 ha of marginal potential foraging habitat and six potential den trees (trees with medium hollows)	Removal / modification of approximately 8.76 ha of marginal potential foraging habitat and seven potential den trees (trees with medium hollows)
Petaurus norfolcensis Squirrel Glider	Removal / modification of approximately 0.03 ha of potential foraging habitat and two potential den trees (trees with tiny or small hollows)	Removal / modification of approximately 48.27 ha of known foraging habitat and six potential den trees (trees with tiny or small hollows). Proposal may affect at least four family groups.	Removal / modification of approximately 8.76 ha of potential foraging habitat and 14 potential den trees (trees with tiny or small hollows). Proposal may affect at least one family group.
Mormopterus norfolkensis East Coast Freetail-bat	Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential roost trees (trees with tiny hollows or cracks)	Removal / modification of approximately 48.27 ha of potential foraging habitat and 18 potential roost trees (trees with tiny hollows or cracks)	Removal / modification of approximately 9.02 ha of potential foraging habitat and 13 potential roost trees (trees with tiny hollows or cracks)

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Chalinolobus nigrogriseus Hoary Wattled Bat	Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential roost trees (trees with tiny hollows or cracks)	Removal / modification of approximately 48.27 ha of potential foraging habitat and 18 potential roost trees (trees with tiny hollows or cracks)	Removal / modification of approximately 9.02 ha of potential foraging habitat and 13 potential roost trees (trees with tiny hollows or cracks)
Miniopterus australis Little Bentwing-bat	Removal / modification of approximately 1.64 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.	Removal / modification of approximately 48.27 ha of potential foraging habitat. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.	Removal / modification of approximately 9.02 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	Removal / modification of approximately 1.64 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.	Removal / modification of approximately 48.27 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.	Removal / modification of approximately 9.02 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.
Myotis macropus Large-footed Myotis	Unlikely. Unlikely to use dams within zone. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.	The removal or modification of a number of small farm dams may occur within the zone. However, these areas represent marginal habitat for the species. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.	The removal or modification of a number of small farm dams may occur within the zone. However, these areas represent marginal habitat for the species. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Scoteanax rueppellii Greater Broad-nosed Bat	Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential roost trees (trees with tiny hollows or cracks)	Removal / modification of approximately 48.27 ha of potential foraging habitat and 18 potential roost trees (trees with tiny hollows or cracks)	Removal / modification of approximately 9.02 ha of potential foraging habitat and 13 potential roost trees (trees with tiny hollows or cracks)
Pteropus poliocephalus Grey-headed Flying-fox	Removal / modification of approximately 0.03 ha of foraging habitat. No camps were recorded within the zone.	Removal / modification of approximately 48.27 ha of foraging habitat. No camps were recorded within the zone.	Removal / modification of approximately 8.76 ha of foraging habitat. No camps were recorded within the zone.
INDIRECT IMPACTS			
Flora species			
Persicaria elatior	Possible hydrological impacts, eutrophication	Possible hydrological impacts, eutrophication	Unlikely
Maundia triglochinoides	Possible hydrological impacts, eutrophication	Possible hydrological impacts, eutrophication	Unlikely
EECs			
Freshwater Wetlands on Floodplain	Possible hydrological impacts, eutrophication	Unlikely	Possible hydrological impacts, eutrophication
Swamp Oak Floodplain Forest	Possible hydrological impacts, eutrophication	Unlikely	Possible hydrological impacts, eutrophication
Swamp Sclerophyll Forest on Floodplain	Possible hydrological impacts, eutrophication	Unlikely	Possible hydrological impacts, eutrophication

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Fauna species			
Litoria brevipalmata Green-thighed Frog	Possible hydrological impacts, eutrophication of adjacent habitat. Slight chance of disease transmission in low-lying areas	Unlikely	Possible hydrological impacts, eutrophication of adjacent habitat. Slight chance of disease transmission in low-lying areas
Ephippiorhynchus asiaticus Black-necked Stork	Possible hydrological impacts, eutrophication of adjacent habitat	Unlikely	Possible hydrological impacts, eutrophication of adjacent habitat
Botaurus poiciloptilus Australasian Bittern	Possible hydrological impacts, eutrophication of adjacent habitat	Unlikely	Possible hydrological impacts, eutrophication
Lophoictinia isura Square-tailed Kite	Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets	Increase in the potential for competition and predation of nests by exotic animals and domestic pets	Unlikely
Pandion cristatus Eastern Osprey	Unlikely	Unlikely	Unlikely
Irediparra gallinacea Comb-crested Jacana	Possible hydrological impacts, eutrophication of adjacent habitat	Unlikely	Possible hydrological impacts, eutrophication of adjacent habitat
Rostratula australis Australian Painted Snipe	Possible hydrological impacts, eutrophication of adjacent habitat	Unlikely	Possible hydrological impacts, eutrophication of adjacent habitat

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Calyptorhynchus lathami Glossy Black-Cockatoo	Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets	Increase in the potential for competition and predation of nests by exotic animals and domestic pets	Very slight habitat fragmentation.
Glossopsitta pusilla Little Lorikeet	Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets	Increase in the potential for competition and predation of nests by exotic animals and domestic pets	Unlikely
Lathamus discolor Swift Parrot	Unlikely	Unlikely	Unlikely
Ninox strenua Powerful Owl	Unlikely	Slight habitat fragmentation	Slight habitat fragmentation
Tyto longimembris Eastern Grass Owl	Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets Potential for increase in weed invasion of adjacent low-lying areas	Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets Potential for increase in weed invasion of adjacent low-lying areas	Potential for increase in weed invasion of adjacent low-lying areas
Tyto novaehollandiae Masked Owl	Unlikely	Unlikely	Unlikely
Daphoenositta chrysoptera Varied Sittella	Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets	Habitat fragmentation and edge effects Increase in the potential for competition and predation of nests in adjacent areas by exotic animals and domestic pets	Habitat fragmentation and edge effects

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Dasyurus maculatus Spotted-tailed Quoll	Unlikely	Slight habitat fragmentation Increase in the potential for competition and predation by exotic animals and domestic pets Potential for mortality through accidental baiting / trapping	Slight habitat fragmentation
Phascogale tapoatafa Brush-tailed Phascogale	Increase in the potential for competition and predation in adjacent areas by exotic animals and domestic pets	Habitat fragmentation Increase in the potential for competition and predation by exotic animals and domestic pets	Habitat fragmentation
Phascolarctos cinereus Koala	Slight increase in road mortality risk during travel to adjacent habitat.	Slight increase in road mortality risk.	Slight increase in road mortality risk.
Petaurus australis Yellow-bellied Glider	Increase in the potential for competition and predation in adjacent areas by exotic animals and domestic pets	Habitat fragmentation Increase in the potential for competition and predation by exotic animals and domestic pets	Habitat fragmentation
Petaurus norfolcensis Squirrel Glider	Increase in the potential for competition and predation in adjacent areas by exotic animals and domestic pets	Habitat fragmentation Increase in the potential for competition and predation by exotic animals and domestic pets	Habitat fragmentation

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Mormopterus norfolkensis East Coast Freetail-bat	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets Increase in the potential for competition from urban-adapted species Street light pollution	Slight habitat fragmentation Increase in the potential for competition and predation at roosts by exotic animals and domestic pets Increase in the potential for competition from urban-adapted species Street light pollution	Slight habitat fragmentation Increase in the potential for competition from urban-adapted species Street light pollution
Chalinolobus nigrogriseus Hoary Wattled Bat	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets Increase in the potential for competition from urban-adapted species Street light pollution	Slight habitat fragmentation Increase in the potential for competition and predation at roosts by exotic animals and domestic pets Increase in the potential for competition from urban-adapted species Street light pollution	Slight habitat fragmentation Increase in the potential for competition from urban-adapted species Street light pollution
Miniopterus australis Little Bentwing-bat	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets	Slight habitat fragmentation
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets	Slight habitat fragmentation

Threatened Entity	Potential New Zones		
	R1 Residential	**R5 Rural Residential**	**IN1 Industrial**
Myotis macropus Large-footed Myotis	Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets Possible hydrological impacts, eutrophication of adjacent habitat	Unlikely.	Possible hydrological impacts, eutrophication of adjacent habitat
Scoteanax rueppellii Greater Broad-nosed Bat	Slight habitat fragmentation Increase in the potential for competition and predation at roosts in adjacent areas by exotic animals and domestic pets Increase in the potential for competition from urban-adapted species Street light pollution	Slight habitat fragmentation Increase in the potential for competition and predation at roosts by exotic animals and domestic pets Increase in the potential for competition from urban-adapted species Street light pollution	Slight habitat fragmentation Increase in the potential for competition from urban-adapted species Street light pollution
Pteropus poliocephalus Grey-headed Flying-fox	Unlikely	Very slight habitat fragmentation	Very slight habitat fragmentation

4.1.2 Direct Impacts

Direct impacts on threatened species, populations and communities listed under TSC Act and / or EPBC Act associated with the potential increased urbanisation of the study area relate to removal or modification of habitat.

Clearing or modification of native vegetation

The rezoning of the R1 Residential area will remove only a small amount of native vegetation to permit higher density residential dwellings and as such it is unlikely to have a major contribution within the study area. However the rezoning of the R5 Rural Residential and IN1 Industrial areas will require the clearing of larger areas of native vegetation. There will be clearing or modification of vegetation as a short term impact during the construction of housing, roads and other infrastructure. However, vegetation clearing and modification is likely to continue during the operational stage of the R5 Rural Residential zoning area for asset protection and as residents are likely to continue to modify and remove native vegetation. The magnitude of this impact will depend on the final configuration of the R5 Rural Residential zone in relation to remnant vegetation. The clearing or modification (including understorey maintenance) of native vegetation is the major direct impact associated with a change in land-use. The *clearing of native vegetation* is listed as a KTP under the TSC Act and represents a direct loss of habitat for a number of threatened fauna species and also for the candidate EEC.

Rural residential zonings have a large ecological footprint and contribute very little to rural primary production. Therefore, they are the least desirable types of residential development from a sustainability perspective. Standard residential housing is preferred over sprawling rural residential developments.

In addition, clearing and modification of native vegetation is likely to involve the removal of woody debris from the ground to permit housing to be built, establish bushfire asset protection zones, or by future property owners. A reduction in understorey and woody debris within the subject site is likely to reduce the amount of habitat available to small terrestrial mammals and other fauna species that require shelter opportunities. The *removal of dead wood and dead trees* is listed as a KTP under TSC Act.

To minimise these ecological impacts it is recommended to focus any new zonings into areas that have already been cleared. Suitable offsets (Section 4.9) may need to be entered into conservation for perpetuity under an appropriate legal framework. Infrastructure and asset protection zone requirements should be considered in the structure plan process with an aim to minimise vegetation clearing and avoid encroaching on riparian and EEC buffers.

Loss of hollow-bearing trees

Hollow-bearing trees are a key habitat resource for at least 40 threatened fauna species in NSW (Gibbons and Lindenmayer 2002). Hollows are used as diurnal or nocturnal shelter sites, for rearing young, foraging, thermoregulation and to facilitate ranging behaviour and dispersal (Gibbons and Lindenmayer 2002). The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. Hollows may take a century or more to form and so are slow to be replaced.

While some hollow-bearing trees remain within the study area, it is likely that many more hollow-bearing trees have been removed for grazing in rural areas and to permit housing, for infrastructure, safety and aesthetics in rural residential areas. An increase in urbanisation is likely to result in the removal of further hollow-bearing trees to permit further development, roads and infrastructure. Depending on the extent, hollow loss within the study area may reduce the viability of local populations of threatened hollow-dependent fauna species.

An increase in urbanisation within the study area will contribute to the *loss of hollow-bearing trees* and the *removal of dead wood and dead trees* KTPs listed under TSC Act. The further loss of hollow-bearing trees within the study area may also contribute to the operation of a number of other KTPs listed under TSC Act such as indirect impacts associated with *Competition from feral honey bees Apis melifera.*

4.1.3 Indirect Impacts

The potential rezonings of the study area may result in a number of indirect impacts resulting from increased human population both within and adjacent to the study area.

Habitat fragmentation, edge effects and connectivity

Much of the remnant vegetation within the study area is already fragmented and subject to edge effects. Vegetation in the west of the study area is well connected to more intact bushland further to the west. Riparian vegetation along the central-east drainage line forms a linear remnant that runs north-east to south-west. There is a relatively isolated dry forest fragment to the immediate north of the golf course. However, some fauna may still be able to use this area via the swamp forest to the north-west. There is almost no remnant vegetation to link the northern bushland remnants of the study area with Christmas Creek or the Macleay River.

The proposed R1 Residential zoning will have very little impact on bushland connectivity as little native vegetation remains in this study area. The proposed R5 rural residential zoning will sever connectivity between vegetation in the east of the study area and the larger forested area to the west. The proposed IN1 industrial zoning will similarly sever east-west connectivity between remnant vegetation along Raymond's Lane. However, this connectivity may be retained through the protection of appropriately located vegetated corridors to facilitate safe faunal movement.

Feral animals and domestic pets

Impacts to wildlife from domestic dog and cat attacks are likely to increase with an increase in residential development. Predation on wildlife by domestic animals is common wherever free-ranging dogs and cats occur. Rural residential properties are often a source of dog attacks as dogs free-range across large, semi-vegetated properties. Domestic cats from any residential or rural residential area can impact native wildlife within adjacent bushland as they are able to roam widely. Additionally, domestic pets may also contribute to feral populations of both dogs and cats which cause large impacts on wildlife. While these impacts are likely to be already occurring within the study area, an increase in housing will put further pressure on wildlife persisting in the local area.

The potential impacts associated with domestic pets are likely to be a particular issue within the R5 rural residential proposed zone. These impacts will likely extend beyond the R5 zone itself into the more intact bushland that occurs adjacent. The increased potential for dog and cat predation will place increased pressure on the local Squirrel Glider population that is likely to already suffer from loss of habitat and hollow-bearing trees as a result of the R5 rural residential zone.

Cat predation into the swamp areas is likely to be the main issue associated with the proposed R1 residential zone as dog activity in higher density residential areas is more strictly managed.

The IN1 industrial development is unlikely to contribute to this indirect impact.

There are a number of KTPs listed under TSC Act that address impacts from feral animals. While domestic pets are likely to be a potential issue associated with the rezoning proposal, we consider it unlikely that an increase in urbanisation will increase the activity of feral animals beyond what is currently occurring (see Appendix F for further details).

Competition from urban-adapted fauna species

Introduced and native fauna species that are well-adapted to urban areas are likely to outcompete many native fauna species currently existing within the study area. Bird species such as the introduced *Acridotheres tristis* (Indian Mynah) and native *Manorina melanocephala* (Noisy Miner) flourish in the environments created by residential development. These species are quite territorial and compete with other bird species for good foraging areas and for birds and mammals for nesting hollows. This competition may extend into surrounding bushland areas. *The aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners Manorina melanocephala* is listed as a KTP under the TSC Act.

The potential loss of hollow-bearing trees as a result of the proposed rezonings may contribute to competition pressure among hollow-dependent fauna. It may exacerbate pressures currently acting on native fauna such as competition from feral honey bees. *Competition from feral honey bees, Apis melifera* is a KTP listed under TSC Act.

Increased lighting

Increased residential development within the study area will result in an increase of light pollution from street lights and other community features. The response of fauna to increased levels of light varies greatly even among closely related species. High levels of light may discourage some mobile species from flying over urban areas, while some other diurnal species may benefit by extending their foraging period into the night. Similarly, insects attracted to street lights provide prey for some nocturnal bird and bat species. However again, this response isn't universal with some insectivorous species found to actively avoid street lights. The impacts of increased urban lighting also extend to adjacent bushland where light spill may affect animal behaviour and decrease survival rates.

Weed invasion

A number of weeds were recorded within the study area during surveys and others are likely to be present in the pasture areas that were not studied in detail. An increase in urbanisation within the study area may result in additional weed invasion through inappropriate garden waste disposal into adjacent bushland areas and during construction. However, there are also opportunities for increased urbanisation to result in greater weed control due to the implementation of vegetation management plans for areas of conservation.

The following six KTPs relating to exotic weed invasion are listed under TSC Act:

- The invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of Lantana (*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 exotic perennial grasses;
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. Cuspidate; and
- Invasion of native plant communities by *Chrysanthemoides monilifera*.

Water Quality and Alteration to hydrology

Increased urbanisation will result in changes to the hydrology of the study area by creating more impermeable surfaces for water to runoff. This may influence flow volumes, duration and groundwater recharge. Water quality may be negatively affected due to increased nutrient loads, erosion and sedimentation. However, potential impacts to water quality may be ameliorated through careful stormwater planning and management.

The unnamed watercourse that runs through the centre of the study area appears to be already experiencing high nutrient loads as indicated by eutrophic conditions. More downstream areas contain a high abundance of weedy exotic plant species, further

indicating existing disturbance. The proposed R1 residential and IN1 Industrial zones occur within the catchment of this drainage line and the proposal may further decrease the quality of these riparian areas without careful mitigation measures.

Road Mortality
Increased traffic as a result of increased urbanisation has the potential to result in a higher number of wildlife roadkills. However, this is considered to only be a slight increase, the increased local traffic for residential purposes is unlikely to pose a substantial risk to local wildlife.

Disease Transmission
Amphibian chytrid fungus has been found to cause the disease chytridiomycosis which is thought to be responsible for amphibian declines globally and in Australia. *Infection of frogs by amphibian chytrid causing the disease chytridiomycosis* is listed as a KTP under TSC Act. An increase in urbanisation may result in the transport of chytrid fungus to previously uninfected areas via soil transfer during construction.

Phytophthora cinnamomi is another fungus associated with tree dieback in Australia's forests. *Infection of native plants by Phytophthora cinnamomi* is a KTP listed under TSC Act. An increase in urbanisation may result in the transport of this fungus to previously uninfected areas via soil transfer during construction.

Appropriate construction vehicle hygiene is required to minimise these potential impacts.

Altered Fire Frequency
Increased urbanisation in close proximity to bushland often results in high frequency fires due to hazard reduction burns for asset protection, accidental fires and arson. While occasional fires promote diversity in many Australian ecosystems. High frequency fire may reduce the diversity of plant species, remove hollow-bearing trees and cause fauna mortality. High frequency fire is listed as a key threatening process under the TSC Act.

Climate change
It is likely that an increase in urbanisation within the study area will contribute slightly to climate change through in increase in greenhouse gas emissions during construction and operation. *Anthropogenic climate change* is listed as a KTP under TSC Act. However, there are opportunities for future residential development to incorporate sustainable design elements to reduce carbon footprints.

4.1.4 Cumulative Impacts

Any change in land-use within the study area is likely to contribute to cumulative impacts at both a local and regional scale. At a local scale, the development of the rural residential estate in the west of the study area is likely to continue to contribute to ecological impacts through tree loss and domestic pet predation. Regionally, the mid-north coast is also experiencing a high level of urban growth.

4.2 Threatened Flora

4.2.1 *Persicaria elatior*

This species normally grows in damp places, especially beside streams and lakes; occurs occasionally in swamp forest or is associated with disturbance. The species was first recorded in the unnamed watercourse receiving area by targeted searches for the species for the proposed motorway in 2006 and subsequently by this study. For the purpose of this assessment it is assumed that the local population is viable. Its persistence to date in the face of known threats operating in the habitat, which include clearing or disturbance of habitat, hydrological changes to wetland vegetation, predation by grazing livestock and damage to the plant and its seedbank from trampling by livestock, indicates that it may be resilient to the additional hydrological impacts likely to arise from the proposed rezoning. However, the population appears to be very small and as such may be vulnerable to any increase in hydrological impacts, especially eutrophication.

4.2.2 *Maundia triglochinoides*

The essential habitat of *Maundia triglochinoides* is considered to be swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. The species was recorded in several locations in the south of the study area near Christmas Creek and the Macleay River in 1987. It has not been recorded in the unnamed watercourse (in the central-east of the study area) receiving area despite targeted searches for the species for the proposed motorway and for this study, suggesting that the habitat may be unsuitable. Given that known threats to the species including changes in water quality and weed invasion are evident in the habitat and appear to have been operating for some time it is unlikely to occur there.

4.3 Endangered Ecological Communities

While the rezoning areas will not directly remove any EEC, there is potential for increased urbanisation to result in indirect impacts on the EECs through altered hydrology, decreased water quality and weed invasion. These indirect impacts will need to be assessed and strictly managed at both the individual development and local area scales.

4.4 Threatened Fauna

Unless otherwise stated, habitat description information was sourced from NSW OEH Threatened Species Profile Database (http://www.environment.nsw.gov.au/threatenedspecies).

4.4.1 Diurnal Birds

Woodland birds

Daphoenositta chrysoptera (Varied Sittella) is a small songbird that feeds on insects gleaned from tree canopies, trunks, dead branches and decorticating bark. 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. Suitable habitat occurs in remnant eucalypt bushland throughout the study area. Being fairly sedentary, the species absence during surveys indicates that it is unlikely to occur within this zone. However, its occurrence within the subject site at some future stage cannot be discounted.

Increased urbanisation has the potential to directly impact *Daphoenositta chrysoptera* (Varied Sittella) through fragmentation and habitat loss in bushland remnants and treed rural areas. Additionally, indirect impacts including predation by domestic cats and competition from urban-adapted bird species such as *Acridotheres tristis* (Indian Mynah) and *Manorina melanocephala* (Noisy Miner) is likely to have a detrimental effect on this urban-sensitive species.

Raptors

Lophoictinia isura (Square-tailed Kite), listed as Vulnerable under the TSC Act, is considered likely to occur within the study area. This species is a specialist hunter of passerine birds and insects. Remnant forest patches, particularly those along drainage lines, provide suitable foraging habitat and large eucalypts offer nesting opportunities. No raptor nests were observed within the subject site during surveys. An increase in urbanisation within the study area has the potential to impact on the *Lophoictinia isura* (Square-tailed Kite) through the loss of remnant bushland habitat. However, there is also the opportunity to enhance habitats within the study area through the rehabilitation of riparian corridors and consolidation of fragmented habitats. The riparian habitats preferred by the species will not be removed.

Pandion cristatus (Eastern Osprey) is a specialist hunter of fish and is listed as Vulnerable under the TSC Act. It favours coastal areas, particularly the mouths of large rivers, lagoons and lakes. Within the study area, it is likely to hunt along the Macleay River and possibly along the more marginal and smaller Christmas Creek. It is unlikely to forage over any of the small dams and vegetated wetlands that occur within or adjacent to the subject sites. The species is unlikely to be adversely affected by the rezoning proposal.

Wetland birds

Ephippiorhynchus asiaticus (Black-necked Stork) is a large and distinctive waterbird that forages in water or flooded grasslands for vertebrate and invertebrate prey. *Ephippiorhynchus asiaticus* (Black-necked Stork) is listed as Endangered under TSC Act. Suitable foraging habitat for the species occurs in the low-lying floodplain areas of the study area. In particular, the low-lying pasture which contains wetlands in the south of the study area near Christmas Creek are likely to be used by the species, despite the cattle

grazing land use. The low-lying areas of the subject site represent marginal foraging habitat for the species as they are outside of the floodplain. However, the species occurrence within the subject site cannot be entirely discounted.

Potential impacts on *Ephippiorhynchus asiaticus* (Black-necked Stork) arising from the proposal are mostly associated with the indirect impact on the water quality of adjacent areas of habitat. The proposal will also remove a small amount of marginal habitat for the species.

Botaurus poiciliptilus (Australasian Bittern) is listed as Vulnerable under the TSC Act and it favours permanent freshwater wetlands with tall dense vegetation, particularly bulrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.). *Rostratula australis* (Australian Painted Snipe) is listed as Endangered under both the TSC Act and EPBC Act. It prefers the fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.

Potential habitat for *Botaurus poiciliptilus* (Australasian Bittern) and *Rostratula australis* (Australian Painted Snipe) species occurs within the sedgeland / rushland freshwater wetland vegetation within the central-east of the study area. These species are unlikely to occur within the subject site and as such potential impacts from the proposal are limited to the potential for indirect impacts on water quality in adjacent wetlands.

Irediparra gallinacea (Comb-crested Jacana) inhabits freshwater wetlands, either still or flowing, with a good surface cover of floating vegetation, especially water-lilies or fringing aquatic vegetation. It is listed as Vulnerable under the TSC Act. Potential habitat occurs within some large dams within the study area that contain floating vegetation including some marginal habitat within the R5 Rural Residential rezoning area. Additionally, the freshwater wetland in the central-east of the study area contains some areas of suitable habitat. Potential impacts on the species associated with the proposal are limited to a small amount of habitat removal / modification and the potential for indirect impacts on water quality in adjacent wetlands.

Cockatoos and parrots

Calyptorhynchus lathami (Glossy Black-Cockatoo) is a small cockatoo listed as Vulnerable under TSC Act that feeds almost exclusively on the seeds of *Casuarina* spp. and *Allocasuarina* spp.. Potential foraging (*Allocasuarina* spp.) and nesting habitat (large tree hollows) occur within the study area. The proposal will remove < 10 ha of potential foraging habitat and two hollow-bearing trees that may be potentially used for nesting (trees with large DBH and large hollows). However, no evidence of the species was recorded during surveys within this zone (undertaken during the breeding season) and as such, it is unlikely that a resident pair currently nests nearby. Indirect impacts including increased predation risk from domestic and feral cats may also impact this species.

Glossopsitta pusilla (Little Lorikeet) is a highly mobile nectarivorous bird species that is listed as Vulnerable under TSC Act. It nests in small tree hollows (approximately 3 cm

diameter) of smooth-barked trees. Potential foraging habitat occurs in flowering eucalypts across the study area which are ranked highly as a nectar resource by Eby and Law (2008). Increased urbanisation is likely to reduce the amount of foraging habitat available to the species, fragment habitat slightly and may remove 22 potential nesting hollows. However, as riparian trees are most often selected for nest sites, the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows.

Lathamus discolor (Swift Parrot) is listed as Endangered under the TSC Act and EPBC Act. It is a small to medium parrot that breeds in Tasmania and migrates to south-eastern mainland Australia during winter. Winter-flowering eucalypts within the study area may represent foraging habitat for the species during good flowering years. As for the *Glossopsitta pusilla* (Little Lorikeet), increased urbanisation within the study area is likely to reduce the amount of potential foraging habitat available to the species.

4.4.2 Forest Owls

There are two forest owls listed as Vulnerable under the TSC Act that have the potential to occur within the study area, being *Ninox strenua* (Powerful Owl) and *Tyto novaehollandiae* (Masked Owl). *Ninox strenua* (Powerful Owl) is the largest owl in Australia and is able to tolerate fragmented landscapes such as the study area. *Ninox strenua* (Powerful Owl) hunts medium-sized arboreal mammals including gliders, possums and occasionally flying-foxes. *Ninox strenua* (Powerful Owl) roost in dense, often riparian vegetation and breeds in large tree hollows in large, old eucalypts. *Tyto novaehollandiae* (Masked Owl) is a medium-sized owl that often hunts along the edges of forests including roadsides for both arboreal and terrestrial mammals, particularly rats. *Tyto novaehollandiae* (Masked Owl) roosts and breeds in moist eucalypt gullies, nesting in large tree hollows. *Ninox strenua* (Powerful Owl) was recorded within the central-west of the study area. Foraging habitat for *Ninox strenua* (Powerful Owl) occurs within forested areas of the study area and subject site. Foraging habitat for *Tyto novaehollandiae* (Masked Owl) occurs across the semi-vegetated rural areas of Raymond's Lane and forest edges within the remainder of the study area. Two trees with large hollows occur within the R5 Rural Residential and two trees with large hollows occur within the IN1 Industrial zone. It is unlikely that *Ninox strenua* (Powerful Owl) would nest within this zone as the hollow-bearing trees do not occur in dense rainforest gullies. However, these four hollow-bearing trees may represent potential roosting habitat for *Tyto novaehollandiae* (Masked Owl). However, no evidence of use by owls was recorded at these trees during our study which was undertaken during the breeding season. Potential impacts arising from the proposal on these two owl species relate mainly to the direct loss of foraging and potential nesting habitat for *Tyto novaehollandiae* (Masked Owl).

4.4.3 Eastern Grass Owl

*Tyto longimembris (*Eastern Grass Owl) is another owl species, listed as Vulnerable under the TSC Act that also has the potential to occur within the study area. *Tyto longimembris (*Eastern Grass Owl) hunts in more open habitats for terrestrial mammals, particularly small rodents. *Tyto longimembris (*Eastern Grass Owl) makes nests on the ground in areas of tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath and in cane grass or sedges on floodplains. There are local records of *Tyto longimembris (*Eastern Grass Owl) and suitable habitat occurs within low-lying ungrazed areas. Depending on seasonal land use and grazing pressure additional low-lying areas may become suitable for nesting by the species over time where cattle grazing is removed to allow grass to become long and undisturbed. Searches were undertaken for the species within low-lying grassy areas on the edge of wetlands adjacent to the subject site. However, no evidence of nesting was found. Potential impacts arising from the proposal on this owl species relate mainly to the potential indirect impacts on the water quality of surrounding wetlands. A small area of marginal potential nesting habitat occurs in the south of the IN1 Industrial rezoning area.

4.4.4 Frogs

Litoria brevipalmata (Green-thighed Frog) is a small frog listed as Vulnerable under the TSC Act. They occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. Breeding occurs following heavy rainfall from spring to autumn, with larger temporary pools and flooded areas preferred. Lemckert et al. (2006) found that frogs called from temporary water bodies within or near areas of wetter forest types in depressions with a leafy/shrubby substrate. Grass-filled depressions were rarely used. All but one site investigated by Lemckert et al. (2006) was located within 100m of a tract of natural vegetation > 20 ha and none were found in largely cleared grazing lands or within entirely urban areas. This is likely to be due to their preference for low shrubs and leaf litter as shelter (Lemckert et al. 2006). However, the species appears to be somewhat tolerant of disturbance such as partial land clearing and logging (Lemckert et al. 2006).

Within the study area potential habitat for *Litoria brevipalmata* (Green-thighed Frog) occurs in low-lying forested areas such as the paperbark swamp in the central-eastern portion of the study area where pools form after substantial rainfall. Low-lying grassy and grazed areas of the study area, such as those that occur within the subject site are unlikely to provide habitat for this species.

4.4.5 Microbats

A total of six microbat species listed as Vulnerable under the TSC Act have the potential to occur within the study area.

Mormopterus norfolkensis (East Coast Freetail-bat) is a small, fast-flying insectivorous microbat that appears to prefer productive floodplain habitats and avoid urban areas

(McConville et al. 2014). It roosts singularly or communally in tree hollows and appears to prefer to breed in tree hollows in patches of forest that have a high density of hollow-bearing trees (McConville et al. 2013b). It may fly up to 10 km from roosts to forage (McConville et al. 2013b).

Chalinolobus nigrogriseus (Hoary Wattled Bat) occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common. It flies fast below the canopy level, so forests with naturally sparse understorey layers are likely to provide the best habitat. It roosts in tree hollows and rock crevices and is somewhat tolerant of urban areas.

Miniopterus australis (Little Bentwing-bat) occurs in a range of habitat types, generally in well-timbered areas. It roosts in caves, tunnels, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings. Females congregate in large maternity colonies in caves to give birth, of which only five are known. The nearest maternity colony is located at Willi Willi caves, west of Kempsey.

Miniopterus schreibersii oceanensis occurs in a range of habitat types including urban areas. It roosts in caves, derelict mines, culverts and other man-made structures. Females congregate in large maternity colonies in caves to give birth, of which only two remain. The nearest maternity colony is located at Willi Willi caves, west of Kempsey.

Scoteanax rueppellii (Greater Broad-nosed Bat) is a medium-sized insectivorous bat that has been recorded from a variety of habitats from woodland to moist and dry eucalypt forest and rainforest. Roosts in tree hollows, but has been also found in buildings.

Myotis macropus (Southern Myotis) forage over streams and pools catching insects and small fish by raking their feet across the water surface. Roost and breed close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. Suitable habitat for *Myotis macropus* (Southern Myotis) within the study area occurs along the Macleay River and Christmas Creek. It may also use large dams with open water in close proximity to these major watercourses.

Potential roosting (and breeding) habitat for threatened hollow-roosting microbat species (*Mormopterus norfolkensis, Chalinolobus nigrogriseus* and *Scoteanax rueppellii*) occurs within hollow-bearing trees recorded within the study area. Hollow-bearing trees close to the major watercourses (Macleay River and Christmas Creek) may provide roosting opportunities for *Myotis macropus*. There are some culverts within the study area that may provide roosting habitat for the three cave-dwelling threatened microbats that have the potential to occur within the study area (*Myotis macropus, Miniopterus australis* and *Miniopterus schreibersii oceanensis*).

An increase in house density in the future within the study area would reduce foraging habitat for these species and is also likely to result in the loss of some potential roosting and breeding habitat for hollow-roosting species. While some common microbat species have been found to be able to exploit urban habitats (e.g. *Chalinoblobus gouldii* and *Mormopterus ridei*), out of the threatened species likely to occur within the study area, only the two *Miniopterus* spp. and *Chalinolobus nigrogriseus* (Hoary Wattled Bat) are often recorded from urban environments. As our surveys were undertaken during winter when microbats are less active it is difficult to determine the importance of the habitats within the subject site to these threatened species.

While the proposal will modify a large area of foraging habitat for cave-roosting microbat species, no breeding habitat would be disturbed. In addition, these two cave-roosting species are recorded from urban areas and appear to be urban-tolerant, meaning that it is likely that the subject site will continue to provide habitat for the species. Therefore, impacts on threatened cave-roosting microbat species are considered unlikely to result in a significant impact.

No potential foraging or roosting habitat for *Myotis macropus* (Southern Myotis) will be removed as a result of the proposal. While indirect impacts on riparian habitats may have affect the species, overall the proposal is not considered likely to result in a significant impact.

Without further surveys to determine the importance of the subject site to these species, any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we have adopted the precautionary principle in our assessment of significance (Appendix H) and have assumed that due to the large amount of habitat to be removed (including hollow-bearing trees) that a significant impact may occur on a local population of these hollow-dependent microbat species.

Retaining hollow-bearing trees, minimising street light pollution and encouraging native landscaping will assist in reducing potential impacts on threatened microbat species within the study area. Culvert checks should also be undertaken prior to any road upgrading to ensure that threatened microbats are not impacted by infrastructure upgrades. Nest boxes have not been found to be successful for most of the threatened hollow-roosting microbat species. However, this may improve with increased box design experimentation in the future.

4.4.6 Grey-headed Flying-fox

Pteropus poliocephalus (Grey-headed Flying-fox) is listed as Vulnerable under the TSC Act and EPBC Act. It feeds on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines. Roosts in camps generally found in gullies, close to water in vegetation with a dense canopy.

Pteropus poliocephalus (Grey-headed Flying-fox) was recorded foraging within the study area during surveys. No evidence of flying-fox camps was found and the nearest known camp is located in Kempsey. Within the study area, important nectar-producing trees are tall *Eucalyptus pilularis* (Blackbutt), *Corymbia intermedia* (Pink Bloodwood), *Eucalyptus siderophloia* (Grey Ironbark), *Syncarpia glomulifera* (Turpentine), tall *Eucalyptus tereticornis* (Forest Red Gum) and *Lophostemon confertus* (Brushbox) (Eby and Law 2008). The subject site contains high quality foraging habitat (two highest ranking categories for nectar reliability and quantity by Eby and Law (2008)).

Key potential impacts on *Pteropus poliocephalus* (Grey-headed Flying-fox) associated with the proposed rezonings are likely to be a result of habitat loss. The proposal will result in the removal of a large area of high quality foraging habitat for the species. However, this species is highly mobile and large tracts of similar vegetation occur nearby. Therefore, the removal of this habitat alone is considered unlikely to have a significant impact on the species.

4.4.7 Arboreal Mammals

Koala

Phascolarctos cinereus (Koala) is listed as Vulnerable under TSC Act and EPBC Act. The study area contains preferred koala habitat under the Kempsey CKPoM and 11 records exist of *Phascolarctos cinereus* (Koala) in the local area. We undertook a range of survey methods within the subject site: spotlighting; Song Meter acoustic recording; targeted (SAT plots) and opportunistic scat and scratch surveys; and tree canopy searches during the hollow-bearing tree survey. No evidence of koalas was found. However, it is possible that Koalas do still persist in the area at low density.

The proposal will directly impact the Koala through the removal or modification of Secondary (A) and Secondary (B) Koala habitat and indirectly through dog attack and habitat fragmentation. Free-ranging domestic dogs currently occurring within the study area also pose a substantial risk to any koalas attempting to forage or move through the area. This risk of dog attack is likely to increase as a result of the R5 Rural Residential rezoning proposal as many pet owners allow dogs to roam freely across their entire properties. In comparison, the risks from the R1 Residential proposal from domestic dogs are largely restricted to unrestrained dogs in adjacent bushland areas.

There is opportunity to strengthen local fauna movement corridors and this is likely to benefit the Koala. However, care should be taken with tree planting initiatives to ensure that primary Koala food tree species are not planted along roadsides where they may place Koalas at further risk of vehicle collision.

Brush-tailed Phascogale

Phascogale tapoatafa (Brush-tailed Phascogale) is a small arboreal carnivore that is listed as Vulnerable under TSC Act. *Phascogale tapoatafa* (Brush-tailed Phascogale) forages preferentially on rough-barked trees of greater than 25 cm diameter for invertebrates,

nectar and sometimes small vertebrates. They nest in tree hollows with entrances of 2.5 - 4 cm diameter and regularly switch hollows. Females have exclusive territories of 20 - 40 ha, while males have overlapping territories of more than 100 ha. We did not record *Phascogale tapoatafa* (Brush-tailed Phascogale) within the study area during surveys. However, one anecdotal record exists from a landowner at the eastern end of Raymond's Lane and another record from the Atlas of NSW Wildlife occurs along Quarry Road. As suitable habitat exists and they can have large home ranges that extend beyond the bushland within the study area, it is possible that they still persist in the area at low density.

This rezoning proposal could remove 1 - 2 female home ranges from the area and may have indirect impacts on adjacent areas of habitat. There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also slightly fragment habitat for the species.

Without any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the large amount of habitat to be removed (including hollow-bearing trees) that a significant impact may occur on a local population of *Phascogale tapoatafa* (Brush-tailed Phascogale). Further targeted surveys would be required if the absence of the species was to be asserted.

Squirrel Glider

Petaurus norfolcensis (Squirrel Glider) is a medium-sized glider that lives in family groups comprised of an adult male, with one or two adult females and offspring. They switch den sites regularly and so require a number of suitable tree hollows within their home range. Den entrance size used by *Petaurus norfolcensis* (Squirrel Glider) varied in one study from 2.5 - 12 cm wide, but most were ≤ 5 cm in diameter (Beyer et al. 2008). They feed on eucalypt sap, nectar, honeydew, manna and Acacia gum, with invertebrates and pollen providing protein (Sharpe and Goldingay 1998, Dobson et al. 2005, Holland et al. 2007, Ball et al. 2009).

We recorded seven *Petaurus norfolcensis* (Squirrel Gliders) around Raymond's Lane during our surveys. One den site was recorded in a hollow-bearing tree to the east of Raymond's Lane, outside of the subject site. The distribution of these records indicate that at least 4-5 family groups occur within this part of the study area. Two historical *Petaurus norfolcensis* (Squirrel Glider) records occur in the west of the study area from 2001 and 2005 along Everinghams Lane and near the rail line. Another record occurs outside of the study area to the north. Other nearby records to the north of the Macleay River are near Aldavilla. There are no other records north until the east of Eungai Rail and the large population known from South West Rocks.

During winter, *Petaurus norfolcensis* (Squirrel Gliders) are most often found where there is a reliable supply of winter-flowering plants (Smith and Murray 2003). This appears to be the case within the study area, with Squirrel Gliders recorded around Raymond's Lane that contained the following winter-flowering eucalypts: *Eucalyptus siderophloia* (Grey

Ironbark), *Corymbia maculata* (Spotted Gum) and *Eucalyptus tereticornis* (Forest Red Gum).

Home range size varies depending on habitat quality 1.5 - 10 ha (Quin 1995, Smith 2002, van der Ree and Bennett 2003, Sharpe and Goldingay 2007, Brearley et al. 2011b). *Petaurus norfolcensis* (Squirrel Glider) density near Brisbane, QLD was 0.5 - 1.6 individuals per hectare (Sharpe and Goldingay 2010). Average density in Wyong and Lake Macquarie regions was 0.39 animals / hectare (Smith and Murray 2003). Due to the partly cleared nature of the habitat within the subject site it is likely that Squirrel Gliders are at a relatively low density, requiring a larger home range size than they would in the adjacent intact forest. (Brearley et al. 2011a) greater trap success rate in forest interiors than edges, roads and residential areas.

Petaurus norfolcensis (Squirrel Glider) has been reported to travel up to 800 m from den sites to feeding areas where den trees are scarce (Smith 2002). Nightly movements range from 547 -1909 m (Sharpe and Goldingay 2007). *Petaurus norfolcensis* (Squirrel Glider) density has been found to be highest in forests with > 18 hollow-bearing trees / hectare (Smith 2002). In Wyong Shire remnants > 250 ha or populations of > 90 individuals should have close to a 100 % probability of surviving in the short term (40 - 60 years). (Smith 2002)

Petaurus norfolcensis (Squirrel Glider) can glide up to 50 m depending on tree height (Goldingay and Taylor 2009). This study predicted that trees beside a two-lane road need to be at least 13 m tall (Goldingay and Taylor 2009). While the upgrade of Raymond's Lane might remove a number of old hollow-bearing trees and reduce east-west connectivity for the Squirrel Glider, it is unlikely to result in a barrier to movement across the road.

Based on the distribution of *Petaurus norfolcensis* (Squirrel Gliders) recorded during our study and the approximated home range size of 10 ha (the highest value from previous studies due to the partially cleared nature of the subject site), we estimate that at least four family groups occur within the subject site. The historical records of *Petaurus norfolcensis* (Squirrel Gliders) in the west of the study area around Everinghams Lane may indicate that additional family groups occur there but went undetected during our study. This may be the case in areas that we did not survey. Spotlighting and trapping have been found to have success rates of only 21 - 25 % (Goldingay and Sharpe 2004). Therefore, additional family groups may have gone undetected even within areas sampled. The large patch of vegetation to the west of the study area may support additional family groups that may use the study area as part of their home ranges. Such a large patch of remnant vegetation to the west of the study area (> 1500 ha) is likely to provide some stability for the Squirrel Glider population in the local area, providing that the local population extends to this area. However, we have few local records and so it is difficult to estimate the local population size or extent confidently.

Following the precautionary principle we cannot assume that the large patch of vegetation to the west contains a large population of Squirrel Gliders (even though it may). Therefore, for our assessment of significance (Appendix H) we have assumed that the local Squirrel Glider population is limited to those animals that occur within and immediately adjacent to the study area. The removal or modification of habitat within the R5 Rural Residential zone may significantly impact the local Squirrel Glider population. The IN1 Industrial zone will also remove or modify habitat for at least one family group of Squirrel Gliders and may contribute to habitat fragmentation if no corridor along Raymond's Lane is protected.

Yellow-bellied Glider

Petaurus australis (Yellow-bellied Glider) is a large glider that also lives in family groups. They occur in tall mature eucalypt forest, generally in areas with high rainfall and nutrient-rich soils. They feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. They make characteristic 'V'-shaped incisions on the trunks and branches of favoured trees to extract sap. They den in the hollows of large trees and occupy large home ranges of 20-85 ha. Marginal potential foraging and den habitat occurs within the study area. However, no evidence of this highly vocal species was recorded during targeted spotlighting, call playback and Song Meter recording. Additionally, no characteristic feeding scars were observed. More suitable habitat occurs approximately 10 km to the north of the study area in the taller forests of Tamban State Forest and Ngambaa Nature Reserve.

4.4.8 Spotted-tailed Quoll

Dasyurus maculatus (Spotted-tailed Quoll) is a cat-sized carnivorous mammal that is listed as Vulnerable under the TSC Act and Endangered under the EPBC Act. It spends most of its time on the ground, although is an excellent climber. It is a generalist predator consuming gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. They are known to traverse their home ranges along densely vegetated creeklines. It will also eat carrion and domestic fowl. It has been recorded from a variety of vegetation types such as rainforest, open forest, woodland, coastal heath, inland riparian forest. Den sites may be located in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky cliffs.

The major potential impacts to *Dasyurus maculatus* (Spotted-tailed Quoll) resulting from increased urbanisation within the study area is loss of habitat (the species is not known to frequent urban areas) and increased competition with domestic cats. Other threats to *Dasyurus maculatus* (Spotted-tailed Quoll) currently occurring within the study area include deliberate poisoning, shooting and trapping in response to chicken predation. However, these threats are unlikely to substantially increase as a result of increased urbanisation. No potential den sites were found to occur within the subject site.

4.5 Kempsey CKPoM Considerations

Our field surveys found that some areas of the subject site contain preferred Koala habitat as defined under the Kempsey CKPoM. We did not find any Core koala habitat during our SAT plots and as such only the provisions of the Kempsey CKPoM associated with areas of preferred Koala habitat apply to the proposal. For this rezoning proposal, we have assumed that retention of all Preferred Koala Food Trees ≥ 250 mm DBH will not be able to be achieved. As such, the habitat compensation measures outlined in Section 4.12 of the Kempsey CKPoM (outlined below) apply to the proposal.

Habitat Compensation Measures (Section 4.12 of CKPoM)

a) Loss of koala habitat must be compensated via the securement of a corresponding measure of land that equates to no less than two times the total area to be affected by vegetation removal. Habitat Compensation should be undertaken on the same site as clearing where possible;
b) The Habitat Compensation Measures must take the form of a valid legally binding agreement between the proponent of the development and any person being the lawful owner of land that is (preferably) within a Koala Management Area, or otherwise on land to which the plan applies, to the satisfaction of Council. Consideration will be given to habitat compensation measures taking place outside the CKPoM boundary, but within the Kempsey Shire LGA, on a case by case basis, if the proponent can sufficiently demonstrate securement of appropriate habitat quality and area as per c) below, as well as evidence of a koala population on or near the habitat compensation site;
c) For purposes of a) and b) above, the area to be secured as compensation must comprise no more than half existing preferred koala habitat, the remaining area comprising cleared or partially cleared land for revegetation purposes;
d) Secured existing preferred koala habitat must be at least of equivalent habitat value to koalas as that to be impacted by development. If the land to be secured is of a lesser quality to that subject to impact, enhancement of the secured existing habitat will also be required;
e) Cleared, or partially cleared land for revegetation purposes must be planted out with a species mix to establish a vegetation community (including an appropriate understorey, midstorey and overstorey) equivalent to the area being disturbed. The proportion of preferred koala feed trees in the vegetation community must be equivalent to that being disturbed, or 15%, whichever is the larger. Half of all replanted preferred koala feed trees must be tallowwood.
f) Areas being the subject of the compensation measures must be protected by a valid legally binding agreement, that ensures the protection of the habitat compensation area in perpetuity through the rezoning of land for habitat protection and/or the application of restrictive covenants on title. Development Consent must be conditional upon the agreement being in place (ie signed registered or otherwise as per the legal requirements of the relevant agreement) prior to any work related to the Development Application occurring

on the site, or where the proposed development involves the erection of a building, prior to the release of the Occupation Certificate. The agreement must include, to the satisfaction of Council, a Vegetation Management Plan, that specifies details of:

i. pre-revegetation forest cover and composition;
ii. post-revegetation forest cover and composition targets;
iii. the species to be planted (all should be endemic natives not horticultural hybrids), number of trees/plants to be planted, location and density of replanted vegetation;
iv. PKFTs seedlings must be of a minimum size and maturity to best ensure survival. Any loss of seedlings within the agreed maintenance period must be replaced by the applicant.
v. details of the sourcing of all seedlings (demonstrating local seedstock has been used);
vi. bush regeneration methods, timeframes and objectives;
vii. a schedule of management, monitoring and maintenance activities to ensure establishment and ongoing protection and management of replanted vegetation;
viii. the length of proposed monitoring and management periods, the timing of key milestones, and reporting requirements;
ix. provisions for planting mortality replacements; and
x. responsible parties for undertaking and funding all works and activities included in the plan.

g) All costs associated with enacting the valid legally binding agreement, including funding and maintenance of the revegetation component, must be borne by the applicant; and
h) Landholders will be invited to register their land with Council as a potential site for use as a habitat compensation area and a register of same will be maintained by Council.

The rezoning is then to be assessed against the Section 4.10 Kempsey CKPoM Performance Criteria for areas mapped and determined to be preferred Koala habitat.

Performance Criteria for Areas Mapped as PKH and Determined to be PKH (Section 4.10 of CKPoM)

Consent may be granted with or without conditions where the following criteria are met:

a) maximise retention and minimise degradation of native vegetation across the subject land;
b) minimise the removal of any identified preferred koala food trees, where they occur across the subject land;
c) ensure such trees will not be negatively impacted by subsequent development works including the construction of buildings, associated infrastructure and/or provision of public utilities;
d) maintain key linkages across the landscape, where they occur, to reduce the effects of habitat fragmentation;

e) comply with the Habitat Compensation Measures where relevant as per Section 4.12 of this plan;
f) Where Onsite PKFT Tree Replacement Measures have been applied, as per Section 4.9 of this plan, measures to ensure the retention of replacement trees over time, which may include but are not limited to restrictions on title; and
g) Where koala habitat and associated linkages are proposed to be retained on the development site to mitigate impacts, measures to ensure the protection of those areas in the long term, which may include but are not limited to restrictions on title;
h) Appropriate measures (ie erection of exclusion fencing) are to be in place to ensue koalas are protected during site construction works. Should koalas be found on site during clearing, construction or site works then provisions (i) and (j) in Section 4.11 apply.

These criteria will mean that offsets will need to be sought from within or surrounding the subject site to compensate for the loss of koala habitat within the proposed R5 rural residential and IN1 Industrial zones. This compensatory habitat will need to be two times that to be removed. The total amount of preferred Koala habitat within the subject site is 44.97 ha (0.03 ha R1 Residential; 36.18 ha R5 Rural Residential; and 8.76 ha IN1 Industrial), so a total of 89.93 ha of compensatory koala habitat will be required to offset the entire rezoning proposal. At least half of the compensatory habitat must include cleared or partially cleared land that is to be revegetated. Compensatory habitat may also be secured from within the subject site as part of the rezoning stage, with the total amount of compensatory habitat adjusted depending on the amount of preferred koala habitat removed by the final proposal design. Koala movement corridors will also need to be considered.

4.6 Water Management Act Considerations

Under the WM Act riparian buffers (vegetated riparian zones) are to be fully vegetated. Where areas within the buffers are currently cleared, bush regeneration and weed control will need to be undertaken and as such it is likely that riparian buffers will need to be managed in accordance with a vegetation management plan.

The construction of infrastructure within these buffers should be avoided where possible and the number of creek crossing should be minimised. However, some allowances may be made for stormwater management facilities where other alternatives are not feasible.

4.7 Ecological Constraints and Opportunities Mapping

The key ecological constraints identified during the study are indicated on Figure 4-1. The ecological constraints mapping included the following classifications:

- Riparian buffers;

- Corridor and enhancement areas;
- Hollow-bearing trees and buffers;
- Endangered Ecological Communities;
- Moderate conservation value vegetation; and
- Low conservation value vegetation.

Legend

- Study Area
- Hollow-bearing tree 20m buffer
- Riparian buffer (vegetated)
- EEC buffer (35-100m)

Endangered Ecological Communities

- Candidate EEC (unsurveyed)
- Other EEC

Ecological Constraint Ranking

- Moderate
- Low

N

0 0.5 1 km

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Frederickton Flora and Fauna Study

Client: Kempsey Shire Council

Job No. 36

Rev. 0

Date 21 September 2016

SOURCE
Aerial Photo - © Land and Property Information (2016)
Cadastre & Study Area Boundaries -© Kempsey Shire Council (2016)

ECHO ECOLOGY

DISCLAIMER:
Indicative only
All boundaries, scale and points are approximate only
GPS locations recorded at > 5 m accuracy

Figure 4-1
Ecological Constraints

4.8 Impact Assessment

4.8.1 7-part test assessment of significance summary (EPA Act / TSC Act)

The proposal will require the removal of large areas of vegetation (albeit partially cleared) within the R5 Rural Residential rezoning area, with a smaller amount of vegetation removal proposed within the IN1 Industrial area. At this stage the proposal does not include any conservation zonings, habitat retention proposals or the provision of compensatory habitat (offsets). As such our assessment has been based on the worst case of total vegetation removal and we have adopted the precautionary principle when applying the 7-part test.

Our assessment found that the R5 Rural Residential and IN1 Industrial rezoning proposals may have a significant impact on the following species due to the combined removal of foraging and breeding habitat (whether potential or known):

- *Phascogale tapoatafa* (Brush-tailed Phascogale);
- *Petaurus norfolcensis* (Squirrel Glider);
- *Mormopterus norfolkensis* (East Coast Freetail-bat);
- *Chalinolobus nigrogriseus* (Hoary Wattled Bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);

While the IN1 Industrial rezoning area will remove a much smaller area of habitat than the R5 Rural residential area, due to the high density of hollow-bearing trees in parts of the IN1 Industrial rezoning area, we have concluded that the proposal may have a significant impact on the above-listed hollow-dependent threatened fauna species. However, these impacts may be avoided if the rezoning proposal is redesigned to avoid the most critical habitat elements.

Without any redesign or an assessment under another approval pathway (e.g. Biocertification), we recommend the preparation of a Species Impact Statement to further investigate the potential impacts of the R5 Rural Residential and IN1 Industrial rezoning areas.

4.8.2 EPBC Act Considerations

Searches of the Department of the Environment On-line Database were used to gather baseline data on the site and general locality. This data, combined with other local knowledge and records, was utilised to assess whether the type of activity proposed on the site will have, or is likely to have a significant impact upon a matter of National Environmental Significance (NES), or on the environment of Commonwealth land.

Environment of Commonwealth Land
The study area contains some parcels of Crown land and may require assessment under the EPBC Act.

Matters of NES

World Heritage areas

The study area is not a World Heritage area and is not in close proximity to any such area.

Wetlands of International Importance (RAMSAR)

The study area is not within 10km of any RAMSAR Wetland area

Nationally listed threatened species and ecological communities:

A total of 49 threatened species and one EEC listed under the EPBC Act have been recorded within the proximate region of the study area (see Appendix E for full list). No EECs listed under the EPBC Act were considered likely to occur within the study area (Appendix E). However, the following one threatened flora species and six threatened fauna species listed under EPBC Act were found to be at least moderately likely to occur or recorded (in **bold**) within the study area at some stage (Appendix E):

- ***Persicaria elatior*** **(Knotweed)**
- *Botaurus poiciloptilus* (Australasian Bittern)
- *Rostratula australis* (Australian Painted Snipe)
- *Lathamus discolor* (Swift Parrot)
- *Dasyurus maculatus* (Spotted-tailed Quoll)
- *Phascolarctos cinereus* (Koala)
- *Pteropus poliocephalus* (Grey-headed Flying-fox)

As the assessment of significance under the TSC Act (7-part test Appendix H) concluded that the proposal was unlikely to have a significant impact on any threatened species listed under EPBC Act.

Nationally listed migratory species

The following migratory species listed under the EPBC Act may occur within the site on an occasional basis:

Migratory Terrestrial Species

- *Cuculus optatus* (Oriental Cuckoo)
- *Hirundapus caudacutus* (White-throated Needletail)
- *Monarcha melanopsis* (Black-faced Monarch)
- *Monarcha trivirgatus* (Spectacled Monarch)
- *Myiagra cyanoleuca* (Satin Flycatcher)
- *Rhipidura rufifrons* (Rufous Fantail)

Migratory Wetland Species

- *Ardea alba* (Great Egret)
- *Ardea ibis* (Cattle Egret)
- *Gallinago hardwickii* (Latham's Snipe)
- *Pandion cristatus* (Eastern Osprey)

- *Rostratula benghalensis* (Painted Snipe)

The proposal will remove a small amount of habitat for these species and may have some indirect impacts. However, the proposal is considered unlikely to have a significant impact on these migratory species.

All nuclear actions
No type of nuclear activity is proposed for the site.

The environment of Commonwealth marine areas
The proposed activity on the study area will not have a significantly adverse effect on any Commonwealth marine area.

Conclusion
As no significant impact is considered likely on any matters of NES as a result of the proposal, it is considered unlikely that a referral to the Federal Minister of the Environment is required.

4.9 Offsets

Given the ecological constraints presented in this report, including a potential significant impact on a number of threatened fauna species, it is likely that any required clearing of native vegetation and hollow-bearing trees for future development will require appropriate offsetting. As a minimum, the Kempsey CKPoM requires that the removal of Koala habitat is offset with the protection of at least twice the amount removed.

It is prudent to consider the need for these offsets at this rezoning stage, rather than adopting a fragmentary approach for each development application. A coordinated approach among landholders of constrained properties (those with remnant native vegetation or hollow-bearing trees) may be an option to come to an agreement to dedicate some of the land to offset impacts in other areas. The large area of bushland immediately to the west of the study area may also be appropriate for use as offsets for future development within the study area. Preferentially, offsets should be sought within the study area or bushland immediately adjacent to protect local habitats of threatened species. However, arrangements under the Biobanking scheme do allow offsets to be secured further away if suitable areas cannot be negotiated nearby.

The impact assessment (Section 4.7) was undertaken based on the provision of no offset areas.

For the offsetting of native vegetation (including threatened species habitat), there are currently a number of options for calculating the amount of area required for offsets (usually ‘like for like’ in principle) including:

- The Biobanking Assessment Methodology and Credit Calculator; and
- OEH 'offsetting principles'.

Biocertification of the rezoning proposal is also an option for the Frederickton study area. Biocertification implements the principles of Biobanking at a local scale and reduces the need for full assessment at the Development Application stage.
However, specific detail hasn't been provided here as offsetting mechanisms in NSW are currently under review and are likely to be amended in the near future.

5.0 RECOMMENDATIONS

5.1 Housing density

From an ecological perspective, higher density housing is preferred to larger block sizes. Standard residential development has a far smaller ecological footprint than sprawling rural residential estates. Therefore, we recommend considering meeting future housing needs with standard residential estates, rather than incorporating large areas of rural residential development.

5.2 Indirect impacts on water quality and hydrology

The R1 Residential and IN1 Industrial rezoning areas occur within the catchment of the central drainage line that contains three EECs and habitat for one threatened flora species and a number of threatened fauna species. Potential impacts on water quality and hydrology arising from the rezoning proposals need to be carefully considered with strict mitigation measures put in place to minimise potential impacts to this receiving environment.

5.3 Hollow-bearing trees

We recommend that hollow-bearing trees are retained as far as possible and surrounded by an appropriately sized buffer based on tree height. Large trees with numerous hollows should be prioritised, but hollow-bearing trees in any location should be retained if feasible as isolated paddock trees still provide important habitat for more mobile species such as threatened insectivorous bats. In addition, consideration should be given to providing for future recruitment of hollow-bearing trees into the area through the protection of mature trees to act as recruitment hollow-bearing trees. Consideration should be given to the spatial distribution of hollow-bearing trees within the subject site, with retained biodiversity corridors and offsets located in areas of high hollow-bearing tree density.

The hollow-bearing tree survey was undertaken based on a rapid visual assessment from the ground. Particular trees that appear difficult to retain within any proposed rezoning should be re-examined in the field by a suitably qualified and experienced ecologist to determine whether the classification is justified. This re-examination should verify the characteristics of tree hollows via a closer inspection, such as by using a camera on a telescopic pole.

Care should also be taken to acknowledge the accuracy limitations of the hollow-bearing tree location data as the mapped location of hollow-bearing trees may be inaccurate by up to 30 m as positions were collected using a hand-held GPS. Therefore, we also recommend that where the location of hollow-bearing trees is a potential issue (e.g. within 50 m of any proposed rezoning) trees are located to high accuracy by a qualified surveyor. Hollow-bearing trees within rezoning areas have been tagged to aid future identification and survey.

5.4 Riparian Buffers

For final zone delineation it is recommended that the top of bank of watercourses close to new zones are located accurately by qualified surveyors to ensure that riparian buffers are accurately placed.

5.5 EEC Buffers and Candidate EEC areas

The EEC buffers presented in Figure 4-1 are based on those recommended by Port Macquarie - Hastings Council for their LGA. The area mapped as Candidate EEC (unsurveyed) in the south of the study area was not surveyed as part of our study. However, this floodplain area is likely to contain areas of Freshwater Wetland EEC and possibly other EECs. The 100 m buffer we have used for this area is a worst-case scenario based on the occurrence of Freshwater Wetland at the very edge of the polygon. If any land adjacent to this area is to be rezoned in the future, we recommend a targeted survey of the southern floodplain area to more accurately map EEC occurrence.

5.6 Corridors

The provision, enhancement and maintenance of biodiversity corridors within the study area should aim to create a safe movement corridor for fauna species. In particular, these corridors should not remain as private property to minimise disturbance and potential fauna mortality from free-ranging domestic dogs. Where residential estates border any designated corridor or buffer, then fencing should be in place to prevent properties and pets encroaching on these conservation areas. If services or infrastructure cannot be located outside of a riparian corridor, then they should be located within a disturbed area

of the riparian corridor and positioned to avoid sensitive ecological features. The advice of an appropriately qualified ecologist should be sought to guide this.

Raymond's Lane east-west dry canopy corridor

There is the opportunity to promote the east-west vegetation connectivity along Raymond's Lane through the conservation of large old street trees within the road reserve and through the targeted planting of street trees along the northern side of Raymond's Lane. This corridor should be at least 20 m wide and preferably up to 40 m wide along the edge of the IN1 Industrial rezoning area to ensure east-west connectivity. Larger house setbacks along Raymond's Lane in the R5 Rural Residential rezoning area may also promote this corridor. This will provide canopy connectivity for birds and arboreal mammals between remnant vegetation patches in the north and south of the study area. The understorey may still be maintained for safety and infrastructure and services may still be placed within this area. However, care should be taken when selecting tree species to plant so as to reflect native plant communities occurring within the study area and to improve nectar resources. However, tree species preferred by Koalas should be avoided to minimise the risk of vehicle collision if the local koala population recovers.

North-south Raymond's Lane dry corridors

The semi-cleared agricultural land within the R5 Rural Residential rezoning area is likely to provide north-south connectivity for arboreal mammals and birds. North-south movement corridors should be incorporated into the rezoning proposal to provide for ongoing fauna movement through the area. As a minimum these corridors should be comprised of canopy trees. However, some of these areas that contain native pasture with good rehabilitation potential may be able to function as movement corridors for small terrestrial fauna with bush regeneration work.

Central riparian corridor

The central drainage line contains remnant vegetation that varies in condition. The eastern portion that consists of freshwater wetland, paperbark and swamp oak forest provides reasonable connectivity for species that prefer riparian areas. However, the drainage line contains little remnant vegetation in the heavily cleared agricultural land in the centre of the study area. The western portion of the central drainage line becomes more vegetated (though still heavily disturbed). The central portion of this central drainage line would benefit from bush regeneration and ongoing weed control to reinstate this riparian connectivity through the study area. The provision of woody debris on the ground and reduced grazing pressure would also provide habitat for small mammals and reptiles.

Golf course connectivity

The small area of dry forest remnant vegetation that occurs surrounding the Frederickton Golf Course is relatively isolated from other patches of dry forest. Some more mobile fauna species (arboreal mammals and birds) would be able to move through the paperbark and swamp oak forest areas of the central drainage line and into the drier open forest remnants

near Raymond's Lane. This connectivity should be enhanced as far as possible and care taken to ensure that this tenuous link is maintained.

5.7 Further Targeted Surveys

Our survey was undertaken during winter when many fauna species are inactive and flora species are not flowering. It is therefore recommended that further targeted surveys are undertaken during appropriate seasons for some threatened flora and fauna species. These are discussed below for each species or group.

5.7.1 Microbat Survey

A number of threatened microbat species have the potential to occur within the study area and be affected by any future land-use change. While our survey recorded a reasonable sample of the microbat species likely to be present, we were unable to draw many conclusions about the importance of the habitat to these species. This is particularly the case for threatened hollow-dependent microbat species that may be most affected by the proposal. Our assessment of significance (Section 4.8) concluded that a significant impact was likely on three threatened microbat species due to the combined removal of foraging and potential roosting habitat. Further targeted microbat surveys may be able to provide a greater insight into the importance of habitat within the subject site for these species. A survey is recommended during Spring - Summer to adequately target these species. The survey should include both bat call recording and harp trapping to target the threatened microbat species with potential to occur (DEC 2004). December would be a good time to conduct this survey as it coincides with the maternity season for a number of species so that maternity roosts (breeding habitat) may be detected via stagwatching of hollow-bearing trees. Searches of nearby artificial structures for *Myotis macropus* (Large-footed Myotis) roosts which could be disturbed as a result of future land-use change would also assist the ecological constraints identification.

6.0 CONCLUSION

In its current form, without the provision of any conservation zonings, habitat retention proposals or the provision of compensatory habitat (offsets), we have found that the R5 Rural Residential and IN1 Industrial rezoning areas are likely to have a significant impact on two threatened arboreal mammal species and three threatened hollow-dependent microbat species. We recommend the preparation of a Species Impact Statement to further investigate these potential impacts and / or the redesign of the proposal to incorporate these ecological constraints.

7.0 REFERENCES

Atkinson, G. 1999. Soil Landscapes of the Kempsey-Korogoro Point 1:100,000 Sheet map and report. NSW Department of Land and Water Conservation, Sydney.

Ball, T., E. Adams, and R. L. Goldingay. 2009. Diet of the squirrel glider in a fragmented landscape near Mackay, central Queensland. Australian Journal of Zoology **57**:295-304.

Beyer, G. L., R. L. Goldingay, and D. J. Sharpe. 2008. The characteristics of squirrel glider (Petaurus norfolcensis) den trees in subtropical Australia. Australian Journal of Zoology **56**:13-21.

Biolink. 2009. Comprehensive Koala Plan of Management for Eastern Portion of Kempsey Shire LGA Volume II - Resource Study.

Brearley, G., A. Bradley, S. Bell, and C. A. McAlpine. 2011a. Change in habitat resources and structure near urban edges and its influence on the squirrel glider (Petaurus norfolcensis) in southeast Queensland, Australia. Austral Ecology **36**:425-432.

Brearley, G., C. A. McAlpine, S. Bell, and A. Bradley. 2011b. Squirrel glider home ranges near urban edges in eastern Australia. Journal of Zoology **285**:256-265.

Brooker, M. I. H. and D. A. Kleinig. 2006. Field Guide to Eucalypts: Volume 1 South-eastern Australia. Third edition. Bloomings Books Pty Ltd, Melbourne, Australia.

DEC. 2004. Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (working draft). NSW Department of Environment and Conservation, Husrtville, NSW.

Department of Environment and Climate Change. 2007. Landscape Selection Process: key altitudinal, latitudinal and coastal corridors for response to climate change. Northern Rivers Catchment Management Authority.

Dobson , M., R. Goldingay , and D. Sharpe 2005. Feeding behaviour of the squirrel glider in remnant habitat in Brisbane. Australian Mammalogy **27**:27-35.

Eby, P. and B. Law 2008. Ranking the feeding habitats of Grey-headed flying foxes for conservation management. Department of Environment and Climate Change (NSW) and Department of Environment Water Heritage and the Arts, Hurstville.

GHD. 2007. Report for Vegetation Mapping for Western Portion Kempsey LGA.

Gibbons, P. and D. Lindenmayer. 2002. Tree Hollows and Wildlife Conservation in Australia. CSIRO Publishing, Collingwood, VIC.

Goldingay, R. L. and D. J. Sharpe. 2004. How effective is spotlighting for detecting the squirrel glider? Wildlife Research **31**:443-449.

Goldingay, R. L. and B. D. Taylor. 2009. Gliding performance and its relevance to gap crossing by the squirrel glider (Petaurus norfolcensis). Australian Journal of Zoology **57**:99-104.

Hashimoto, T. R. and A. L. Troedson. 2007. Kempsey 1:100 000 and 1:25 000, Coastal Quaternary Geology Map Series. Geological Survey of NSW, Maitland.

Holland, G. J., A. F. Bennett, and R. van der Ree. 2007. Time-budget and feeding behaviour of the squirrel glider (Petaurus norfolcensis) in remnant linear habitat. Wildlife Research **34**:288-295.

Kempsey Shire Council. 2011. Comprehensive Koala Plan of Management for Eastern Portion of Kempsey Shire LGA Volume 1 Working Provisions. Kempsey Shire Council.

Lemckert, F., M. Mahony, T. Brassil, and C. Slatyer. 2006. The biology of the threatened Green-thighed frog *Litoria brevipalmata* (Anura: Hylidae) in the central and mid-north coastal areas of New South Wales Australian Zoologist **33**:337-344.

McConville, A. 2013. The ecology of the east-coast freetailed bat (Mormopterus norfolkensis) in the Hunter Region. PhD. University of Newcastle, Callaghan, NSW.

McConville, A., B. Law, and M. Mahony. 2013a. Are regional habitat models useful at a local-scale? A case study of threatened and common insectivorous bats in south-eastern Australia. PLoS ONE **8**:e72420.

McConville, A., B. Law, and M. Mahony. 2013b. Mangroves as maternity roosts for a colony of the rare east-coast free-tailed bat (*Mormopterus norfolkensis*) in south-eastern Australia. Wildlife Research **40**:318-327.

McConville, A., B. Law, T. D. Penman, and M. Mahony. 2014. Contrasting habitat use of morphologically similar bat species with differing conservation status in south-eastern Australia. Austral Ecology **39**:83-94.

Parsons Brinckerhoff. 2006. Project Application Report Supporting Information Ecological Assessment: Kempsey to Eungai Upgrading the Pacific Highway. Sydney, NSW.

QGIS Development Team. 2015. QGIS Geographic Information System. Open Source Geospatial Foundation Project, http://qgis.osgeo.org.

Quin, D. 1995. Population ecology of the squirrel glider (Petaurus norfolcensis) and the sugar glider (P. breviceps) (Maruspialia : Petauridae) at Limeburners Creek, on the central north coast of New South Wales. Wildlife Research **22**:471-505.

Scotts, D. 2003. Key Habitats and Corridors for Forest Fauna: A Landscape Framework for Conservation in North-east New South Wales. NSW National Parks and Wildlife Service, Sydney, NSW.

Sharpe, D. J. and R. L. Goldingay. 1998. Feeding behaviour of the squirrel glider at Bungawalbin Nature Reserve, north-eastern New South Wales. Wildlife Research **25**:243-254.

Sharpe, D. J. and R. L. Goldingay. 2007. Home range of the Australian Squirrel Glider Petaurus norfolcensis (DIPROTODONTIA). Journal of Mammalogy **88**:1515-1522.

Sharpe, D. J. and R. L. Goldingay. 2010. Population ecology of the nectar-feeding squirrel glider (Petaurus norfolcensis) in remnant forest in subtropical Australia. Wildlife Research **37**:77-88.

Smith, A. 2002. Squirrel Glider (*Petaurus norfolcensis*) Conservation Management Plan: Wyong Shire. Wyong.

Smith, A. P. and M. Murray. 2003. Habitat requirements of the squirrel glider (Petaurus norfolcensis) and associated possums and gliders on the New South Wales central coast. Wildlife Research **30**:291-301.

Telfer, D. and P. Kendall. 2006. Native Vegetation and Candidate Endangered Ecological Community Mapping Report: Kempsey LGA East.

van der Ree, R. and A. F. Bennett. 2003. Home range of the squirrel glider (Petaurus norfolcensis) in a network of remnant linear habitats. Journal of Zoology **259**:327-336.

APPENDIX A FLORA SPECIES LIST

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	2	7	8	18	5	19	20	3	4	6	9	11	1	10	15	16	12	17	21	13	14	22
NATIVE SPECIES																						
Acacia concurrens						1					1	2				3						
Acacia falcata		1					1															
Allocasuarina littoralis		1	1					3				2				1						
Allocasuarina torulosa			1		2		1		2	3	2	1										
Alphitonia excelsa					1		1					1		1								
Alternanthera denticulata	1																2	3	2		2	
Aristida vagans								2			1											
Baumea articulata																	2					
Blechnum indicum																		1				
Breynia oblongifolia		1			1		2			1		2			1							
Capillipedium spicigerum								1														
Carex appressa																	3	4			1	
Carex sp																			4			
Casuarina glauca													3	4	4	5	2	1	1		1	
Centella asiatica								2	2						1	1	3	2			2	
Cheilanthes sieberi		1					1	1								1						
Commelina cyanea	1																					
Corymbia gummifera							1															
Corymbia intermedia			1	2	1	2			3	3	3	2			1							
Corymbia maculata	4	4																				

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	2	7	8	18	5	19	20	3	4	6	9	11	1	10	15	16	12	17	21	13	14	22
Cyathea australis															1							
Cymbopogon refractus		1			1		2	2				1										
Cynodon dactylon	2			2													5				2	
Cyperus gracilis	2																					
Daviesia ulicifolia							1				1	2										
Desmodium gunnii							1															
Desmodium varians	2																					
Dianella longifolia					1				2		2											
Dichondra repens	6		2				2	2			2					2						
Digitaria parviflora		1	1		1		1			1	1											
Echinopogon ovatus	2															1						
Entolasia stricta	4	5	3		3		2	2	5	2	2	2		6	2	3						
Eragrostis leptostachya	2						1	2			2	2										
Eragrostis sp									2													
Eucalyptus carnea	3	4					2	3	3	1		2										
Eucalyptus globoidea		2						4	2		1	1										
Eucalyptus microcorys	3				4	4	3		3		4	3										
Eucalyptus pilularis			5	3	4		3															
Eucalyptus propinqua	3						1		3			2										
Eucalyptus siderophloia	3			1				3	3	4												
Eucalyptus tereticornis			1			1																
Eustrephus latifolius		2				1	2					1										
Geitonoplesium cymosum			2		1			1	2	2	1											
Glochidion ferdinandi												1				1						

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	2	7	8	18	5	19	20	3	4	6	9	11	1	10	15	16	12	17	21	13	14	22
Glycine clandestina		1	2		2		1	2	2		2			1								
Goodenia rotundifolia		2	1						2		1	1										
Hemarthria uncinata															2		2	2			2	
Hibbertia aspera											1					1						
Hibbertia scandens							1															
Hybanthus stellarioides		1			2				2													
Hydrocotyle sp									2													
Hydrocotyle verticillata																	2	1				
Hypolepis glandulifera															2							
Hypolepis muelleri																		1				
Imperata cylindrica		2	4		4		5	3	3	1	3	3			3							
Indigophora australis							1															
Jagera pseudorhus							1															
Juncus polyanthemus													2				2		3	3	1	2
Juncus sp															1							
Laxmannia gracilis		2	2					2			1	1										
Lepidosperma laterale		2																				
Livistona australis																		1				
Lomandra filiformis		2					2	2			2	1										
Lomandra longifolia					3		1	2	2	2		2				2						
Lomandra multiflora		2	2		1			1			2					2						
Lophostemon confertus					3		1	1	3	4	3											
Maclura cochinchinensis																		1				
Melaleuca nodosa			2								2											

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	2	7	8	18	5	19	20	3	4	6	9	11	1	10	15	16	12	17	21	13	14	22
Melaleuca quinquenervia								3							3	4	5	5	6		1	
Melaleuca sieberi										2												
Mentha diemenica	2																					
Microlaena stipoides	2	1		1	2			3	2	1						2						
Notelea ovata					1																	
Oplismenus aemulus									2													
Oxalis sp	2		1				1	2			1					1						
Ozotharmus diosmifolius								1						2								
Panicum simile								2														
Parsonsia straminea										1				2				2				
Paspalidium distans							1	2			3											
Paspalidium sp																		2				
Paspalum distichum																						3
Paspalum orbiculare			1					2							1							
Persicaria decipiens													1									
Persicaria elatior																						1
Persicaria orientalis?																					2	
Philydrum lanuginosum															1							
Phragmites australis																	1					
Pimelea linifolia			2					2			2				1	1						
Pittosporum revolutum												1										
Pittosporum undulatum		1														1						
Poa labillardieri		2			2							1										
Polymeria calycina			2						2							1						

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	**2**	**7**	**8**	**18**	**5**	**19**	**20**	**3**	**4**	**6**	**9**	**11**	**1**	**10**	**15**	**16**	**12**	**17**	**21**	**13**	**14**	**22**
Poranthera microphylla																1						
Pratia purpurascens	2	2	2		2		2	2	2	1						1						
Pseuderanthemum variabile	1		2		2				2	2	2			1		1						
Pteridium esculentum											1											
Pultenaea villosa									1													
Ranunculus inundatus																	1			2	1	
Samantha angusta																2						
Seringia arborescens							1															
Stylidium graminifolium											1											
Themeda triandra			3		1		1	2			4	2			2							
Trema tomentosa															2							
Unknown Faboideae											1											
Unknown forb	2	1														1						
Unknown grass																		1				
Velleia spathulata											1											
Vernonia cinerea		2	2		1			2	2	1						1						
Veronica plebiea																1						
Viola betonicifolia			2																			
Viola hederacea																	2	3	2			
Zieria sp							1															
EXOTIC SPECIES																						
*Ageratum houstonianum**						1							2		2							
*Andropogon virginicus**		2	2				2	1			2	3										
*Aster subulatus**																	2		1		1	1

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	2	7	8	18	5	19	20	3	4	6	9	11	1	10	15	16	12	17	21	13	14	22
*Axonopus fissifolius**	2			2			2	4			2		1									
*Baccharis halimifolia**							1					1					1					
*Bidens pilosa**				2		2	2							1								
*Cestrum parqui**				1		2																
*Cinnamomum camphora**		2	1		1		2			1		2		1	2	1		2				
*Cirsium vulgare**				2			1						1									
*Conyza albida**							2						1									
*Cuphea carthagenensis**				2																		
*Drymaria cordata**	1																					
*Eichornia crassipes**																					3	
*Eragrostis tenuifolia**				1																		
*Eriochloa sp**													1									
*Hypochoeris radicata**			2				2	2			2											
*Lantana camara**		2					2	1		1		2		2	2	2						
*Malva parviflora**	1			1																		
*Panicum bisulcatum**																				3	1	
*Paspalum mandiocanum**	2			5	1	6	2	2					1	2	5	1						
*Paspalum urvillei**															2							
*Pennisetum clandestinum**	2			2									6									
*Phytolacca octandra**															1							
*Pinus sp**															3							
*Polygonum strigosum**																	4	1	2	5	6	3
*Rubus sp agg**															1							
*Rumex crispus**						1																

	Spotted Gum		Blackbutt - Bloodwood		Blackbutt - Tallowwood			Tallowwood - Grey Gum					Swamp Oak				Paperbark			Rushland - Herbland		
Scientific name - Plot Number	2	7	8	18	5	19	20	3	4	6	9	11	1	10	15	16	12	17	21	13	14	22
*Senecio madagascariensis**				1			1						1				2					
*Senna pendula**					2																	
*Setaria sphacelata**							2										2				2	
*Sida rhombifolia**	2			2		2																
*Solanum capsicoides**	2					0																
*Solanum mauritianum**	1			1			1						1		2							
*Solanum nigrum**	1					1							1									
*Solanum viarum**						1																
*Sporobolus fertilis**	2			2		2	1	1				2										
*Stellaria media**				2		2																
*Trifolium repens**				2									2									
*Verbena bonariensis**													2									

* Exotic species

APPENDIX B FAUNA SPECIES LIST

Group	Family	Scientific Name	Common Name	TSCA	EPBC
Amphibia	Hylidae	*Litoria tyleri*	Tyler's Tree Frog	-	-
Amphibia	Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	-	-
Amphibia	Myobatrachidae	*Limnodynastes peronii*	Brown-striped Frog	-	-
Amphibia	Myobatrachidae	*Limnodynastes tasmaniensis*	Spotted Grass Frog	-	-
Amphibia	Myobatrachidae	*Mixophyes fasciolatus*	Great Barred Frog	-	-
Aves	Acanthizidae	*Acanthiza lineata*	Striated Thornbill	-	-
Aves	Acanthizidae	*Acanthiza pusilla*	Brown Thornbill	-	-
Aves	Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk	-	-
Aves	Accipitridae	*Aquila audax*	Wedge-tailed Eagle	-	-
Aves	Accipitridae	*Aviceda subcristata*	Pacific Baza	-	-
Aves	Accipitridae	*Circus approximans*	Swamp Harrier	-	-
Aves	Accipitridae	*Haliastur sphenurus*	Whistling Kite	-	-
Aves	Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra	-	-
Aves	Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher	-	-
Aves	Anatidae	*Anas castanea*	Chestnut Teal	-	-
Aves	Anatidae	*Anas superciliosa*	Pacific Black Duck	-	-
Aves	Anatidae	*Chenonetta jubata*	Australian Wood Duck	-	-
Aves	Anatidae	*Cygnus atratus*	Black Swan	-	-
Aves	Ardeidae	*Ardea ibis*	Cattle Egret	-	M
Aves	Ardeidae	*Ardea pacifica*	White-necked Heron	-	-
Aves	Ardeidae	*Egretta novaehollandiae*	White-faced Heron	-	-
Aves	Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	-	-

Group	Family	Scientific Name	Common Name	TSCA	EPBC
Aves	Artamidae	*Cracticus tibicen*	Australian Magpie	-	-
Aves	Artamidae	*Cracticus torquatus*	Grey Butcherbird	-	-
Aves	Cacatuidae	*Eolophus roseicapillus*	Galah	-	-
Aves	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	-	-
Aves	Centropodidae	*Centropus phasianinus*	Pheasant Coucal	-	-
Aves	Charadriidae	*Vanellus miles*	Masked Lapwing	-	-
Aves	Columbidae	*Columba leucomela*	White-headed Pigeon	-	-
Aves	Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	-	-
Aves	Columbidae	*Leucosarcia melanoleuca*	Wonga Pigeon	-	-
Aves	Columbidae	*Ocyphaps lophotes*	Crested Pigeon	-	-
Aves	Corvidae	*Corvus coronoides*	Australian Raven	-	-
Aves	Corvidae	*Corvus orru*	Torresian Crow	-	-
Aves	Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	-	-
Aves	Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	-	-
Aves	Estrildidae	*Neochmia temporalis*	Red-browed Finch	-	-
Aves	Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch	-	-
Aves	Hirundinidae	*Petrochelidon ariel*	Fairy Martin	-	-
Aves	Maluridae	*Malurus cyaneus*	Superb Fairy-wren	-	-
Aves	Megaluridae	*Megalurus timoriensis*	Tawny Grassbird	-	-
Aves	Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	-	-
Aves	Meliphagidae	*Caligavis chrysops*	Yellow-faced Honeyeater	-	-
Aves	Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	-	-
Aves	Meliphagidae	*Manorina melanocephala*	Noisy Miner	-	-
Aves	Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater	-	-
Aves	Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater	-	-

Group	Family	Scientific Name	Common Name	TSCA	EPBC
Aves	Meliphagidae	*Philemon citreogularis*	Little Friarbird	-	-
Aves	Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	-	-
Aves	Meliphagidae	*Ptilotula fuscus*	Fuscous Honeyeater	-	-
Aves	Monarchidae	*Grallina cyanoleuca*	Magpie-lark	-	-
Aves	Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	-	-
Aves	Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	-	-
Aves	Pardalotidae	*Pardalotus striatus*	Striated Pardalote	-	-
Aves	Passeridae	*Passer domesticus*	House Sparrow	-	-
Aves	Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	-	-
Aves	Petroicidae	*Microeca fascinans*	Jacky Winter	-	-
Aves	Podargidae	*Podargus strigoides*	Tawny Frogmouth	-	-
Aves	Psittacidae	*Alisterus scapularis*	Australian King-Parrot	-	-
Aves	Psittacidae	*Glossopsitta concinna*	Musk Lorikeet	-	-
Aves	Psittacidae	*Platycercus elegans*	Crimson Rosella	-	-
Aves	Psittacidae	*Platycercus eximius*	Eastern Rosella	-	-
Aves	Psittacidae	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet	-	-
Aves	Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	-	-
Aves	Rallidae	*Porphyrio porphyrio*	Purple Swamphen	-	-
Aves	Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	-	-
Aves	Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	-	-
Aves	Strigidae	*Ninox strenua*	Powerful Owl	V	-
Aves	Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	-	-
Aves	Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	-	-
Aves	Timaliidae	*Zosterops lateralis*	Silvereye	-	-
Mammalia	Canidae	*Vulpes vulpes*	Fox	-	-

Group	Family	Scientific Name	Common Name	TSCA	EPBC
Mammalia	Dasyuridae	*Antechinus stuartii*	Brown Antechinus	-	-
Mammalia	Felidae	*Felis catus*	Cat	-	-
Mammalia	Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	-	-
Mammalia	Macropodidae	*Macropus rufogriseus*	Red-necked Wallaby	-	-
Mammalia	Macropodidae	*Wallabia bicolor*	Swamp Wallaby	-	-
Mammalia	Molossidae	*Austronomus australis*	White-striped Freetail-bat	-	-
Mammalia	Molossidae	*Mormopterus norfolkensis*	Eastern Freetail-bat	V	-
Mammalia	Molossidae	*Mormopterus ridei*	Eastern Free-tailed Bat	-	-
Mammalia	Muridae	*Mus musculus*	House Mouse	-	-
Mammalia	Muridae	*Rattus rattus*	Black Rat	-	-
Mammalia	Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	-	-
Mammalia	Petauridae	*Petaurus breviceps*	Sugar Glider	-	-
Mammalia	Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V	-
Mammalia	Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	-	-
Mammalia	Pseudocheiridae	*Pseudocheirus peregrinus*	Common Ringtail Possum	-	-
Mammalia	Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V
Mammalia	Pteropodidae	*Pteropus scapulatus*	Little Red Flying-fox	-	-
Mammalia	Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat	-	-
Mammalia	Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	-	-
Mammalia	Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat	-	-
Mammalia	Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V	-
Mammalia	Vespertilionidae	*Miniopterus orianae oceanensis*	Eastern Bentwing-bat	V	-
Mammalia	Vespertilionidae	*Vespadelus pumilus*	Eastern Forest Bat	-	-
Reptilia	Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake	-	-

Group	Family	Scientific Name	Common Name	TSCA	EPBC
Reptilia	Scincidae	*Lampropholis delicata*	Dark-flecked Garden Sunskink	-	-

* Introduced; V - Vulnerable; E - Endangered; M - Migratory

APPENDIX C SITE PHOTOGRAPHS

Quadrat 1 Swamp oak

Quadrat 2 Spotted gum – Grey ironbark

Quadrat 3 Tallowwood – Grey gum

Quadrat 4 Tallowwood – Grey gum

Quadrat 5 Blackbutt - Tallowwood

Quadrat 6 Tallowwood – Grey gum

Quadrat 7 Spotted gum – Grey ironbark

Quadrat 8 Blackbutt – Bloodwood

Quadrat 9 Tallowwood – Grey gum

Quadrat 10 Swamp oak

Quadrat 11 Tallowwood – Grey gum

Quadrat 12 Paperbark

Quadrat 13 Rushland - Herbland

Quadrat 14 Rushland - Herbland

Quadrat 15 Swamp oak

Quadrat 16 Swamp oak

Quadrat 17 Paperbark

Quadrat 18 Blackbutt - Bloodwood

Quadrat 19 Blackbutt - Tallowwood

Quadrat 20 Blackbutt - Tallowwood

Quadrat 21 Paperbark

Quadrat 22 Rushland - Herbland

Eutrophic watercourse near Quadrat 10

Song Meter set on site for acoustic recordings

Anabat detector on site for ultrasonic recordings

Arboreal Elliott trap set on site

Camera trap and lure set on tree trunk on site

Paperbark forest to the north of R1

Blackbutt forest to the north of the Frederickton Golf Course

APPENDIX D BAT CALL IDENTIFICATION

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1.0 METHODS

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Chris Corben, Version 4.2d) software. The calls were recorded using Div Ratio 8. The identification of calls was undertaken with reference to Pennay et al. (2004) and through the comparison of recorded reference calls from north-eastern NSW. Reference calls were obtained from the NSW database and from the authors personal collection.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality
- Unknown - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Activity levels should not be compared among species as different species have different detectability due to factors such as call loudness, foraging strategy and call identifying features. Activity comparisons among sites are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

Nomenclature follows the Australian Chiroptera taxonomic list described by Reardon et al. (2015).

1.1 Characteristics Used to Differentiate Species

Miniopterus australis was differentiated from *Vespadelus pumilus*, by characteristic frequency or the presence of a down-sweeping tail on pulses. Call sequences which had a majority of pulses containing an up-sweeping tail were assigned to *Vespadelus pumilus*.

Chalinolobus morio calls were differentiated from those of *Vespadelus* sp. by the presence of a down-sweeping tail on the majority of pulses. We do not confidently identify *Vespadelus troughtoni* from bat calls in this region as it overlaps in frequency with both *Vespadelus pumilus* and *Vespadelus vulturnus* and we find it difficult to distinguish based on other call characteristics.

Calls from *Miniopterus orianae oceanensis* were differentiated from *Vespadelus* spp. by a combination of uneven consecutive pulses and the presence of down-sweeping tails. Long, high quality call sequences with regularly-spaced consecutive pulses, few down-sweeping tails were assigned to *Vespadelus darlingtoni* or *Vespadelus regulus* depending on characteristic frequency.

Calls from *Mormopterus* spp. were differentiated by the presence of mainly flat pulses. *Mormopterus norfolkensis* was differentiated from *Mormopterus ridei* in long call sequences where pulses alternated, often with a downward sloping tail. Calls from *Mormopterus planiceps* were distinguished from *Mormopterus ridei* only where they do not overlap in characteristic frequency.

Chalinolobus gouldii was differentiated from other species by the presence of curved, alternating call pulses.

Scotorepens orion, *Scoteanax rueppellii* and *Falsistrellus tasmaniensis* were unable to be differentiated from one another. *Falsistrellus tasmaniensis* is most frequently recorded from more elevated locations in the region and so its occurrence within the study area is unlikely. However, some records exist from coastal lowlands and so we have included it in our species groups as a precautionary measure. We do not distinguish *Falsistrellus tasmaniensis* from *Scotorepens orion* where they overlap in frequency.

Chalinolobus nigrogriseus was unable to be differentiated from *Scotorepens* sp. from the calls recorded.

Nyctophilus spp. calls were identified from *Myotis macropus* by pulse intervals > 95 ms and an initial slope of < 300 OPS. *Nyctophilus geoffroyi* and *Nyctophilus gouldi* were unable to be differentiated.

Rhinolophus megaphyllus and *Austronomus australis* were differentiated from other bat species on the basis of characteristic frequency.

Phoniscus papuensis (Golden-tipped Bat) has a very quiet call that is not often recorded on bat detectors.

2.0 RESULTS

A total of 3,087 call sequences were recorded, of which 2,644 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 1,536 call sequences (58 %) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 3-1). Species recorded confidently within the site include:

- *Austronomus australis* (White-striped Free-tailed Bat)
- *Chalinolobus gouldii* (Gould's Wattled Bat)
- *Chalinolobus morio* (Chocolate Wattled Bat)
- *Miniopterus australis* (Little Bent-winged Bat)
- *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat)
- *Mormopterus norfolkensis* (Eastern coastal Free-tailed Bat)
- *Mormopterus ridei* (Ride's Free-tailed Bat)
- *Rhinolophus megaphyllus* (Eastern Horseshoe Bat)
- *Vespadelus pumilus* (Eastern Forest Bat)

Additionally, the following bat species potentially occurred within the site, but could not be confidently identified (those calls classified as possible or as a species group):

- *Chalinolobus nigrogriseus* (Hoary Wattled Bat)
- *Falsistrellus tasmaniensis* (Eastern Falsistrelle)
- *Myotis macropus* (Large-footed Myotis)
- *Nyctophilus geoffroyi* (Lesser long-eared bat)
- *Nyctophilus gouldi* (Gould's long-eared bat)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Scotorepens* sp. (Parnaby's Broad-nosed Bat)
- *Scotorepens orion* (Eastern Broad-nosed Bat)
- *Vespadelus darlingtoni* (Large Forest Bat)
- *Vespadelus regulus* (Southern Forest Bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturnus* (Little Forest Bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors (or are difficult to identify by bat call) and habitat assessment

should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Table 3-1 below summarises the results of the bat call analysis.

Table 3-1: Results of bat call analysis (number of passes per site per night)

IDENTIFICATION	ANA1 28/06/2016	ANA1 29/06/2016	ANA2 28/06/2016	ANA2 29/06/2016	ANA3 28/06/2016	ANA3 29/06/2016	ANA4 30/06/2016	ANA4 1/07/2016	ANA5 30/06/2016	ANA5 1/07/2016	ANA5 2/07/2016	ANA5 3/07/2016	ANA5 4/07/2016	ANA6 30/06/2016	ANA6 1/07/2016	ANA6 2/07/2016
DEFINITE																
Austronomus australis	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Chalinolobus gouldii	-	-	1	1	-	-	-	-	1	-	-	-	-	1	1	-
Chalinolobus morio	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Miniopterus australis	331	360	64	24	17	27	68	-	40	6	21	-	-	234	34	3
Mormopterus ridei	1	2	-	-	-	1	-	-	4	-	-	-	-	-	-	-
Rhinolophus megaphyllus	-	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Vespadelus pumilus	12	26	3	-	-	1	-	-	11	46	14	2	-	11	6	-
PROBABLE																
Chalinolobus gouldii	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
Chalinolobus morio	1	-	-	-	-	-	-	-	5	-	-	-	-	1	-	-
Miniopterus australis	13	1	-	-	-	-	2	-	2	1	2	-	-	-	-	-
Miniopterus orianae oceanensis	2	-	10	1	-	2	-	-	4	1	1	-	-	32	7	1
Mormopterus norfolkensis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mormopterus ridei	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vespadelus pumilus	11	10	3	-	-	-	1	-	1	5	8	2	-	3	7	-
POSSIBLE																
Chalinolobus gouldii	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chalinolobus morio	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miniopterus orianae oceanensis	1	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-
Mormopterus norfolkensis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

IDENTIFICATION	ANA1 28/06/2016	ANA1 29/06/2016	ANA2 28/06/2016	ANA2 29/06/2016	ANA3 28/06/2016	ANA3 29/06/2016	ANA4 30/06/2016	ANA4 1/07/2016	ANA5 30/06/2016	ANA5 1/07/2016	ANA5 2/07/2016	ANA5 3/07/2016	ANA5 4/07/2016	ANA6 30/06/2016	ANA6 1/07/2016	ANA6 2/07/2016
SPECIES GROUPS																
Chalinolobus gouldii / Mormopterus norfolkensis / Mormopterus ridei	24	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Chalinolobus gouldii / Mormopterus ridei	2	1	-	1	-	-	1	-	1	-	-	-	-	-	-	-
Chalinolobus morio / Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	128	89	1	1	1	-	2	-	22	3	1	-	-	57	10	-
Chalinolobus nigrogriseus / Falsistrellus tasmaniensis / Scotorepens species	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Chalinolobus nigrogriseus /Scotorepens species	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
Falsistrellus tasmaniensis / Scotorepens orion	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Miniopterus australis / Vespadelus pumilus	211	91	6	-	1	1	8	-	10	20	2	1	1	14	4	-
Miniopterus orianae oceanensis / Vespadelus darlingtoni / Vespadelus regulus	-	3	24	4	1	6	-	-	17	1	5	-	1	26	19	1
Mormopterus norfolkensis / Mormopterus ridei	57	7	-	-	-	-	2	-	-	1	-	-	-	-	-	-
Myotis macropus / Nyctophilus geoffroyi / Nyctophilus gouldi	1	3	-	-	-	-	1	-	19	5	-	-	-	-	2	-
Nyctophilus geoffroyi / Nyctophilus gouldi	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	78	23	2	2	-	-	-	-	1	-	13	-	-	22	25	-
UNKNOWN																
'Noise' files	6	8	3	2	4	3	1	3	1	4	3	2	1	18	14	43
Unknown	53	90	23	10	5	14	15	-	22	5	7	-	-	63	18	2
TOTAL	**950**	**722**	**142**	**46**	**29**	**56**	**105**	**3**	**162**	**103**	**78**	**7**	**3**	**484**	**147**	**50**

3.0 SAMPLE CALLS

A sample of the calls actually identified from the site for each species is given below.

Figure 4-1: *Austronomus australis* definite call

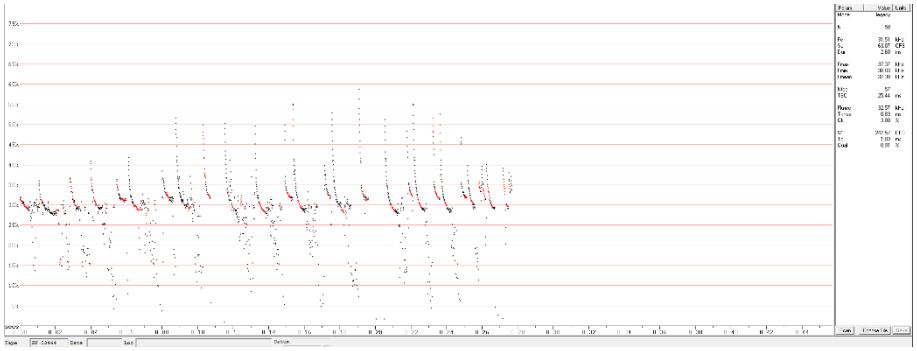

Figure 4-2: *Chalinolobus gouldii* definite call

Figure 4-3: *Chalinolobus morio* definite call

Figure 4-4: *Miniopterus australis* definite call

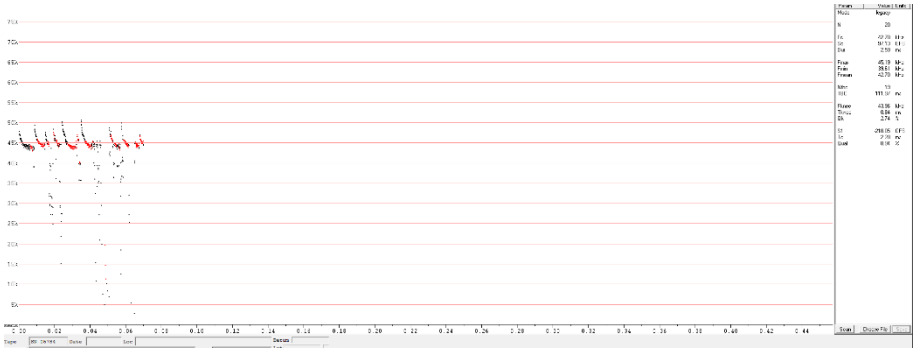

Figure 4-5: *Miniopterus orianae oceanensis* probable call

Figure 4-6: *Mormopterus norfolkensis* probable call

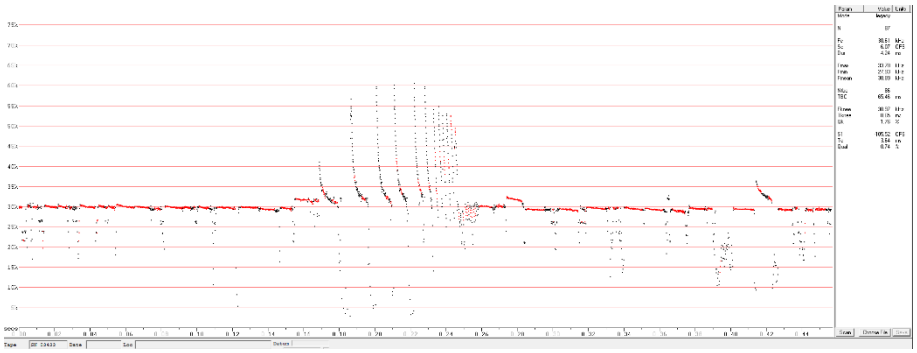

Figure 4-7: *Mormopterus ridei* definite call

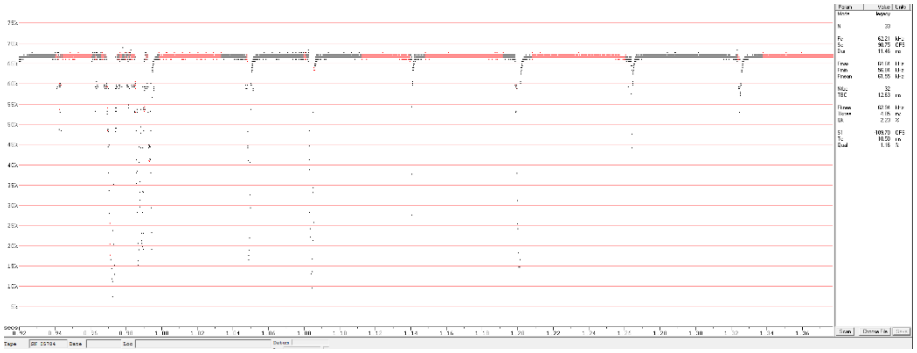

Figure 4-8: *Rhinolophus megaphyllus* definite call

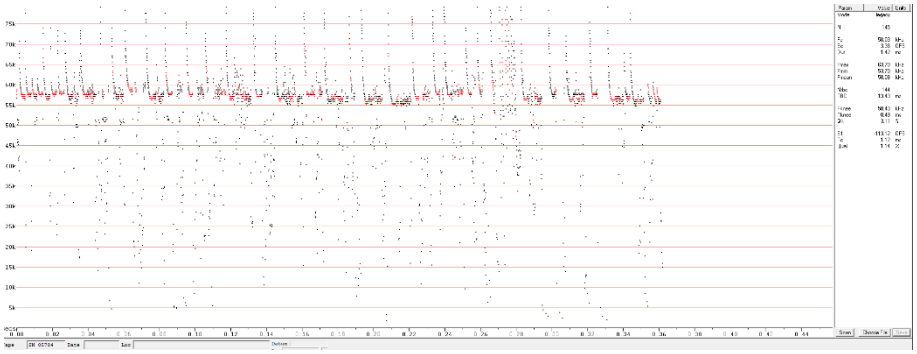

Figure 4-9: *Vespadelus pumilus* definite call

4.0 REFERENCES

Adams, M. D., Law, B.S., French, K.O. (2009). "Vegetation structure influences the vertical stratification of open- and edge-space aerial-foraging bats in harvested forests." Forest Ecology and Management 258(9): 2090-2100.

Adams, M. D., Law, B.S., French, K.O. (2010). Reliable automation of bat call identification for eastern New South Wales, Australia, using classification trees and AnaScheme software. *Acta Chiropterologica* 12(1): 231-245.

Australasian Bat Society Incorporated (undated) *Standards for reporting bat detector surveys*, http://batcall.csu.edu.au/abs/issues/ABS_Anabat_survey_standards.pdf

Churchill, S. (2008). *Australian Bats.* Second Edition Allen & Unwin; Crows Nest, NSW.

Law, B.S., Reinhold, L. and Pennay, M. (2002). Geographic variation in the echolocation calls of Vespadelus spp. (Vespertilionidae) from New South Wale and Queensland, Australia. *Acta Chiropterologica* 4: 201-215.

Pennay, M., Law, B. and Reinhold, L. (2004). *Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.

Reardon, T., Armstrong, K., Jackson, S. (2015). *A current taxonomic list of Australian Chiroptera*, Australasian Bat Society, Inc. Version 2015-05-15.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001a). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Queensland Department of Natural Resources and Mines, State Forests of New South Wales, University of Southern Queensland, and New South Wales National Parks and Wildlife Service, Australia.

Reinhold, L., Herr, A., Lumsden, L., Reardon, T., Corben, C., Law, B., Prevett, P., Ford, G., Conole, L., Kutt, A., Milne, D. and Hoye, G. (2001b). Geographic variation in the echolocation calls of Gould's wattled bat *Chalinolobus gouldii*. *Australian Zoologist* 31: 618-624.

Van Dyck, S. and Strahan, R. (Eds.) (2008). *The Mammals of Australia: Third Edition*. New Holland; Sydney.

APPENDIX E LIKELIHOOD OF OCCURRENCE OF THREATENED SPECIES, POPULATIONS AND ECOLOGICAL COMMUNITIES

All threatened species, populations and ecological communities identified through database searches have been included in the following tables. A description of the habitat for each threatened species, population and ecological community is provided, along with a summary of local records. Additionally, an assessment of the likelihood of occurrence of each species, population and ecological community within the study area has been made based on the results of field surveys, habitat assessment and the presence of local records. For each threatened species, population or ecological community that is considered more than moderately likely to occur within the study area, further discussion is contained within the report.

The following likelihood of occurrence rankings have been applied to each flora species:

- **Known:** the species has been observed in the study area;
- **Likely**: there is a medium to high probability that a species occupies the study area;
- **Possible**: suitable habitat for a species may occur in the study area but there is insufficient information to categorise the species as likely or unlikely to occur;
- **Unlikely**: a low probability that a species occupies the study area;
- **Nil**: habitat in the study area is unsuitable for the species.

The following likelihood of occurrence rankings have been applied to each fauna species:

- **Low**: No suitable habitat is present and the species is unlikely to occur;
- **Low - Moderate**: The study area either:
    a) Contains suitable habitat, but the species was not recorded during the survey (mainly non-cryptic plant species that are readily identified during surveys if present); or
    b) Contains marginal habitat and there are very few local records.
- **Moderate**: the study area contains suitable habitat and the species cannot be discounted from occurring at some stage;
- **Moderate - High**: The study area is likely to be used by the species as there is suitable habitat and local records. However, it was not recorded during the study; and
- **High**: the species has been recorded within the study area.

The following abbreviations are used:

- **E1**: Endangered species;
- **E2**: Endangered Population;
- **E3**: Endangered ecological community;
- **CE**: Critically endangered species;
- **K**: Known occurrence;
- **PR**: Predicted occurrence; and
- **V**: Vulnerable.

Threatened Flora Species

Scientific name	TSC Act	EPBC Act	Detectable	Habitat	Associated vegetation classes/types in study area	Likelihood of occurrence in study area
Allocasuarina defungens	E	E	All year	mainly tall heath on sand, but can also occur on clay soils and sandstone on exposed coastal hills or headlands adjacent to sandplains.	None	Nil
Arthraxon hispidus	V	V	Nov-May	moist sites on edges of rainforest or in wet eucalypt forest	Forested wetlands, Blackbutt - Tallowwood dry grassy open forest	Unlikely - one record in LGA, 2001, 20km away
Cryptostylis hunteriana	V	V	Nov - Feb	swamp heath on sandy soils.	Spotted Gum - Grey Ironbark open forest	Unlikely - no record in LGA
Cynanchum elegans	V	E	All year	rainforest gullies, scrub, scree slopes	Spotted Gum - Grey Ironbark open forest	Unlikely - habitat features not present
Euphrasia arguta	CE	CE	(Oct)-Jan-April	eucalypt forest with a mixed grass and shrub understorey	None	Nil
Marsdenia longiloba	E	V	Flowering (Summer) but leaf characters indicative	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and rock outcrops	Blackbutt - Pink Bloodwood shrubby open forest	Unlikely - few records, nearest 28km away, species and related genera not detected by targeted search
Maundia triglochinoides	V	-	morphological features	swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients	Waterbodies, forested & freshwater wetlands	Possible - last recorded in study area in 1987

Scientific name	TSC Act	EPBC Act	Detectable	Habitat	Associated vegetation classes/types in study area	Likelihood of occurrence in study area
Parsonsia dorrigoensis	V	E	all year	subtropical and warm-temperature rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils	Spotted Gum - Grey Ironbark open forest, Blackbutt - Tallowwood dry grassy open forest, Tallowwood - Grey Gum dry grassy open forest, Blackbutt - Pink Bloodwood shrubby open forest	Unlikely - nearest records located in Tamban SF, species and related genera not detected by targeted search
Persicaria elatior	V	V	morphological features	damp places, especially beside streams and lakes, occasionally in swamp forest or associated with disturbance	Waterbodies, forested & freshwater wetlands	Known - detected in study area
Phaius australis	E	E	September & October but morphology indicative	damp or swampy areas in rainforest, eucalypt or paperbark forest in coastal areas	Coastal floodplain wetlands, swamp forests, North Coast wet sclerophyll forests (Blackbutt-Pink bloodwood shrubby open forest)	Unlikely - 2 records, nearest 14km away, species and related genera not detected by targeted search
Thesium australe	V	V	Flowering (mid-Summer) but morphology indicative	grassland, grassy open forest or woodland on fertile or moderately fertile soils and coastal headlands, often in association with Kangaroo Grass	None	Nil

Threatened Fauna Species

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Amphibians						
Mixophyes iteratus	Giant Barred Frog	E1	E	Rainforests, moist eucalypt forest and nearby dry eucalypt forest generally at low elevation. May also occur in other riparian habitats such as drier forest, degraded remnants and occasionally around dams. Generally found within 20 m of the stream during the breeding season (late spring to summer) and may disperse away from the stream (50m or further) outside of the breeding season. Eggs are laid and fertilised in the water and the female kicks them out of the water where they stick onto a suitable bank (overhanging or steeply sloped). The Coffs Harbour-Dorrigo area is a stronghold.	PR	**Low - Moderate**. Habitat within the study area is highly marginal. Moderate-sized watercourses have very little remnant fringing vegetation remaining. Other watercourses are mostly slow-flowing swamps. No local records occur.
Litoria aurea	Green and Golden Bell Frog	E1	V	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). May inhabit highly disturbed areas. Species has retracted to the coast and remnant populations occur in highly coastal locations.	PR	**Low**. No local records and few recent regional records. Potential habitat within farm dams and wetlands that contain reeds.
Litoria booroolongensis	Booroolong Frog	E1	E	Permanent streams with fringing vegetation. Prefer rocky structures near stream banks. Occurs predominantly along western flowing streams of the Great Dividing Range.	PR	**Low**. Unlikely to occur in coastal areas and no local records.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Litoria brevipalmata	Green-thighed Frog	V		Occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath. Typically in areas where surface water gathers after rain. Breeding occurs following heavy rainfall from spring to autumn, with larger temporary pools and flooded areas preferred. They are difficult to detect unless calling after substantial rain. Appear to prefer ephemeral habitats with leaf litter and not recorded from grassy ponds (Lemckert et al. 2006).	1	**Moderate**. Most of the study area is not suitable habitat for the species. However, small areas of potential habitat exists within forested area slow-lying areas. Small ephemeral pools may occur in vegetated low-lying areas after heavy rain, which may be used for breeding. Low-lying areas with remnant native forest with leaf litter and shrubby understorey are most suitable.
Birds						
Ephippiorhynchus asiaticus	Black-necked Stork	E1		Shallow, permanent, freshwater terrestrial wetlands and a wide variety of more marginal surrounding vegetation types including farm dams, paddocks and estuarine areas. Floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers are the key habitat in NSW. They build large nests high in tall trees close to water with a clear view of the surrounding floodplain.	22	**Moderate - High**. Foraging habitat exists within the study area for this mobile species. Particularly paddocks in the floodplain areas in the south of the study area that remain wet after rain. The species is unlikely to nest in the study area.
Botaurus poiciloptilus	Australasian Bittern	E1	E	Favours permanent freshwater wetlands with tall, dense vegetation, particularly cumbungi and spikerushes.	K	**Moderate.** Potential habitat occurs for the species in the low-lying large wetland areas within the study area. However, no local records occur.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Erythrotriorchis radiatus	Red Goshawk	CE	V	Open woodland and forest, preferring a mosaic of vegetation types, a water source and a large population of birds as a food source. Often found in riparian habitats along watercourses. In NSW, preferred habitats include mixed subtropical rainforest, paperbark swamp forest and riparian eucalypt forest of coastal rivers.	PR	**Low - Moderate**. Marginal habitat present within the study area. However, no local records.
Lophoictinia isura	Square-tailed Kite	V		Timbered habitats including dry woodlands and open forests. Prefers timbered watercourses. Specialist hunter of passerines and insects.	2	**Moderate**. Remnant forest patches, particularly those along drainage lines, within the study area provide suitable foraging habitat and large eucalypts offer nesting opportunities for raptors.
Pandion cristatus	Eastern Osprey	V		Prefers coastal areas, especially the mouths of large rivers, lagoons and lakes. It feeds on fish over clear, open water and is dependent on water.	1	**Moderate - High**. The species is likely to forage over the Macleay River in the east of the study area and may forage over Christmas Creek occasionally. No potential Osprey nests were recorded during surveys. However, we did not undertake detailed surveys in the southern floodplain areas and along the Macleay River so nests cannot be discounted from occurring in these areas close to the River. The species may fly over the potential rezoning areas, but is unlikely to forage or nest within the rezoning areas.
Irediparra gallinacea	Comb-crested Jacana	V		Permanent freshwater wetlands, either still or flowing with abundant floating vegetation such as water lilies.	6	**Moderate**. Suitable foraging habitat occurs in the low-lying wetlands and dams with floating vegetation within the study area.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Calidris ferruginea	Curlew Sandpiper	E1		Estuarine habitats mostly on intertidal mudflats of sheltered coasts. Also occurs in non-tidal swamps, lakes and lagoons on the coast and occasionally inland.	1	**Low - Moderate**. The study area contains only marginal swamp habitats for the species. However, its occurrence at some stage cannot be entirely discounted given the relatively close proximity to the coast and a nearby banding record at Austral Eden.
Sternula albifrons	Little Tern	E1		Coastal areas, preferring sheltered areas harbours, inlets and rivers up to several kilometres inland.	1	**Low - Moderate**. The species may fly inland and forage along the Macleay River. However, these are more marginal habitats for the species and it is unlikely to roost or breed within the study area.
Rostratula australis	Australian Painted Snipe	E1	V	Fringes of swamps, dams and nearby marshy areas where there is a cover of grass, lignum, low scrub or open timber.	PR	**Moderate**. Potential habitat occurs in low-lying wetland areas in the study area. However, no local records.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Feeds almost exclusively on the seeds of *Casuarina* spp. and *Allocasuarina* spp.. Open forest and woodlands up to 1000 m with feed trees present. Nests in hollows in trunks, spouts and stumps of living or dead Eucalypts 5 - 28 m above the ground with a hollow entrance > 20 cm diameter and > 40 cm deep (Gibbons and Lindenmayer 2002).	14	**Moderate - High**. Potential foraging habitat present within the study area (*Allocasuarina torulosa and A. littoralis*). However, no evidence of occurrence (chewed *Allocasuarina* cones) was recorded. Potential nesting hollows do occur within the study area. However, the species was not recorded during surveys.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Glossopsitta pusilla	Little Lorikeet	V		Forages in flowering eucalypts and paperbarks. Riparian habitats are particularly used, due to higher productivity. Roosts in tree tops. Nests in tree hollows, most typically in the limb or trunk of smooth-barked eucalypts with small entrances (~3 cm), usually high above the ground (2 - 15 m). Nest sites are often used repeatedly for decades. Riparian trees are often chosen including *Allocasuarina* spp.	3	**Moderate - High**. Potential foraging and nesting habitat present within the study area.
Lathamus discolor	Swift Parrot	E1	E	Migrates to south-eastern mainland Mar-Oct. Winter-flowering trees such as *Eucalyptus robusta, Corymbia maculata, C. gummifera, E. sideroxylon* and *E. albens* are important. Breeds in Tasmania	PR	**Moderate**. Foraging habitat present across study area in winter flowering eucalypts. *E. pilularis* is known to be a tree species that Swift Parrot forages for lerps.
Ninox strenua	Powerful Owl	V		A range of vegetation types, from open forest and woodland to wet forest and rainforest. Can occur in fragmented landscapes. It hunts medium-sized arboreal mammals such as greater glider, ringtail possum and sugar glider. Birds and flying-foxes may also be taken. Nests in large (> 30 cm diameter) vertical hollow (e.g. broken-off trunk) also horizontal or sloping sponts, often in living, but very old large Eucalypts (Gibbons and Lindenmayer 2002)	2	**High**. Recorded within the study area. Potential foraging habitat within the study area where trees and forest remain. While hollows that may be used for nesting exist within the subject site, no evidence of nesting (owl pellets) was found during the hollow-bearing tree survey which was undertaken during the breeding season.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Tyto longimembris	Eastern Grass Owl	V		Tall grass in swampy areas, grassy plains, swamp heath and in cane grass or sedges on floodplains. Rest and nest on the ground in heavy vegetative growth, often accessed by tunnels through vegetation with a large landing pad.	2	**Moderate**. Potential foraging habitat is present in low-lying paddock areas that are not grazed or only lightly. We undertook searches for potential nests in low-lying areas adjacent to the potential rezoning areas and did not find any evidence of nests. However, depending on future land-use practices areas may become more or less suitable in the future. This species was not recorded during surveys.
Tyto novaehollandiae	Masked Owl	V		Dry eucalypt forest and woodlands up to 1100m elevation. Often hunts along the edges of forests, including roadsides. Tree-dwelling and ground mammals, especially rats. Uses large tree hollows or sometimes caves for nesting. Nests in large tree hollows (> 20 cm diameter), usually a trunk or vertical spout in large old living or dead trees (usually Eucalypts) (Gibbons and Lindenmayer 2002). Sometimes uses caves, ledges or sinkholes for nesting.	1	**Moderate - High**. Potential foraging habitat is present throughout much of the study area, particularly along forest remnant edges. While hollows that may be used for nesting exist within the study area, no evidence of nesting (owl pellets) was found during the hollow-bearing tree survey which was undertaken during the breeding season. This species was not recorded during surveys.
Tyto tenebricosa	Sooty Owl	V		Occurs in rainforest (dry, subtropical and warm temperate) as well as moist eucalypt forests. Roosts in the hollow of a tall forest tree or in heavy vegetation. Nests in very large tree-hollows. Nests in very large tree-hollows (> 30 cm diameter) often in the trunk of living old Eucalypts (Gibbons and Lindenmayer 2002).	PR	**Low - Moderate**. Marginal foraging habitat is present along the creeklines and wet sclerophyll forest. While hollows that may be used for nesting exist within the study area, no evidence of nesting (owl pellets) was found during the hollow-bearing tree survey which was undertaken during the breeding season. This species was not recorded during surveys and no local records occur.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Dasyornis brachypterus	Eastern Bristlebird	E	E	Dense, low vegetation including heath and open woodland with a heath or tussock grass understorey.	PR	**Low**. The study area does not contain a heath understorey and there are no local records.
Daphoenositta chrysoptera	Varied Sittella	V		Eucalypt forests and woodlands, particularly those with rough-barked species, mature smooth-barked gums with dead branches, mallee and *Acacia* woodland.	4	**Moderate**. Potential habitat occurs within remnant forested areas within the study area.
Mammals						
Dasyurus maculatus	Spotted-tailed Quoll	V	E	A variety of vegetation such as rainforest, open forest, woodland, coastal heath, inland riparian forest. Den sites may be located in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky cliffs.	K	**Moderate**. Potential habitat exists within the study area. However, no local records occur.
Phascogale tapoatafa	Brush-tailed Phascogale	V		Mostly found in dry sclerophyll open forest with sparse groundcover, east of the Great Dividing Range. However, has been recorded in heath, swamps, rainforest and wet sclerophyll forest. Nest and shelter in tree hollows with small entrances (2.5 - 4cm)	3	**Moderate**. Suitable habitat exists within the study area and local records occur. They were not recorded during our study. However, they have large home ranges and can be difficult to detect during surveys so their occurrence cannot be discounted.
Phascolarctos cinereus	Koala	V	V	Found in eucalypt woodlands and forest foraging on preferred food trees. Primary food tree species listed in the Kempsey Comprehensive Koala Plan of Management (Biolink 2009) are: *Eucalyptus microcorys, E. tereticornis* and *E. robusta*. Secondary food tree species are: *E. propinqua, E. globoidea* and *E. tindaliae*.	11	**Moderate**. The study area contains Koala habitat and local records occur. Spotlighting was undertaken, opportunistic scat and scratch surveys were undertaken, SAT plots and tree canopies were searched thoroughly during the hollow-bearing tree survey and no evidence of koalas was found.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Petauroides volans	Greater Glider	-	V	Restricted to eucalypt forests and woodlands, feeding on eucalypt leaves and occasionally flowers. It is most abundant in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. Distribution may be patchy even in suitable habitat. It prefers large hollows in large, old trees (EPBC Conservation Advice).	K	**Low - Moderate.** The study area contains highly marginal habitat for the species as it is lower-lying. No local records occur.
Petaurus australis	Yellow-bellied Glider	V		Tall mature eucalypt forest, generally in areas with high rainfall and nutrient rich soils. Feed primarily on nectar, sap, honeydew and manna with pollen and insects also taken. Often leave a distinctive V-shaped feeding scar on tree trunks. Den in tree hollows of large trees.	1	**Moderate**. Potential foraging habitat exists within the study area. However, no characteristic V shaped feeding incisions were noted and the species was not detected during field surveys (spotlighting, call playback and Song Meter recording). However, it is possible that the species occurs within less surveyed areas of the study area.
Petaurus norfolcensis	Squirrel Glider	V		Inhabits mature or old growth box, box-ironbark woodlands and river red gum forest west of the Great Dividing Range. Prefers mixed species stands with a shrub or Acacia midstorey. Uses tree hollows as dens sites.	3	**High**. Suitable foraging and denning habitat are present within the study area. We recorded the species at a number of locations around Raymond's Lane.
Potorous tridactylus	Long-nosed Potoroo	V	V	Coastal heath and dry and wet sclerophyll forest. Dense understorey with occasional open areas is essential and may consist of grass-trees, sedges, ferns, heath or low shrubs. A sandy-loam soil is also a common feature. Small diggings similar to bandicoots.	PR	**Low - Moderate**. Potential habitat exists within the remnant forested areas within the study area. However, there are no local records.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Petrogale penicillata	Brush-tailed Rock-wallaby	E1	V	Rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges often facing north.	PR	**Low**. No suitable complex rocky escarpment present.
Pseudomys novaehollandiae	New Holland Mouse		V	Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. It is a social animal, living predominantly in burrows shared with other individuals. Distribution is patchy in time and space, with peaks in abundance during early to mid-stages of vegetation succession typically induced by fire.	PR	**Low**. The study area does not contain forest with a heath understorey and no local records exist.
Mormopterus norfolkensis	East Coast Freetail-bat	V		Highly mobile insectivorous species that appears to prefer productive floodplain habitats and avoids urban areas (McConville et al. 2013a, McConville et al. 2014). It roosts singularly or communally in tree hollows and appears to prefer to breed in tree hollows in patches of forest that have a high density of hollow-bearing trees (McConville et al. 2013b). It may fly up to 10 km from roosts to forage (McConville 2013).	6	**High**. The species was recorded during surveys. The species is highly mobile and may forage over the study area on occasional. Potential roosting habitat occurs within tree hollows.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Insectivorous species that roosts in cave overhangs in the twilight zone, crevices in cliffs, old mine workings, fairy martin nests and rarely buildings. Recorded in well-timbered areas containing gullies.	PR	**Low - Moderate**. Foraging habitat is present. However, there are no local records and no nearby roosting habitat (cave overhangs).

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Chalinolobus nigrogriseus	Hoary Wattled Bat	V		Dry open eucalypt forests favouring forests dominated by C. maculata, box and ironbark and heathy coastal forests dominated by *C. gummifera* and scribbly gums.	2	**Moderate - High**. The species is highly mobile and may forage over the study area on occasional. Potential roosting habitat occurs within tree hollows.
Miniopterus australis	Little Bentwing-bat	V		Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, paperbark forest, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roosts in caves, tunnels, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day. Only five maternity colonies are known in Australia.	6	**High**. Recorded during surveys. Potential foraging habitat exists across much of the study area. Potential roosting habitat occurs within the few culverts and the bridge over Christmas Creek within the study area.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		Forages in a range of habitat types including urban areas. Roosts in caves, derelict mines, culverts and other man-made structures. Form maternity colonies that are faithful to particular caves. Only two known maternity sites remain.	5	**High**. Recorded during surveys. Potential foraging habitat exists across much of the study area. Potential roosting habitat occurs within the few culverts and the bridge over Christmas Creek within the study area.
Myotis macropus	Large-footed Myotis	V		Forage over streams and pools catching insects and small fish by raking their feet across the water surface. Roost close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage.	1	**Moderate**. Potential foraging habitat occurs along the Macleay River, Christmas Creek and adjacent large wetlands within the study area. Potential roosting habitat occurs within the few culverts and the bridge over Christmas Creek within the study area.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Variety of habitats from woodland to moist and dry eucalypt forest and rainforest. Roosts in tree hollows, but has been found in buildings.	1	**Moderate**. Local records occur and potential foraging and roosting habitat (tree hollows) occur within the study area.

Scientific Name	Common Name	TSC Act status	EPBC Act status	Habitat Description[1]	Records[2]	Likelihood of Occurrence
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Feeds on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Roosts in camps generally found in gullies, close to water in vegetation with a dense canopy.	6	**High**. Recorded during surveys. Likely to forage on flowering eucalypts throughout the year. Potential camp habitat in low-lying creekline gullies within the study area.

[1] Unless otherwise cited, habitat description information was sourced from NSW OEH Threatened Species Profile Database (http://www.environment.nsw.gov.au/threatenedspecies)

[2] Records obtained from OEH Atlas of NSW Wildlife and EPBC Protected Matters database searches

APPENDIX F KEY THREATENING PROCESSES

Table F1: Each key threatening process (KTP) listed under *NSW Threatened Species Conservation Act 1995* (TSC Act) is assessed as to the likelihood that it operates within the study area. The potential contribution of the proposal to the operation of the KTP within the study area is also assessed.

Key Threatening Process	Likelihood of Operation within Study Area	Potential Contribution of Proposal
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners *Manorina melanocephala*	Moderate. Noisy Miners were common within the study area, particularly where the understorey was maintained.	**Moderate - High**. The proposal may increase the operation of this KTP by allowing higher urban density which promotes use by this species.
Alteration of habitat following subsidence due to longwall mining	Low. No longwall mining has occurred within the study area.	**Low**. No longwall mining is proposed.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Moderate. A number of farm dams occur within the study area that are likely to alter the natural flow regimes. Additionally historical land-clearing is likely to have altered the hydrology.	**Moderate - High**. Higher density urban development within the site will result in changes to the hydrology of the study area and put additional pressure on local creek systems.
Anthropogenic Climate Change	Low - Moderate. Historical land-clearing and residential development within the study area is likely to have contributed slightly to climate change.	**Low - Moderate**. The project will have a minor contribution to overall greenhouse gas emission during construction. There will also be ongoing emissions by residents. However, there is also the opportunity to incorporate sustainable design elements into any new residential areas to reduce emissions.
Bushrock removal	Low. The study area contains very little bushrock.	**Low**. The study area contains very little bushrock.
Clearing of native vegetation	Moderate. Clearing has been historically undertaken in rural areas for cattle grazing and continues in rural residential areas.	**Moderate - High**. Rezoning of the study area will contribute to this KTP by facilitating greater urbanisation which is likely to result in additional vegetation removal and modification. However, there is an opportunity to minimise the operation of this KTP through the rezoning process by minimising urban expansion into areas of native vegetation.

Key Threatening Process	Likelihood of Operation within Study Area	Potential Contribution of Proposal
Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus* (L.)	Low - Moderate. Historical land-clearing for cattle grazing has created suitable conditions for this species to thrive. However, rabbits did not appear to be abundant during surveys.	**Low**. Increased urbanisation will not exacerbate the operation of this KTP.
Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758	Low. No evidence of goats was recorded within the study area during surveys.	**Moderate**. The increase in the number of rural residential properties has the potential to increase the action of this KTP slightly through the accidental release of domestic goats.
Competition from feral honey bees, *Apis mellifera* L.	Moderate. Historical land-clearing has likely exacerbated the activity of this KTP within the study area by reducing the number of hollow-bearing trees available to native fauna.	**Moderate**. The removal of hollow-bearing trees within the study area may contribute to the operation of this KTP by increasing competition pressure on native fauna.
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	Low. No Bell miners were recorded within the study area.	**Low**. The proposal will not provide habitat for Bell Miners.
Herbivory and environmental degradation caused by feral deer	Low - Moderate. No evidence of deer was recorded within the study area during surveys. However, they are often difficult to detect	**Moderate**. The increase in the number of rural residential properties has the potential to increase the action of this KTP slightly through the accidental release of domestic deer.
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Low - Moderate. Few of the properties appear to be regularly burnt such to contribute substantially to this KTP.	**Low - Moderate**. Increased urbanisation may result in high fire frequency in surrounding native bushland remnants as a result of hazard reduction, accidental fire and arson.
Importation of Red Imported Fire Ants *Solenopsis invicta* Buren 1972	Low. No importation of fire ants has occurred.	**Low**. The proposal does not include importing fire ants.
Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations	Unknown. This disease occurs naturally in Australia and its prevalence within the study area is unknown.	**Low - Moderate**. The proposal may place local Psittacine populations under greater stress which may increase their susceptibility to this disease.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Low - Moderate. Chytrid may already be present within the site. Transportation of Chytrid may already be occurring through use of farm machinery in damp areas.	**Moderate**. The proposal has the potential to increase the spread of Chytrid between wet areas during construction.

Key Threatening Process	Likelihood of Operation within Study Area	Potential Contribution of Proposal
Infection of native plants by *Phytophthora cinnamomi*	Low - Moderate. There is some evidence of dieback within the study area. However, it appears to have been caused by cattle rubbing on trees.	**Moderate**. The proposal may facilitate the transmission of plant diseases through machinery transportation during construction.
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Low - Moderate. We did not observe any areas affected by Myrtle rust during our surveys. However, its presence within the study area cannot be discounted.	**Moderate**. The proposal may facilitate the transmission of plant diseases through machinery transportation during construction.
Introduction of the Large Earth Bumblebee *Bombus terrestris* (L.)	Low. No importation of bumblebees has occurred.	**Low**. The proposal does not include importing insects.
Invasion and establishment of exotic vines and scramblers	Low - Moderate. Few invasive exotic vines and scramblers were recorded within the study area during surveys.	**Moderate**. The proposal may facilitate the transmission of plant parts through machinery transportation during construction.
Invasion and establishment of Scotch Broom (*Cytisus scoparius*)	Low. Scotch Broom was not recorded within the study area during surveys.	**Low**. Scotch Broom is unlikely to establish within the study area as it is at low elevation.
Invasion and establishment of the Cane Toad (*Bufo marinus*)	Low. It is unlikely that *Bufo marinus* (Cane Toad) is present within the study area.	**Low**. The proposal will not involve the transportation of frogs.
Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata* (Wall ex G. Don Cirferri)	Low. The species was not recorded within the study area during surveys.	**Low - Moderate**. The proposal may facilitate the transmission of plant parts through machinery transportation during construction. However, this species is not a large problem in the local area.
Invasion of native plant communities by *Chrysanthemoides monilifera*	Low. The species was not recorded within the study area during surveys.	**Low - Moderate**. The proposal may facilitate the transmission of plant parts through machinery transportation during construction.
Invasion of native plant communities by exotic perennial grasses	**Moderate**. Exotic perennial grasses are present in rural areas within the study area. However, they are not a major problem in remnant bushland areas.	**Moderate**. The proposal may facilitate the transmission of plant parts through machinery transportation during construction.
Invasion of the Yellow Crazy Ant, *Anoplolepis gracilipes* (Fr. Smith) into NSW	Low. No importation of fire ants has occurred.	**Low**. The proposal does not include importing fire ants.

Key Threatening Process	Likelihood of Operation within Study Area	Potential Contribution of Proposal
Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)	Moderate. Lantana was patchily distributed in remnant native vegetation throughout the study area.	**Moderate**. The proposal may facilitate the transmission of plant parts through machinery transportation during construction. Additionally, remnant vegetation retained in a more urban landscape may become overrun by weeds if not carefully managed.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Low - Moderate. The study area may already be contributing to this KTP, particularly in the rural residential areas. However, we did not observe it to be a large problem.	**Moderate**. Increased urbanisation will increase the potential for garden plants to escape via dumping of garden refuse or aquarium tanks.
Loss of Hollow-bearing Trees	Moderate. Historical land-clearing for cattle grazing has resulted in the removal of many hollow-bearing trees. Loss continues as trees are removed due to safety or aesthetics in rural and rural residential areas within the study area.	**Moderate to High**. Increased urbanisation has the potential to remove a high number of hollow-bearing trees. However, the rezoning process allows sensitive design of future development areas to avoid key features such as hollow-bearing trees.
Loss or degradation (or both) of sites used for hill-topping by butterflies	Low. The study area or region are not known to be important for threatened hill-topping butterflies.	**Low**. The study area or region are not known to be important for threatened hill-topping butterflies.
Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*	Moderate. The study area may act as a source of feral dogs to surrounding areas.	**Moderate**. While the residential rezoning is unlikely to increase this KTP as dogs in high density residential areas tend to be well fenced. However, additional rural residential areas are likely to contribute to this KTP through domestic dog escapes as these properties tend to allow dogs to roam free.
Predation by *Gambusia holbrooki* Girard, 1859 (Plague Minnow or Mosquito Fish)	Moderate. Gambusia were observed from farm dams within the study area.	**Low**. It is unlikely that the proposed rezonings will increase Gambusia abundance within the study area.
Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)	Moderate to High. Foxes were recorded from numerous locations within remnant bushland in the study area.	**Low**. The proposed rezonings will not increase the abundance of foxes within the study area.

Key Threatening Process	Likelihood of Operation within Study Area	Potential Contribution of Proposal
Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)	Moderate. No feral cats were observed during surveys. However, stray domestic cats from existing properties may already contribute to a feral cat population in the local area.	**Moderate**. While predation by domestic cats in surrounding remnant bushland is likely to increase as a result of urbanisation, feral cat predation is likely to remain the same.
Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758	Low. No evidence of pigs was recorded within the study area during surveys.	**Low**. Increased urbanisation will reduce the amount of habitat available to this species and will not exacerbate the operation of this KTP.
Removal of dead wood and dead trees	Moderate. Evidence of timber collecting for firewood was observed throughout remnant bushland within the study area.	**Moderate to High**. An increase in residential and rural residential areas is likely to increase fire collection activities on properties and in surrounding bushland.

APPENDIX G INVASIVE SPECIES

Table G1: An assessment of the potential for the proposal to assist each invasive species listed under the *Environment Protection and Biodiversity Conservation Act 1999*, identified through the EPBC Act Protected Matters Search.

Scientific Name	Common Name	Assessment
Acridotheres tristis	Indian Myna	**Mod - High** Increased residential areas will create more opportunities that the Indian Myna is likely to exploit
Anas platyrhynchos	Mallard	**Mod** Increased residential areas will create more opportunities that this species may exploit
Carduelis carduelis	European Goldfinch	**Low** The proposed rezoning is unlikely to influence the distribution or abundance of this invasive species
Columba livia	Rock Pigeon	**Mod - High** Increased residential areas will create more opportunities that the Rock Pigeon is likely to exploit
Lonchura punctulata	Nutmeg Mannikin	**Low** The proposed rezoning is unlikely to influence the distribution or abundance of this invasive species
Passer domesticus	House Sparrow	**Mod - High** Increased residential areas will create more opportunities that the House Sparrow is likely to exploit. However, Indian Myna often displaces House Sparrow.
Pycnonotus jocosus	Red-whiskered Bulbul	**Low** The proposed rezoning is unlikely to influence the distribution or abundance of this invasive species
Streptopelia chinensis	Spotted Turtle-Dove	**Mod - High** Increased residential areas will create more opportunities that the Spotted Turtle-Dove is likely to exploit
Sturnus vulgaris	Common Starling	**Mod** Increased residential areas will create more opportunities that the Common Starling is likely to exploit
Turdus merula	Common Blackbird	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Rhinella marina	Cane Toad	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Bos taurus	Domestic Cattle	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species. Cattle grazing will likely be reduced with the proposed rezonings.
Canis lupus familiaris	Domestic Dog	**Moderate** Increased residential areas are likely to increase the abundance of domestic dogs within the study area and this may result in a slight increase in the local feral dog population.
Felis catus	Cat	**Mod - High** Increased residential areas will create more opportunities that this species is likely to exploit

Scientific Name	Common Name	Assessment
	Feral deer	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Lepus capensis	Brown Hare	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Mus musculus	House Mouse	**Mod - High** Increased residential areas will create more opportunities that this species is likely to exploit
Rattus norvegicus	Brown Rat	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Rattus rattus	Black Rat	**Mod - High** Increased residential areas will create more opportunities that this species is likely to exploit
Vulpes vulpes	Red Fox	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Alternanthera philoxeroides	Alligator Weed	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Anredera cordifolia	Madeira Vine	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Asparagus aethiopicus	Asparagus Fern	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Cabomba caroliniana	Cabomba	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Chrysanthemoides monilifera	Bitou Bush, Boneseed	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Eichhornia crassipes	Water Hyacinth	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Genista sp. X Genista monspessulana	Broom	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Lantana camara	Lantana	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Opuntia spp.	Prickly Pears	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Pinus radiata	Radiata Pine	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Protasparagus plumosus	Climbing Asparagus-fern	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species

Scientific Name	Common Name	Assessment
Rubus fruticosus aggregate	Blackberry	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Salix spp.	Weeping Willow	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Salvinia molesta	Salvinia	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species
Senecio madagascariensis	Fireweed	**Low** The proposed rezoning is unlikely to increase the distribution or abundance of this invasive species

APPENDIX H ASSESSMENT OF SIGNIFICANCE (SEVEN-PART TESTS)

Considerations of the effects of the proposed development under the guidelines of Section 5A of the Environmental Planning and Assessment Act 1979 (EPA Act 1979) for threatened species, populations and / or ecological communities considered to have a greater than moderate likelihood of occurrence (see Appendix E for likelihood of occurrence assessment) are given below.

The following threatened species, populations and / or ecological communities have been considered (grouped based on similar habitat requirements where appropriate):

- Endangered Ecological Communities
    - *Freshwater Wetlands on Coastal Floodplains* of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC;
    - *Swamp Oak Floodplain Forest* of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC;
    - *Swamp Sclerophyll Forest on Coastal Floodplains* of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC;
- *Maundia triglochinoides*;
- *Persicaria elatior* (Knotweed);
- *Litoria brevipalmata* (Green-thighed Frog);
- Wetland birds
    - *Ephippiorhynchus asiaticus* (Black-necked Stork);
    - *Botaurus poiciloptilus* (Australasian Bittern);
    - *Rostratula australis* (Australian Painted Snipe);
    - *Irediparra gallinacea* (Comb-crested Jacana);
- *Lophoictinia isura* (Square-tailed Kite);
- *Pandion cristatus* (Eastern Osprey);
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo);
- Nectarivorous birds
    - *Glossopsitta pusilla* (Little Lorikeet);
    - *Lathamus discolor* (Swift Parrot);
- Forest Owls
    - *Ninox strenua* (Powerful Owl);
    - *Tyto novaehollandiae* (Masked Owl);
- *Tyto longimembris* (Eastern Grass Owl);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Dasyurus maculatus* (Spotted-tailed Quoll);
- *Phascogale tapoatafa* (Brush-tailed Phascogale);

- *Phascolarctos cinereus* (Koala);
- *Petaurus australis* (Yellow-bellied Glider);
- *Petaurus norfolcensis* (Squirrel Glider);
- Hollow-dependent microbats
    - *Mormopterus norfolkensis* (East Coast Freetail-bat);
    - *Chalinolobus nigrogriseus* (Hoary Wattled Bat);
    - *Scoteanax rueppellii* (Greater Broad-nosed Bat);
- Cave-roosting bats
    - *Miniopterus australis* (Little Bentwing-bat);
    - *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat);
- *Myotis macropus* (Southern Myotis);
- *Pteropus poliocephalus* (Grey-headed Flying-fox).

Assumptions

Area of impact

The areas of native vegetation to be affected by the proposal are those given in Section 4.1.1.

Type of impacts

For the purpose of this assessment it is assumed that the direct impact of the rezoning on remnant native vegetation would be the eventual removal or modification of all native vegetation within the rezoned areas. In addition to the impact on vegetation within the rezoned areas there is also the potential for indirect impacts on wetland flora and vegetation downstream. These potential impacts would primarily be hydrological impacts from anthropogenic discharges such as wastewater disposal and stormwater runoff from the proposed new R1 and IN1 areas and could include erosion, sedimentation, nutrient enrichment and eutrophication of water bodies and associated changes to flora and vegetation. They would be confined to the unnamed central watercourse that drains the catchment in which the proposed new R1 and IN1 areas are located.

The potential impacts on the subject species are discussed in Section 4.0 and summarised in Table 4-4 of the main report.

Local population

As defined under the TSC Act, the local population is considered to be the population of flora or fauna that occurs within the study area.

Conclusion summary:

The proposal will require the removal of large areas of vegetation (albeit partially cleared) within the R5 Rural Residential rezoning area, with a smaller amount of vegetation removal proposed within the IN1 Industrial area. At this stage the proposal does not include any conservation zonings, habitat retention proposals or the provision of compensatory habitat (offsets). As such our assessment has been based on the worst case of total vegetation removal and we adopted the precautionary principle when applying the 7-part test.

Our assessment found that the R5 Rural Residential and IN1 Industrial rezoning proposals may have a significant impact on the following species due to the combined removal of foraging and breeding habitat (whether potential or known):

- *Glossopsitta pusilla* (Little Lorikeet);
- *Phascogale tapoatafa* (Brush-tailed Phascogale);
- *Petaurus norfolcensis* (Squirrel Glider);
- *Mormopterus norfolkensis* (East Coast Freetail-bat);
- *Chalinolobus nigrogriseus* (Hoary Wattled Bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);

While the IN1 Industrial rezoning area will remove a much smaller area of habitat than the R5 Rural residential area, due to the high density of hollow-bearing trees in parts of the IN1 Industrial rezoning area, we have concluded that the proposal may have a significant impact on the above-listed hollow-dependent threatened fauna species. However, these impacts may be avoided if the rezoning is redesigned to avoid the most critical habitat elements.

Without any redesign or an assessment under another approval pathway (e.g. Biocertification), we recommend the preparation of a Species Impact Statement to further assess the potential impacts of the R5 Rural Residential and IN1 Industrial rezoning areas.

1.0 SEVEN-PART TEST - FACTORS OF ASSESSMENT

The TSC Act Assessment of Significance (the 7-part Test) outlines factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

2.0 7-PART TESTS

2.1 Freshwater Wetlands (FWW) EEC

This community occurs on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains (Scientific Committee 17/12/04a,b,c).

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

N/A

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

N/A

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

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

<u>R1 Residential and IN1 Industrial</u>

Given the extent and distribution of freshwater wetlands in the study area, their adaptation to disturbance impacts associated with natural flooding events and the absence of direct impacts of the proposed rezoning on the extent of the community in the study area, the possible hydrological impact of the proposal in the receiving area is unlikely 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.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as the EEC and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the EEC.

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

R1 Residential and IN1 Industrial

Similarly, given the likely absence of any impacts of the proposed rezoning on the composition of the community elsewhere in the study area, the proposal is unlikely to have an adverse effect on the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as the EEC and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the EEC.

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

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

No habitat for freshwater wetlands would be removed by the proposal; the extent to which that habitat would be modified is limited to minor hydrological impacts.

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

The location and nature of the proposal is such that habitat for the community would not become fragmented or isolated from other areas of habitat.

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

Freshwater wetlands are common in the study area and locality and the importance of the habitat to be modified to the long-term survival of the species, population or ecological community in the locality is likely to be low.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for these EECs. OEH is currently developing a targeted approach for managing Ecological Communities under the Saving our Species program. In the interim, the following management actions are relevant to these communities (http://www.environment.nsw.gov.au/savingourspeciesapp/):

- Use mechanisms such as Voluntary Conservation Agreements to promote the protection, particularly from threats such as grazing, of this EEC on private land.
- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
- Liaise with community to improve recognition of values and encourage landholder participation in site management including weed control.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.
- Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works.

Provided that the Proposal addresses one or more of the management actions listed above, it would be likely to be consistent with the objectives or actions of a recovery plan or threat abatement plan should one be prepared.

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

The proposed activity includes the key threatening process (KTP) 'Native vegetation clearance' and may contribute to the KTPs 'Invasion of exotic perennial grasses' (specifically Broadleaved paspalum *P. mandiocanum*) and 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' (specifically Water hyacinth *Eichornia crassipes*), which is known to impact on Swamp Sclerophyll Forest (Scientific Committee 26/08/11).

As no threat abatement plans have yet been prepared by the NSW National Parks and Wildlife Service, it is not possible to review the proposed activity in light of the plans.
Notwithstanding this, these key threatening processes may be considered in a generic sense ie: is the proposal likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, and in particular, would it:

- cause fragmentation of ecological communities;
- reduce the viability of ecological communities by disrupting ecological functions;
- result in the destruction of habitat and loss of biological diversity; and
- lead to soil and bank erosion or riparian zone degradation.

Based on this assessment it is considered that the proposed rezoning to R1 and IN1 would not be likely to fragment ecological communities, disrupt ecological functions, destroy habitat or lead to erosion.

However, it has the potential to contribute to degradation of riparian zones along the unnamed watercourse and thereby to impact on the survival of *Persicaria elatior* in the locality.

2.2 Swamp Oak Floodplain Forest (SOFF) EEC

This community occurs on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains (Scientific Committee 17/12/04a,b,c), but SOFF may also extend up intermittent creek-lines on fingers of alluvium (Keith 2004), represented in the study area by the Cairncross soil landscape.

However, in the study area Swamp oak forest also extends to elevated areas beyond the floodplain onto the Kundabung residual soil landscape, probably because of the seasonal waterlogging and sodic soils characteristic of this soil landscape and the disturbance regime that has favoured Swamp Oak over eucalypts. These elevated areas, together with small poorly defined stream channels characteristic of residual soil landscapes (Milford *et al* 2008) occurring within the proposed rezoning areas are unlikely to be EEC.

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

N/A

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

N/A

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

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

R1 Residential and IN1 Industrial

Given the extent and distribution of SOFF in the study area and the absence of impacts of the proposed rezoning on the extent of the community in the study area, the possible hydrological impacts of the proposal in the receiving area is unlikely 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.

R5 Rural Residential
The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as the EEC and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the EEC.

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

R1 Residential and IN1 Industrial
Similarly, given the likely absence of any impacts of the proposed rezoning on the composition of the community elsewhere in the study area, the proposal is unlikely to have an adverse effect on the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

R5 Rural Residential
The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as the EEC and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the EEC.

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

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

No habitat for SOFF would be removed by the proposal; the extent to which that habitat would be modified is limited to minor hydrological impacts.

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

The location and nature of the proposal is such that habitat for the community would not become fragmented or isolated from other areas of habitat.

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

SOFF is common in the study area and locality and the importance of the habitat to be modified to the long-term survival of the ecological community in the locality is likely to be low.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for these EECs. OEH is currently developing a targeted approach for managing Ecological Communities under the Saving our Species program. In the interim, the following management actions are relevant to these communities (http://www.environment.nsw.gov.au/savingourspeciesapp/):

- Use mechanisms such as Voluntary Conservation Agreements to promote the protection, particularly from threats such as grazing, of this EEC on private land.
- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
- Liaise with community to improve recognition of values and encourage landholder participation in site management including weed control.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.
- Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works.

Provided that the Proposal addresses one or more of the management actions listed above, it would be likely to be consistent with the objectives or actions of a recovery plan or threat abatement plan should one be prepared.

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

The proposed activity includes the key threatening process (KTP) 'Native vegetation clearance' and may contribute to the KTPs 'Invasion of exotic perennial grasses' (specifically Broadleaved paspalum *P. mandiocanum*) and 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' (specifically Water hyacinth *Eichornia crassipes*), which is known to impact on Swamp Sclerophyll Forest (Scientific Committee 26/08/11).

As no threat abatement plans have yet been prepared by the NSW National Parks and Wildlife Service, it is not possible to review the proposed activity in light of the plans.
Notwithstanding this, these key threatening processes may be considered in a generic sense ie: is the proposal likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, and in particular, would it:

- cause fragmentation of ecological communities;
- reduce the viability of ecological communities by disrupting ecological functions;

- result in the destruction of habitat and loss of biological diversity; and
- lead to soil and bank erosion or riparian zone degradation.

Based on this assessment it is considered that the proposed rezoning to R1 and IN1 would not be likely to fragment ecological communities, disrupt ecological functions, destroy habitat or lead to erosion.

However, it has the potential to contribute to degradation of riparian zones along the unnamed watercourse and thereby to impact on the survival of *Persicaria elatior* in the locality.

2.3 Swamp Sclerophyll Forest (SSF) EEC

This community occurs on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains (Scientific Committee 17/12/04a,b,c).

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

N/A

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

N/A

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

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

R1 Residential and IN1 Industrial

Given the extent of SSF in the study area, their adaptation to disturbance impacts associated with natural flooding events and the absence of impacts of the proposed rezoning on the extent of the community in the study area, the possible hydrological impacts of the proposal in the receiving area is unlikely 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.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as the EEC and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the EEC.

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

R1 Residential and IN1 Industrial

SSF in the study area occupy a niche in which plant species are adapted to the hydrological regime and these appear to have been robust to the disturbances that have occurred since settlement. It is likely that the community will be resilient to the relatively minor hydrological impacts likely to arise from the proposed rezoning. The proposal is therefore unlikely to have an adverse effect on the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as the EEC and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the EEC.

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

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

No habitat for SSF would be removed by the proposal; the extent to which that habitat would be modified is limited to minor hydrological impacts.

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

The location and nature of the proposal is such that habitat for the community would not become fragmented or isolated from other areas of habitat.

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

Swamp sclerophyll forests are common in the study area and locality and the importance of the habitat to be modified to the long-term survival of the ecological community in the locality is likely to be low.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for these EECs. OEH is currently developing a targeted approach for managing Ecological Communities under the Saving our Species program. In the interim, the following management actions are relevant to these communities (http://www.environment.nsw.gov.au/savingourspeciesapp/):

- Use mechanisms such as Voluntary Conservation Agreements to promote the protection, particularly from threats such as grazing, of this EEC on private land.
- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
- Liaise with community to improve recognition of values and encourage landholder participation in site management including weed control.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.
- Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works.

Provided that the Proposal addresses one or more of the management actions listed above, it would be likely to be consistent with the objectives or actions of a recovery plan or threat abatement plan should one be prepared.

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

The proposed activity includes the key threatening process (KTP) 'Native vegetation clearance' and may contribute to the KTPs 'Invasion of exotic perennial grasses' (specifically Broadleaved paspalum *P. mandiocanum*) and 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' (specifically Water hyacinth *Eichornia crassipes*), which is known to impact on Swamp Sclerophyll Forest (Scientific Committee 26/08/11).

As no threat abatement plans have yet been prepared by the NSW National Parks and Wildlife Service, it is not possible to review the proposed activity in light of the plans.

Notwithstanding this, these key threatening processes may be considered in a generic sense ie: is the proposal likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, and in particular, would it:

- cause fragmentation of ecological communities;
- reduce the viability of ecological communities by disrupting ecological functions;
- result in the destruction of habitat and loss of biological diversity; and
- lead to soil and bank erosion or riparian zone degradation.

Based on this assessment it is considered that the proposed rezoning to R1 and IN1 would not be likely to fragment ecological communities, disrupt ecological functions, destroy habitat or lead to erosion.

However, it has the potential to contribute to degradation of riparian zones along the unnamed watercourse and thereby to impact on the survival of *Persicaria elatior* in the locality.

2.4 *Maundia triglochinoides*

The essential habitat *of M. triglochinoides* is considered to be swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients (http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10511).

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

R1 Residential and IN1 Industrial

The species was recorded in several locations in the south of the study area near Christmas Creek and the Macleay River in 1987. It has not been recorded in the unnamed watercourse receiving area despite targeted searches for the species for the proposed motorway and for this study, suggesting that the habitat may be unsuitable. Given that known threats to the species including changes in water quality and weed invasion are evident in the habitat and appear to have been operating for some time it is unlikely to occur there. It is therefore unlikely that 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.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential and IN1 Industrial

No habitat for the species would be removed by the proposal; there may be minor hydrological impacts on potential habitat for the species in the unnamed watercourse. Other habitat for the species adjoining Christmas Creek and the Macleay River would not be impacted by the proposal.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

R1 Residential and IN1 Industrial

The location and nature of the proposal is such that habitat for the species would not be likely to become fragmented or isolated from other areas of habitat.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

R1 Residential and IN1 Industrial

As the species has not been recorded in the central unnamed watercourse and known threats to the species are evident and appear to have been operating for some time, the habitat is unlikely to be suitable for the species and of no importance to the long-term survival of the species in the locality.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. The species has been assigned to the 'Keep-watch' species management stream under the Saving our Species program and is considered likely to be secure in NSW for the long term without targeted management.

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

The proposed activity includes the key threatening process (KTP) 'Native vegetation clearance' and may contribute to the KTPs 'Invasion of exotic perennial grasses' (specifically Broadleaved paspalum *P. mandiocanum*) and 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' (specifically Water hyacinth *Eichornia crassipes*), which is known to impact on Swamp Sclerophyll Forest (Scientific Committee 26/08/11).

As no threat abatement plans have yet been prepared by the NSW National Parks and Wildlife Service, it is not possible to review the proposed activity in light of the plans.
Notwithstanding this, these key threatening processes may be considered in a generic sense ie: is the proposal likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, and in particular, would it:

- cause fragmentation of ecological communities;
- reduce the viability of ecological communities by disrupting ecological functions;
- result in the destruction of habitat and loss of biological diversity; and
- lead to soil and bank erosion or riparian zone degradation.

Based on this assessment it is considered that the proposed rezoning to R1 and IN1 would not be likely to fragment ecological communities, disrupt ecological functions, destroy habitat or lead to erosion.

However, it has the potential to contribute to degradation of riparian zones along the unnamed watercourse and thereby to impact on the survival of *Persicaria elatior* in the locality.

2.5 *Persicaria elatior* (Knotweed)

This species normally grows in damp places, especially beside streams and lakes; occurs occasionally in swamp forest or is associated with disturbance (http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10590).

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

R1 Residential and IN1 Industrial
The species was first recorded in the unnamed watercourse receiving area by targeted searches for the species for the proposed motorway in 2006 and subsequently by this study. For the purpose of this assessment it is assumed that the local population is viable. Its persistence to date in the face of known threats operating in the habitat, which include clearing or disturbance of habitat, hydrological changes to wetland vegetation, predation by grazing livestock and damage to the plant and its seedbank from trampling by livestock, indicates that it may be resilient to the additional hydrological impacts likely to arise from the proposed rezoning.

However, the population appears to be very small and as such may be vulnerable to any increase in hydrological impacts, especially eutrophication. In the absence of any specific proposals for avoidance, minimisation or mitigation of impacts it cannot therefore be concluded that the impact of the proposed rezoning to R1 and IN1 is unlikely 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.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential and IN1 Industrial

No habitat for the species would be removed by the proposal; there may be minor hydrological impacts on potential habitat for the species.

R5 Rural Residential

The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

R1 Residential and IN1 Industrial
The location and nature of the proposal is such that habitat for the species would not be likely to become fragmented or isolated from other areas of habitat.

R5 Rural Residential
The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

R1 Residential and IN1 Industrial
As the species has only been recorded in the central unnamed watercourse receiving area, this area may be very important to the long-term survival of the species in the locality. However, its persistence in the face of known threats to the species that have been operating in the habitat for some time are an indication that that it is likely to be resilient to any minor hydrological impacts associated with the proposed rezoning.

R5 Rural Residential
The R5 Rural Residential rezoning area does not occur immediately adjacent to or within the same catchment as habitat for the species and as such the R5 Rural Residential rezoning is unlikely to have to have any impact on the species.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. The Office of Environment and Heritage has established 5 management sites where conservation activities will take place to secure the species in the wild for 100 years and maintain its conservation status under the TSC Act.

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

The proposed activity includes the key threatening process (KTP) ‘Native vegetation clearance’ and may contribute to the KTPs ‘Invasion of exotic perennial grasses’ (specifically Broadleaved paspalum *P. mandiocanum*) and ‘Loss and degradation of native plant and

animal habitat by invasion of escaped garden plants, including aquatic plants' (specifically Water hyacinth *Eichornia crassipes*), which is known to impact on Swamp Sclerophyll Forest (Scientific Committee 26/08/11).

As no threat abatement plans have yet been prepared by the NSW National Parks and Wildlife Service, it is not possible to review the proposed activity in light of the plans.
Notwithstanding this, these key threatening processes may be considered in a generic sense ie: is the proposal likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, and in particular, would it:

- cause fragmentation of ecological communities;
- reduce the viability of ecological communities by disrupting ecological functions;
- result in the destruction of habitat and loss of biological diversity; and
- lead to soil and bank erosion or riparian zone degradation.

Based on this assessment it is considered that the proposed rezoning to R1 and IN1 would not be likely to fragment ecological communities, disrupt ecological functions, destroy habitat or lead to erosion.

However, it has the potential to contribute to degradation of riparian zones along the unnamed watercourse and thereby to impact on the survival of *Persicaria elatior* in the locality.

2.6 *Litoria brevipalmata* (Green-thighed Frog)

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

R1 Residential and IN1 Industrial

No suitable habitat for the species occurs within the R1 Residential and IN1 Industrial rezoning areas. There is the potential for possible hydrological impacts and eutrophication within the catchment arising from the rezoning proposal. However, these are considered likely to be only slight as these areas are already subject to these effects. There is also the slight chance of disease transmission from low-lying areas of the subject site to other areas outside of the site that may contain habitat for the species. However, with appropriate equipment hygiene this risk is considered to be low. Therefore, we consider it is unlikely that the proposal will 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.

R5 Rural Residential

The R5 Rural Residential rezoning area does not contain suitable habitat, nor is any habitat immediately adjacent. Therefore, it is unlikely that the proposal will 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.

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

N/A

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

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

N/A

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

N/A

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

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

<u>R1 Residential and IN1 Industrial</u>
No suitable habitat for the species occurs within the R1 Residential and IN1 Industrial rezoning areas. There is the potential for possibly hydrological impacts and eutrophication within the catchment arising from the rezoning proposal. However, these are considered likely to be only slight as these areas are already subject to these effects.

<u>R5 Rural Residential</u>
The R5 Rural Residential rezoning area does not contain suitable habitat, nor is any habitat immediately adjacent.

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

<u>R1 Residential</u>
This rezoning areas is already heavily cleared. The small amount of native vegetation to be removed in this area as a result of the proposal is unlikely to further fragment or isolate areas of habitat for this species.

R5 Rural Residential
This rezoning areas is already heavily cleared. Further removal of native canopy vegetation in this area is unlikely to further fragment or isolate areas of habitat for this species.

IN1 Industrial
The development of this rezoning area is unlikely to further fragment or isolate areas of habitat for this species.

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

No habitat will be removed, modified, fragmented or isolated.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'data deficient' management stream. Priority research actions are currently under development.
Threats to the species include:

- Changes to drainage patterns which reduce periodic local flooding.
- Damage to semi-permanent and ephemeral ponds and flood-prone vegetation.
- Clearing of habitat for development.
- Clearing of habitat for agriculture
- Habitat disturbance through timber harvesting.
- Reduction in water quality through pasture fertilisation.
- Reduction in habitat and water quality as a result of grazing
- Reduction of leaf-litter and cover of fallen logs through burning for agricultural purposes.

The proposal is considered unlikely to increase the action of these threats within the study area.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
- Invasion of native plant communities by exotic perennial grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.7 Wetland birds

- *Ephippiorhynchus asiaticus* (Black-necked Stork);
- *Botaurus poiciloptilus* (Australasian Bittern);
- *Rostratula australis* (Australian Painted Snipe);
- *Irediparra gallinacea* (Comb-crested Jacana);

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

R1 Residential

Removal / modification of < 9 ha of low-lying pasture that may provide marginal foraging habitat for *Ephippiorhynchus asiaticus* (Black-necked Stork) after heavy rainfall. The *Ephippiorhynchus asiaticus* (Black-necked Stork) is unlikely to breed within the zone. This is considered to be a very small and marginal portion of the foraging habitat available to the species in the local area.

No habitat will be removed / modified for the remaining three wetland bird species.

Possible minor hydrological impacts, eutrophication of wetland habitats within the catchment of the proposal may occur. However, these receiving environments are not considered to be overly sensitive.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these wetland bird species such that a viable local population of the species is likely to be placed at risk of extinction

R5 Rural Residential

Removal / modification of < 10 ha of low-lying pasture that may provide marginal foraging habitat for *Ephippiorhynchus asiaticus* (Black-necked Stork) after heavy rainfall. The species

is unlikely to breed within the zone. This is considered to be a very small and marginal portion of the foraging habitat available to the species in the local area.

Some farm dams within this zone contain marginally suitable aquatic vegetation for *Irediparra gallinacea* (Comb-crested Jacana). However, it is unlikely that farm dams will be removed as a result of the proposal.

No habitat will be removed / modified for the remaining two wetland bird species and the proposal is unlikely to result in any indirect impacts on nearby habitat.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these wetland bird species such that a viable local population of the species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of < 2.5 ha of low-lying pasture that may provide marginal foraging habitat for *Ephippiorhynchus asiaticus* (Black-necked Stork) after heavy rainfall. The *Ephippiorhynchus asiaticus* (Black-necked Stork) is unlikely to breed within the zone. This is considered to be a very small and marginal portion of the foraging habitat available to the species in the local area.

No habitat will be removed / modified for the remaining three wetland bird species.

Possible minor hydrological impacts, eutrophication of wetland habitats within the catchment of the proposal may occur. However, these receiving environments are not considered to be overly sensitive.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these wetland bird species such that a viable local population of the species is likely to be placed at risk of extinction

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential

Removal / modification of < 9 ha of low-lying pasture that may provide marginal foraging habitat for *Ephippiorhynchus asiaticus* (Black-necked Stork) after heavy rainfall. The *Ephippiorhynchus asiaticus* (Black-necked Stork) is unlikely to breed within the zone. This is considered to be a very small and marginal portion of the foraging habitat available to the species in the local area.

No habitat will be removed / modified for the remaining three wetland bird species.

Possible minor hydrological impacts, eutrophication of wetland habitats within the catchment of the proposal may occur. However, these receiving environments are not considered to be overly sensitive.

R5 Rural Residential

Removal / modification of < 10 ha of low-lying pasture that may provide marginal foraging habitat for *Ephippiorhynchus asiaticus* (Black-necked Stork) after heavy rainfall. The species is unlikely to breed within the zone. This is considered to be a very small and marginal portion of the foraging habitat available to the species in the local area.

Some farm dams within this zone contain marginally suitable aquatic vegetation for *Irediparra gallinacea* (Comb-crested Jacana). However, it is unlikely that farm dams will be removed as a result of the proposal.

No habitat will be removed / modified for the remaining two wetland bird species and the proposal is unlikely to result in any indirect impacts on nearby habitat.

IN1 Industrial

Removal / modification of < 2.5 ha of low-lying pasture that may provide marginal foraging habitat for *Ephippiorhynchus asiaticus* (Black-necked Stork) after heavy rainfall. The *Ephippiorhynchus asiaticus* (Black-necked Stork) is unlikely to breed within the zone. This is considered to be a very small and marginal portion of the foraging habitat available to the species in the local area.

No habitat will be removed / modified for the remaining three wetland bird species.

Possible minor hydrological impacts, eutrophication of wetland habitats within the catchment of the proposal may occur. However, these receiving environments are not considered to be overly sensitive.

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

The rezoning areas are unlikely to fragment or isolate wetland habitats for these species.

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

The small amount of habitat to be removed or modified as a result of the proposal is not considered to be of high importance to the long-term survival of these species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'partnership species' management stream.

OEH is currently developing a targeted approach for managing Partnership species species. In the interim, the following management actions have been identified for this species.

- Identify areas of crown land that provide foraging and/or nesting sites for Black-necked Storks and seek to acquire these sites.
- Promote the Black-necked Stork as an icon species for the conservation of floodplain wetlands and educate the community on important habitat requirements and threats to Black-necked Storks and their habitat.
- Identify sites for rehabilitation or construction in the Northern Rivers catchment, having due consideration for water regime, existing or potential habitat, predators, other threatening processes & monitoring activities.
- Collect baseline data on the abundance of this species and monitor long-term changes in population density. .

- Restore natural hydrological regimes to freshwater wetlands. Maintain existing hydrological regimes. Do not fill or drain wetlands. Retain and protect native vegetation in and around wetlands. Restore degrdaded wetlands.
- Prepare and implement an education campaign to raise public awareness of the value in conserving wetlands in north-eastern NSW for waterbirds, including the Black-necked Stork. .
- Collect baseline data on the population of Black-necked Storks in NSW and develop an appropriate population monitoring program.
- Reduce Black-necked Stork mortality due to powerlines by fitting them with deterrents (eg. coloured metal tags) in the vicinity of nests and flyways.
- Support research into the ecology of Black-necked Storks in NSW. Encourage and support research on movements, habitat use and current threats to Black-necked Storks. Develop strategies to mitigate threats.
- Improve the protection of Black-necked Stork habitat by excluding stock, reducing grazing pressure and controlling weed species at important sites. Avoid placing powerlines over or near wetlands and/or nest sites.
- Reduce nutrient runoff into wetlands known to be used by Black-necked Storks. Avoid the use of herbicides and pesticides near or in wetlands.
- Assess the potential impact of climate change on Black-necked Stork habitat.
- Control feral animals near nesting sites.
- Identify priority breeding wetlands and determine threatening processes at each site in order to target management actions.

The proposal may contribute slightly to the increased nutrient runoff into nearby wetlands for the IN1 Industrial and R1 Residential rezoning areas. However, the recommended appropriate stormwater mitigation measures should reduce these effects.

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

Relevant KTPs to these species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Clearing of native vegetation
- Invasion of native plant communities by exotic perennial grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.8 *Lophoictinia isura* (Square-tailed Kite)

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

R1 Residential
Removal / modification of approximately 1.64 ha of potential habitat. This is considered to be a small portion of the foraging habitat available to the species in the local area, with preferred riparian habitat absent.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of potential habitat. This is considered to be a small portion of the foraging habitat available to the species in the local area, with preferred riparian habitat absent.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

IN1 Industrial
Removal / modification of approximately 9.02 ha of potential habitat. This is considered to be a small portion of the foraging habitat available to the species in the local area, with preferred riparian habitat absent.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 1.64 ha of marginal potential habitat. This is considered to be a small portion of the foraging habitat available to the species in the local area, with preferred riparian habitat absent.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of marginal potential habitat, with preferred riparian habitat absent.

IN1 Industrial
Removal / modification of approximately 9.02 ha of marginal potential habitat. This is considered to be a small portion of the foraging habitat available to the species in the local area, with preferred riparian habitat absent.

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

The species is highly mobile and the rezoning proposals are considered unlikely to fragment or isolate areas of habitat.

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

The habitat to be removed or modified by the proposal is considered unlikely to be important to the long-term survival of the species as it consists of the more marginal dry forest habitats.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Throughout western areas of the species' range, encourage landholders to enter agreements, particularly in-perpetuity covenants or stewardship agreements, that promote the retention of large trees in riparian areas and connectivity of remnant woodland patches (priority should be to create or protect patches larger than 200ha with multi-layered vegetation structure).
- Identify active nest sites and ensure that these sites are not disturbed during the breeding season; August - November (e.g. by restricting access within a 20m buffer to nests on public land and reducing activity within 20m of nests on private land).
- Conduct targeted surveys for breeding pairs and liaise with local field ornithologist groups to locate nest trees in order to track reproductive success (e.g. number of eggs, successfully fledged offspring etc.) across the breeding season (August - November) and evaluate population viability.
- Undertake restoration and revegetation of remnant woodland (prey habitat) patches within 20km of known active nest sites, focusing on patches that are or could be larger than 200ha once connected, to maximise area of structurally diverse woodland for foraging.
- Promote awareness among local communities of the impacts of illegally removing birds or nestlings from the wild or shooting individuals, as well as the threatened status of the species. Encourage the reporting of suspected nest-robbing, trapping or shooting to Environment Line (131 555).

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.9 *Pandion cristatus* (Eastern Osprey)

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

The species is unlikely to forage or nest within any of the rezoning areas. Indirect impacts on the large watercourses (Christmas Creek and Macleay River) that this species is likely to use within the study are unlikely to occur as a result of any of the rezoning proposals.

Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

No habitat will be removed or modified as a result of the proposal.

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

The proposal is unlikely to fragment or isolate habitat for this species.

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

No habitat will be removed or modified as a result of the proposal.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Identify active or inactive nest sites (including old nests built by corvids), ensure that active nests are not disturbed during the breeding season; July-September (e.g. by restricting access within a 100m buffer to nests on public land and reducing activity within 100m of nests on private land), and ensure that nests and surrounding vegetation are protected from damage or removal when inactive.
- Monitor water quality in waterways close to nests and known to be used for foraging. Liaise with relevant authorities with respect to managing any adverse impacts of waste disposal in these systems.
- Raise awareness among the recreational fishing community via liaison with peak groups and other initiatives (e.g. media campaigns, brochures and interpretive signs in key fishing locations) that promote responsible fishing practices and warn about

the impacts of discarding fishing tackle improperly. Place fishing tackle disposal bins at key recreational fishing locations.

- Work with relevant energy suppliers and relevant contractors to raise awareness about the importance of using sensitive pole designs for power lines in areas where the species is known to occur and nest, as well as insulating power lines in close proximity to known active nest sites.
- Encourage private landholders to enter into agreements, particularly in-perpetuity covenants or stewardship agreements that promote the retention of large living or standing dead trees within 1-2km of watercourses in known habitat and management of riparian areas to restore native vegetation and limit water pollution via stormwater and run-off.
- In areas where potential nesting habitat (i.e. large trees close to waterways) has been removed, erect artificial pole and platform nest sites. Ensure that these sites are monitored, maintained and evaluated in terms of their use.
- Liaise with telecommunications companies to raise awareness among their staff and contractors of the importance of retaining existing nests on or near telecommunications infrastructure throughout the non-breeding period (December-April). Also ensure that all active nests are reported to Office of Environment and Heritage so they can be monitored to minimise disturbance.

The proposal is in accordance with these management actions.

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

Relevant KTPs to these species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.10 *Calyptorhynchus lathami* (Glossy Black-Cockatoo)

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

<u>R1 Residential</u>
Removal / modification of < 1.64 ha of potential foraging habitat and no potential nesting trees (eucalypts with large DBH with large hollows).

There is the potential for the indirect impact of a slight increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets as a result of this rezoning proposal.

This is considered to be a very small area of potential foraging habitat and a slight increase in indirect impacts for the local area. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of < 1 ha of potential foraging habitat (only a few casuarina individuals recorded within this zone) and one potential nesting trees (eucalypts with large DBH with large hollows). However, no evidence of the species was recorded during surveys within this zone and as such, it is unlikely that a resident pair currently nests nearby.

There is the potential for the indirect impact of a slight increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets as a result of this rezoning proposal.

This is considered to be a very small area of potential foraging habitat and a slight increase in indirect impacts for the local area. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of < 9.02 ha of potential foraging habitat and one potential nesting trees (eucalypts with large DBH with large hollows). However, no evidence of the species was recorded during surveys within this zone and as such, it is unlikely that a resident pair currently nest nearby.

There is the potential for the indirect impact of very slight habitat fragmentation as a result of this rezoning proposal.

This is considered to be a relatively small area of potential foraging habitat and a slight increase in indirect impacts for the local area. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of < 1.64 ha of potential foraging habitat and no potential nesting trees (eucalypts with large DBH with large hollows).

R5 Rural Residential
Removal / modification of < 1 ha of potential foraging habitat (only a few casuarina individuals recorded within this zone) and one potential nesting trees (eucalypts with large DBH with large hollows).

IN1 Industrial
Removal / modification of < 9.02 ha of potential foraging habitat and one potential nesting trees (eucalypts with large DBH with large hollows).

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

R1 Residential
The species is highly mobile and this rezoning area is considered unlikely to fragment or isolate areas of habitat as it contains very little habitat.

R5 Rural Residential
The species is highly mobile and this rezoning area is considered unlikely to fragment or isolate areas of habitat as it contains very little habitat.

IN1 Industrial

The species is highly mobile, however, this rezoning proposal may fragment existing habitat for the species slightly as it will remove a patch of suitable foraging habitat which may act as a stepping stone. This is considered to be a very minor fragmentation given the overall historical disturbance and fragmentary nature of the local area.

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

R1 Residential

Habitat within this rezoning area is quite small (< 1.64 ha) and unlikely to be important to the long-term survival of the species in the locality.

R5 Rural Residential

Habitat within this rezoning area is quite small (< 1 ha) and unlikely to be important to the long-term survival of the species in the locality.

IN1 Industrial

The proposal will remove up to 9.02 ha of potential foraging habitat and one potential nesting tree. However, no evidence of the species was found within the zone as would be expected if a resident breeding pair nested nearby. Therefore, as the habitat within the zone appears to be used only sporadically and is small in comparison with the habitat available outside of the study area, we consider that it is unlikely to be important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Raise public awareness of the importance of large old trees (living and dead), which provide roosting habitat and important hollow resources. Protect large old trees and smaller trees that contain large hollows, including from the effects of fire. Ensure the recruitment of large old trees by retaining medium-sized trees, facilitating regeneration, and undertaking replanting.

- Increase the quality and extent of foraging habitat within a region. Prevent frequent fire that will result in the elimination of sheoak stands. Manage fire regimes to ensure a mosaic of age classes of important feed species, with a bias toward older age classes (which provide abundant food resources). Encourage the retention of sheoak food species in the understorey, and raise public awareness of the damage caused to food resources by slashing/underscrubbing, fuel reduction burns, and over-grazing. Control feral animals, including pigs and goats, that may degrade the understorey and limit regeneration of sheoak food species.
- Ensure the year round availability of surface water in close proximity to foraging and nesting habitat. Where necessary, install or maintain artificial water resources to ensure continued access to food and nest sites during periods when natural surface water is absent. Maintain vegetation in proximity to water points, including the presence of a smaller trees immediately adjacent to the water's edge, to provide cover and a resting place for drinking birds.
- Raise awareness among landholders in a local area known to have important habitat for the species, to engage them in proactive management and monitoring of the species' population on their land.
- Identify sites where hollows are limiting and develop and implement strategies to increase hollow availability that have clear objectives and include monitoring, maintenance, and reporting requirements. Actions include nest box installation, the humane control of introduced species, and the protection of trees having the potential to develop hollows.
- Maintain connectivity within and between regions. At a local scale, ensure that glossy black-cockatoos can move safely between food, water and roosting resources via corridors that provide cover in the form of woodland or forest vegetation. Identify regional corridors that connect inland populations with those along the Great Divide and coast. Enhance or restore these regional corridors through strategic revegetation and other works that ensure the availability of food, shelter, and water resources.
- To assist in the management of the species and its habitat, model the impacts of climate change projections on the distribution of habitat and abundance of key resources.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of Hollow-bearing Trees

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.11 Nectarivorous birds

- *Glossopsitta pusilla* (Little Lorikeet);
- *Lathamus discolor* (Swift Parrot);

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

R1 Residential

Removal / modification of 0.03 ha of potential foraging habitat and two potential nesting trees for *Glossopsitta pusilla* (Little Lorikeet) (trees with small or tiny hollows). No nesting habitat for *Lathamus discolor* (Swift Parrot).

There is the potential for the indirect impact of a slight increase in the competition and predation of nests of *Glossopsitta pusilla* (Little Lorikeet) in adjacent areas by exotic animals and domestic pets as a result of this rezoning proposal.

This is considered to be a very small area of potential foraging and nesting habitat (*Glossopsitta pusilla* - Little Lorikeet only) and a slight increase in indirect impacts for the local area. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of these species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of 48.27 ha of potential foraging habitat and six hollow-bearing trees with hollows of a suitable size for *Glossopsitta pusilla* (Little Lorikeet) (trees with small or tiny hollows). However, as riparian trees are most often selected for nest sites by *Glossopsitta pusilla* (Little Lorikeet), the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows. No nesting habitat for *Lathamus discolor* (Swift Parrot) occurs. The foraging habitat for these nectarivorous species within this rezoning area is considered to be high quality based on the classification of Eby and Law (2008). In addition, this rezoning area contains a patches of mature and winter-flowing trees which are known to be important to nectarivorous bird species due to their reliability of flowering compared to younger trees.

There is the potential for the indirect impact of a slight increase in the competition and predation of potential nests of *Glossopsitta pusilla* (Little Lorikeet) in adjacent areas by exotic animals and domestic pets as a result of this rezoning proposal.

These species are highly mobile and mostly nomadic, so are able to forage over large distances. Due to the large tracts of similar and more intact native vegetation nearby, this loss of foraging habitat alone is unlikely to have a significant impact on these species such that a viable local population of these species is likely to be placed at risk of extinction. However, the cumulative removal of large patches of important foraging habitat is still a consideration at the local and regional level and compensatory habitat measures should be implemented.

IN1 Industrial

Removal / modification of 8.76 ha of potential foraging habitat and 14 potential nesting trees for *Glossopsitta pusilla* (Little Lorikeet) (trees with small or tiny hollows). However, as riparian trees are most often selected for nest sites by *Glossopsitta pusilla* (Little Lorikeet), the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows. No nesting habitat occurs for *Lathamus discolor* (Swift Parrot).

There is the potential for the indirect impact of very slight habitat fragmentation as a result of this rezoning proposal.

This is considered to be a relatively small area of potential foraging habitat and a slight increase in indirect impacts for the local area. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of 0.03 ha of potential foraging habitat and two potential nesting trees for *Glossopsitta pusilla* (Little Lorikeet) (trees with small or tiny hollows). However, as riparian trees are most often selected for nest sites by *Glossopsitta pusilla* (Little Lorikeet), the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows. No nesting habitat for *Lathamus discolor* (Swift Parrot) occurs.

R5 Rural Residential
Removal / modification of 48.27 ha of potential foraging habitat and six potential nesting trees for *Glossopsitta pusilla* (Little Lorikeet) (trees with small or tiny hollows). However, as riparian trees are most often selected for nest sites by *Glossopsitta pusilla* (Little Lorikeet), the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows. No nesting habitat for *Lathamus discolor* (Swift Parrot) occurs.

IN1 Industrial
Removal / modification of 8.76 ha of potential foraging habitat and 14 potential nesting trees for *Glossopsitta pusilla* (Little Lorikeet) (trees with small or tiny hollows). However, as riparian trees are most often selected for nest sites by *Glossopsitta pusilla* (Little Lorikeet), the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows. No nesting habitat for *Lathamus discolor* (Swift Parrot) occurs.

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

The proposal will result in a further fragmentation of habitat. However, as these species are highly mobile this is considered to be only a slight impact and will not result in habitat isolation.

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

These species are nomadic, with their seasonal movements following mass flowering events of eucalypts. The vegetation within the study area is ranked highly for nectar reliability and

productivity (Eby and Law 2008) and as such is likely to be used by these species when they visit the local area. Hollow-bearing trees are used by *Glossopsitta pusilla* (Little Lorikeet) for breeding. The proposal will remove hollow-bearing trees with hollows of a suitable size to be used by *Glossopsitta pusilla* (Little Lorikeet). However, as riparian trees are most often selected for nest sites by *Glossopsitta pusilla* (Little Lorikeet), the riparian buffers and location of the proposed rezoning areas outside of riparian areas is likely to protect potential nesting hollows. The foraging habitat for *Lathamus discolor* (Swift Parrot) within the study area alone is unlikely to be a critical resource, but rather would be used in conjunction with other habitat in the local area when foraging resources for the species in southern Australia are scarce. In this way, the foraging habitat within the subject site alone is unlikely to be critically important to the long-term survival of *Lathamus discolor* (Swift Parrot) or *Glossopsitta pusilla* (Little Lorikeet) in the local area.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

A national recovery plan for the *Lathamus discolor* (Swift Parrot) has been prepared (Saunders and Tzaros 2011). The following recovery actions are recommended:

- Action 1 - Identify the extent and quality of habitat.
    - Identify and map foraging habitat throughout the range of the species:
    - Identify and map roosting habitat throughout the range of the species with an emphasis on communal and repeatedly used roosting sites.
    - Establish habitat phenology data collection in existing research and monitoring studies, analyse findings and incorporate into recovery program.
    - Identify and map movement patterns throughout the range of the species.
- Action 2 - Manage and protect Swift Parrot habitat at the landscape scale.
    - Manage and protect nesting and foraging habitat.
        - Encourage and support the protection, conservation management and restoration of Swift Parrot nesting and foraging habitat through agreements with landowners, incentive programs and community projects. Relevant onground actions include (but are not limited to):
            - Retaining and expanding mature and mixed age habitat and protecting and managing it by fencing and providing a buffer zone from disturbances.
            - Enabling natural regeneration by fencing off and managing remnant vegetation and buffer zones to

control grazing and other impacts caused by uncontrolled access (such as in urban areas). Revegetating areas and connecting remnant habitats by planting feed and nest tree species, fencing them off and managing them, where natural regeneration is not possible.

- Ongoing management of all the above fenced off areas would also be required, including pest, weed and fire management.
- Provide recommendations for the revision and update of forestry prescriptions to reflect the most recent habitat information available in Victoria and New South Wales.
- Develop a strategic management plan for Swift Parrot breeding habitat in Tasmania. Strategic management plan for Swift Parrot to include landscape and operational level planning guidelines and prescriptions for protection of important breeding habitat. Review and update management prescriptions for Swift Parrots for use in the Forest Practices System and Local Government landuse planning and approvals processes in Tasmania.
- Provide Swift Parrot conservation information for consideration during the New South Wales. Local Government Local Environmental Planning (LEP) review process

  - Monitor and manage for climate change
    - Establish a climate change monitoring program to provide a basis for future adaptive conservation management.
    - Investigate the potential impact of climate change on the Swift Parrot and its habitat.

- Action 3 - Monitor and manage the impact of collisions, competition and disease.
  - Monitor and manage the incidence of collisions
    - Establish and maintain a database for all reported injuries and deaths.
    - Continue to raise public awareness of the risks of collisions and how these can be minimised. Awareness campaigns to target known high risk areas such as the greater Hobart, Melbourne and Western Sydney areas, and the central coast region of New South Wales (Wyong, Gosford, Lake Macquarie and Penrith Local Government areas).
    - Develop and distribute guidelines on collision risk management to relevant planning authorities
  - Monitor the incidence of competition from large aggressive honeyeaters as well as introduced birds and bees for nesting and foraging resources.

    - Develop and implement a Psittacine Beak and Feather Disease management protocol.
- Action 4 - Monitor population and habitat.
    - Develop and implement an effective population monitoring program during the breeding season.
        - Develop an effective population monitoring program during the breeding season
        - Undertake monitoring of breeding distribution on an annual basis to develop a better understanding of the extent and number of important breeding areas in Tasmania and the relative importance of non-aggregated breeding behaviour to conservation of the Swift Parrot.
    - Collect and analyse information on population dynamics and viability
        - Undertake research on breeding success, survival and mortality, as well as genetic structure to provide insight into currently unknown population regulation parameters.
        - Conduct population viability analysis (PVA) using data obtained from above research to provide a greater understanding of the dynamics and long-term viability of the population.
    - Establish and maintain coordination of volunteer surveys
        - Establish coordination of volunteer surveys throughout breeding habitats to complement existing mainland monitoring program.
        - Maintain coordination of the existing long-term volunteer monitoring throughout mainland habitats
- Action 5 - Increase community involvement in, and awareness of, the recovery program.
- Action 6 - Coordinate, review and report on recovery process

The proposal is in slight contradiction to Action 2.

Recovery plans or threat abatement plans have not been prepared for *Glossopsitta pusilla* (Little Lorikeet). A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the ‘landscape species’ management stream.

The actions provided to guide management at a site, regional or state scale are:

- Raise public awareness of the importance of large old trees (particularly isolated paddock trees and hollow-bearing trees, live and dead) and undertaking restoration and revegetation to replace cohorts of trees where they have been removed from the landscape, particularly in areas adjacent to and connecting woodland remnants.

- Encourage landholders to protect ground layer and midstorey vegetation by implementing sensitive grazing practices and avoiding slashing or underscrubbing, and to promote the retention of a floristically and structurally diverse and spatially variable understorey in patches of woodland. Target in-perpetuity covenants or stewardship agreements to landholders with high quality remnant woodland habitat.
- Target removal of weeds significantly compromising habitat values (e.g. invasive perennial grasses) and restore native vegetation. Care should be taken to avoid widespread removal of beneficial exotic woody vegetation without replacement and avoid non-target impacts of herbicides.
- Measure the abundance and impact of noisy miners on species populations and habitat, and implement appropriate management actions with demonstrated effectiveness (e.g. direct control, habitat restoration) to reduce the impacts of noisy miners, if/where required.
- Conduct targeted research into identifying different practical methods for restoring the structure and function of the ground layer in degraded habitat, including soil biota and its functionality.
- Identify sites where tree hollows are limiting and develop and implement a nest box strategy that has clear objectives and includes monitoring, maintenance, and evaluation of success.
- Undertake revegetation, using a diverse mix of locally appropriate native species, focussing on expanding areas of existing habitat, connecting isolated habitat patches (either through corridor or stepping stone plantings) or establishing additional habitat patches in landscapes with already existing, although insufficient, patches of suitable habitat. Areas with access to water, especially riparian areas, are particularly important, although care should be taken to ensure that riparian revegetation programs are sufficiently wide (minimum 50m wide).

The proposal is mostly in accordance with these management actions. However, no provision has been made for conservation or rehabilitation as part of the proposal.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners *Manorina melanocephala*
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations

- Loss of Hollow-bearing Trees
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.12 Forest Owls

- *Ninox strenua* (Powerful Owl);
- *Tyto novaehollandiae* (Masked Owl);

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

R1 Residential
Removal / modification of approximately 1.64 ha of foraging habitat and no potential nesting trees (eucalypts with large hollows)

This is considered to be a very small area of foraging habitat. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of foraging habitat and two potential nesting trees (eucalypts with large hollows). It is unlikely that *Ninox strenua* (Powerful Owl) would nest within this zone as the hollow-bearing trees do not occur in dense rainforest gullies. Additionally, no evidence of occupation by owls was recorded during our surveys (undertaken during the breeding season). However, we cannot discount that *Tyto novaehollandiae* (Masked Owl) may use the two hollow-bearing trees for nesting at some stage in the future.

There is the potential for the indirect impact of a slight habitat fragmentation as a result of this rezoning proposal.

Home range sizes are estimated at 350 - 1500 ha for *Ninox strenua* (Powerful Owl) and 400 - 1000 ha for *Tyto novaehollandiae* (Masked Owl) with home range size dependent on habitat quality. As the subject site is on relatively poor quality soils and has been heavily disturbed, it is likely that any local populations of these species would have relatively large home range sizes. If we assume a moderate-high home range size of 800 ha, then the proposal would remove or modify approximately 6 % of the home range of either species in the local area.

The proposal will remove or modify a relatively small area (estimated as 6 %) of foraging habitat for these species and two potential nesting trees for *Tyto novaehollandiae* (Masked

Owl). Without any plans for habitat retention or offsets at this stage, there is likely to be some impact on any resident breeding pair of either species. However, we consider that it is unlikely to have an adverse effect on the life cycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 9.02 ha of foraging habitat and two potential nesting trees (eucalypts with large hollows). It is unlikely that *Ninox strenua* (Powerful Owl) would nest within this zone as the hollow-bearing trees do not occur in dense rainforest gullies. Additionally, no evidence of occupation by owls was recorded during our surveys (undertaken during the breeding season). However, we cannot discount that *Tyto novaehollandiae* (Masked Owl) may use the two hollow-bearing trees for nesting at some stage in the future.

There is the potential for the indirect impact of a slight habitat fragmentation as a result of this rezoning proposal.

Home range sizes are estimated at 350 - 1500 ha for *Ninox strenua* (Powerful Owl) and 400 - 1000 ha for *Tyto novaehollandiae* (Masked Owl) with home range size dependent on habitat quality. As the subject site is on relatively poor quality soils and has been heavily disturbed, it is likely that any local populations of these species would have relatively large home range sizes. If we assume a moderate-high home range size of 800 ha, then the proposal would remove or modify approximately 1 % of the home range of either species in the local area.

The proposal will remove or modify a relatively small area (estimated as 1 %) of foraging habitat for these species and two potential nesting trees for *Tyto novaehollandiae* (Masked Owl). Without any plans for habitat retention or offsets at this stage, there is likely to be some impact on any resident breeding pair of either species. However, we consider that it is unlikely to have an adverse effect on the life cycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 1.64 ha of foraging habitat and no potential nesting trees (eucalypts with large hollows)

R5 Rural Residential
Removal / modification of approximately 48.27 ha of foraging habitat and two potential nesting trees (eucalypts with large hollows). It is unlikely that *Ninox strenua* (Powerful Owl) would nest within this zone as the hollow-bearing trees do not occur in dense rainforest gullies. Additionally, no evidence of occupation by owls was recorded during our surveys (undertaken during the breeding season). However, we cannot discount that *Tyto novaehollandiae* (Masked Owl) may use the two hollow-bearing trees for nesting at some stage. If we assume a moderate-high home range size of 800 ha, then the proposal would remove or modify approximately 6 % of the home range of either species in the local area.

IN1 Industrial
Removal / modification of approximately 9.02 ha of foraging habitat and two potential nesting trees (eucalypts with large hollows). It is unlikely that *Ninox strenua* (Powerful Owl) would nest within this zone as the hollow-bearing trees do not occur in dense rainforest gullies. Additionally, no evidence of occupation by owls was recorded during our surveys (undertaken during the breeding season). However, we cannot discount that *Tyto novaehollandiae* (Masked Owl) may use the two hollow-bearing trees for nesting at some stage. If we assume a moderate-high home range size of 800 ha, then the proposal would remove or modify approximately 1 % of the home range of either species in the local area.

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

R1 Residential
This rezoning proposal is unlikely to fragment or isolate areas of habitat for these species.

R5 Rural Residential
This rezoning proposal will slightly fragment habitat for these species. However, they are highly mobile and are able to traverse open habitats.

IN1 Industrial
This rezoning proposal will slightly fragment habitat for these species. However, they are highly mobile and are able to traverse open habitats.

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

R1 Residential
The very small portion of habitat to be removed as a result of the proposal is unlikely to be important to the long-term survival of these species in the locality.

R5 Rural Residential
The foraging habitat to be removed as a result of the proposal is moderately-sized and despite being partially cleared, it is likely to provide foraging habitat for both forest owl species. In addition two hollow-bearing trees that may be used by *Tyto novaehollandiae* (Masked Owl) for nesting in the future will be removed. These habitats are considered to be of moderate importance to the long-term survival of the species into the future. If we assume a moderate-high home range size of 800 ha, then the proposal would remove or modify approximately 6 % of the home range of either species in the local area. Overall due to the disturbed nature of this rezoning area and relatively large home ranges of these species, we consider that it is of low overall importance.

IN1 Industrial
The relatively small portion of habitat to be removed as a result of the proposal is highly disturbed. However, we found that it had a high density of arboreal prey species (gliders and possums) with some terrestrial mammals also recorded. Therefore, it is likely to provide a food source for the *Ninox strenua* (Powerful Owl) *Tyto novaehollandiae* (Masked Owl). In addition, two hollow-bearing trees that may be used by *Tyto novaehollandiae* (Masked Owl) for nesting in the future will be removed. If we assume a moderate-high home range size of 800 ha, then the proposal would remove or modify approximately 1 % of the home range of either species in the local area. Overall due to the disturbed nature of this rezoning area and relatively large home ranges of these species, we consider that it is of low overall importance.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)
Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

A state recovery plan for forest owls has been prepared (Department of Environment and Conservation 2006). The following recovery actions are recommended:

- Model and map owl habitat and validate with surveys
- Monitor owl population parameters
- Audit forestry prescriptions
- Manage and protect habitat off reserves and state forests
    - 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.
    - 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.
    - 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.
    - 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.
    - 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.
    - Provide up to date information and data for the BioBanking assessment methodology.
    - 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.
    - 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.
    - 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.
- Undertake research
- Increase community awareness and involvement in owl conservation
- Provide organisational support and integration

The proposal is consistent with these recovery actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of Hollow-bearing Trees
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.13 *Tyto longimembris* (Eastern Grass Owl)

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

R1 Residential
Removal / modification of approximately 39.6 ha of potential marginal foraging habitat. No potential nesting habitat within zone.

There is the potential for the indirect impact an increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets. In addition, there is the potential for an increase in weed invasion of adjacent low-lying areas.

This is considered to be a small area of foraging habitat for the species within the local area with much of the low-lying floodplain habitats now made up of grasslands. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 85.4 ha of potential marginal foraging habitat. No potential nesting habitat within zone.

There is the potential for the indirect impact an increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets. In addition, there is the potential for an increase in weed invasion of adjacent low-lying areas.

This is considered to be a relatively small area of marginal foraging habitat for the species within the local area with much of the low-lying floodplain habitats now made up of grasslands. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 24.4 ha of potential foraging habitat and approximately 1 ha of marginal potential nesting habitat (ungrazed grassland adjacent to wetland).

There is the potential for the indirect impact of an increase in weed invasion of adjacent low-lying areas.

This is considered to be a small area of foraging habitat for the species within the local area with much of the low-lying floodplain habitats now made up of grasslands. Additionally, no nests were recorded during targeted surveys within this area. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 39.6 ha of potential marginal foraging habitat. No potential nesting habitat within zone.

R5 Rural Residential
Removal / modification of approximately 85.4 ha of potential marginal foraging habitat. No potential nesting habitat within zone.

IN1 Industrial
Removal / modification of approximately 24.4 ha of potential foraging habitat and approximately 1 ha of marginal potential nesting habitat (ungrazed grassland adjacent to wetland).

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

The proposed rezonings will not fragment or isolate preferred foraging habitat for this species (low-lying grassland / wetland areas)

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

R1 Residential
The marginal potential foraging habitat to be removed by the proposal is considered to be a small and disturbed portion of the habitat available to the species in the locality and is likely to be of low importance to the long-term survival of the species in the locality.

R5 Rural Residential
The marginal potential foraging habitat to be removed by the proposal is considered to be a relatively small and disturbed portion of the habitat available to the species in the locality and is likely to be of low importance to the long-term survival of the species in the locality.

IN1 Industrial

The marginal potential foraging habitat to be removed by the proposal is considered to be a small and disturbed portion of the habitat available to the species in the locality. Additionally, the species was not found to be using the potential nesting habitat within the zone during our targeted surveys during the breeding season. Therefore, the habitat within this rezoning area is considered likely to be of low importance to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Conduct targeted survey and research into the species' ecology, particularly in relation to habitat use and response to fire.
- Raise awareness, particularly in the agricultural community, about the damaging impacts to owls of secondary poisoning from pesticides such as brodifacoum-based rodenticides.
- Encourage landholders to enter into land management agreements that promote the protection and maintenance of tall grass and grassy tussocks in swamps, heath and sedges.
- Ensure that any relevant land managers or agencies are aware of the location of potential habitat and its sensitivity to fire, prior to conducting hazard reduction burns.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Clearing of native vegetation

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.14 *Daphoenositta chrysoptera* (Varied Sittella)

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

R1 Residential

Removal / modification of approximately 0.03 ha of potential eucalypt foraging and nesting habitat.

There is the potential for the indirect impact an increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets.

This is considered to be a very small area of foraging habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 48.27 ha of potential eucalypt foraging and nesting habitat. The species was not recorded during surveys. Being fairly sedentary, the species absence during surveys indicates that it is unlikely to occur within this zone. However, its occurrence within the zone at some future stage cannot be discounted.

There is the potential for the indirect impact an increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets. Additionally, there is the potential for the proposal to slightly fragment habitat for the species.

While the area of habitat to be removed is of a moderate size, the species was not recorded during surveys. Therefore, we consider it unlikely that the proposal will have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 8.76 ha of potential eucalypt foraging and nesting habitat. The species was not recorded during surveys. Being fairly sedentary, the species

absence during surveys indicates that it is unlikely to occur within this zone. However, its occurrence within the zone at some future stage cannot be discounted.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

While the proposal will remove some habitat for the species, the species was not recorded during surveys. Therefore, we consider it unlikely that the proposal will have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

<u>R1 Residential</u>
Removal / modification of approximately 0.03 ha of potential eucalypt foraging and nesting habitat.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of potential eucalypt foraging and nesting habitat. The species was not recorded during surveys. Being fairly sedentary, the species absence during surveys indicates that it is unlikely to occur within this zone. However, its occurrence within the zone at some future stage cannot be discounted.

IN1 Industrial
Removal / modification of approximately 8.76 ha of potential eucalypt foraging and nesting habitat. The species was not recorded during surveys. Being fairly sedentary, the species absence during surveys indicates that it is unlikely to occur within this zone. However, its occurrence within the zone at some future stage cannot be discounted.

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

R1 Residential
This rezoning area will not fragment or isolate preferred foraging habitat for this species.

R5 Rural Residential
There is the potential for the proposal to slightly fragment habitat for the species.

IN1 Industrial
There is the potential for the proposal to slightly fragment habitat for the species.

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

R1 Residential
Given the small size of the habitat within this zone, it is unlikely to be important to the long-term survival of the species in the locality..

R5 Rural Residential
As the habitat within this zone appears to be presently uninhabited, it is likely to be of a marginal nature and as such is unlikely to be of high importance to the long-term survival of the species in the locality.

IN1 Industrial
As the habitat within this zone appears to be presently uninhabited, it is likely to be of a marginal nature and as such is unlikely to be of high importance to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Raise public awareness of the importance of large old trees (particularly isolated paddock trees and hollow-bearing trees, live and dead) and undertaking restoration and revegetation to replace cohorts of trees where they have been removed from the landscape, particularly in areas adjacent to and connecting woodland remnants.

- Encourage landholders to protect ground layer and midstorey vegetation by implementing sensitive grazing practices and avoiding slashing or underscrubbing, and to promote the retention of a floristically and structurally diverse and spatially variable understorey in patches of woodland. Target in-perpetuity covenants or stewardship agreements to landholders with high quality remnant woodland habitat.

- Target removal of weeds significantly compromising habitat values (e.g. invasive perennial grasses) and restore native vegetation. Care should be taken to avoid widespread removal of beneficial exotic woody vegetation without replacement and avoid non-target impacts of herbicides.
- Measure the abundance and impact of noisy miners on species populations and habitat, and implement appropriate management actions with demonstrated effectiveness (e.g. direct control, habitat restoration) to reduce the impacts of noisy miners, if/where required.
- Conduct targeted research into identifying different practical methods for restoring the structure and function of the ground layer in degraded habitat, including soil biota and its functionality.
- Undertake revegetation, using a diverse mix of locally appropriate native species, focussing on expanding areas of existing habitat, connecting isolated habitat patches (either through corridor or stepping stone plantings) or establishing additional habitat patches in landscapes with already existing, although insufficient, patches of suitable habitat. Areas with access to water, especially riparian areas, are particularly important, although care should be taken to ensure that riparian revegetation programs are sufficiently wide (minimum 50m wide).

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners *Manorina melanocephala*
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Invasion of native plant communities by exotic perennial grasses
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)
- Removal of dead wood and dead trees

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.15 *Dasyurus maculatus* (Spotted-tailed Quoll)

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

R1 Residential

Removal / modification of approximately 1.64 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.

This is considered to be a very small area of foraging habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 48.27 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. Additionally, there is the potential for the proposal to increase the risk of mortality through accidental baiting and trapping. The proposal may also slightly fragment habitat for the species.

While the area of habitat to be removed is of a moderate size, the species has large home ranges and no potential breeding habitat would be affected. Therefore, we consider it unlikely that the proposal will have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

IN1 Industrial
Removal / modification of approximately 9.02 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

While the proposal will remove some habitat for the species, it has large home ranges and no potential breeding habitat would be affected. Therefore, we consider it unlikely that the proposal will have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 1.64 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.

IN1 Industrial
Removal / modification of approximately 9.02 ha of disturbed potential foraging habitat. No potential den sites were found to occur within this zone.

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may also slightly fragment habitat for the species.

IN1 Industrial
The proposal may also slightly fragment habitat for the species.

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

R1 Residential
Given the small area of foraging habitat within this zone and that there was no potential breeding habitat, we consider that the habitat to be removed or modified is of low importance to the long-term survival of the species in the locality.

R5 Rural Residential
While proposal will remove some habitat for this species, it has large home ranges and no potential breeding habitat was found to occur. Therefore, the habitat within the zone is not considered to be of high importance to the long-term survival of the species in the locality.

IN1 Industrial
While the area of habitat to be removed is of a moderate size, the species has large home ranges and no potential breeding habitat was found to occur. Therefore, the habitat within the zone is not considered to be of high importance to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Conserve old-growth forest stands and other areas of known habitat under perpetual, funded conservation agreements such as BioBanking agreements, conservation property vegetation plans or inclusion in the conservation reserve system.
- Identify and target restoration and revegetation projects at areas where connectivity between large areas of known habitat is compromised, with the aim of increasing the width, condition and security of critical landscape links.
- Implement (or augment coordinated), cross-tenure, landscape scale predator control programs in areas where significant populations of spotted-tailed quoll are known to occur, and monitor populations of the target introduced predator.
- Monitor significant spotted-tailed quoll populations to investigate the impact of fox and wild dog baiting.
- Design and distribute an educational brochure for designing 'quoll-proof' poultry runs and aviaries and distribute.
- Modify poultry runs and aviaries based on best-practice guidelines.
- Incorporate methods to reduce the numbers of spotted-tailed quolls killed at sections of roads where road kills are frequently reported. Assess the effectiveness of different mitigation methods.
- Monitor survival of spotted-tailed quoll populations in habitat newly colonised by cane toads.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.16 *Phascogale tapoatafa* (Brush-tailed Phascogale)

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

R1 Residential
Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential den trees (trees with tiny or small hollows)

There is the potential for the indirect impact an increase in the competition and predation of nests in adjacent areas by exotic animals and domestic pets.

This is considered to be a small area of habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of potential foraging habitat and six potential den trees (trees with tiny or small hollows). An anecdotal record of the species exists within this area. However, it was not recorded during our targeted surveys. Further targeted surveys would be required if the absence of the species was to be asserted.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also slightly fragment habitat for the species.

Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories often greater than 100 ha. This rezoning proposal could remove 1 - 2 female home ranges from the area and may have indirect impacts on adjacent areas of habitat.

Without any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the large amount of habitat to be removed (including hollow-bearing trees) that a significant impact may occur on a local population of *Phascogale tapoatafa* (Brush-tailed Phascogale).

IN1 Industrial

Removal / modification of approximately 9.02 ha of potential foraging habitat and 14 potential den trees (trees with tiny or small hollows). An anecdotal record of the species occurs nearby. However, it was not recorded during our targeted surveys. Further targeted surveys would be required if the absence of the species was to be asserted.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

Without any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the hollow-bearing trees to be removed that a significant impact may occur on a local population of *Phascogale tapoatafa* (Brush-tailed Phascogale).

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential den trees (trees with tiny or small hollows)

R5 Rural Residential
Removal / modification of approximately 48.27 ha of potential foraging habitat and six potential den trees (trees with tiny or small hollows). An anecdotal record of the species exists within this area. However, it was not recorded during our targeted surveys. Further targeted surveys would be required if the absence of the species was to be asserted.

IN1 Industrial
Removal / modification of approximately 9.02 ha of potential foraging habitat and 14 potential den trees (trees with tiny or small hollows). An anecdotal record of the species occurs nearby. However, it was not recorded during our targeted surveys. Further targeted surveys would be required if the absence of the species was to be asserted.

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may slightly fragment habitat for the species.

IN1 Industrial
The proposal may slightly fragment habitat for the species.

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

R1 Residential
Given the small area of habitat within this zone, we consider that the habitat to be removed or modified is of low importance to the long-term survival of the species in the locality.

R5 Rural Residential
The proposal will remove both potential foraging and breeding habitat. The area of habitat to be removed is the size of 1 - 2 female home ranges. There are large tracts of dry forest habitat suitable for the species in the local area. However, as it is unknown how large or how far the local population extends from the study area, we must assume that the study area is important to the long-term survival of the species in the locality.

IN1 Industrial
The proposal will remove both potential foraging and breeding habitat. The area of habitat to be removed is the size of part of a single female home range. There are large tracts of dry

forest habitat suitable for the species in the local area. However, as it is unknown how large or how far the local population extends from the study area, we must assume that the study area is important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Undertake a targeted community education program that raises awareness about critical threats to the species, particularly predation from domestic cats, including what individuals can do to reduce threats to nearby populations (i.e. keeping cats indoors).
- Conduct population monitoring at key locations subject to environmental disturbance (e.g. fire, habitat degradation) to improve understanding of the species' response to different disturbances and inform management.
- Design and implement ecological burns with the objective of maintaining suitable vegetation structure (open forest with sparse groundcover) within habitat known to be used by the species (e.g. Dinner Creek, Demon Nature Reserve).
- Encourage landholders to retain and protect hollow-bearing trees in suitable habitat. Ensure long-term hollow availability by protecting recruit trees, that is, trees that will be able to provide hollows when current hollow-bearing trees have died and fallen.

- Negotiate agreements with relevant landholders, particularly in-perpetuity covenants or stewardship agreements that promote the retention and connectivity of suitable native vegetation, including forested areas with stags, tree hollows and recruiting hollow-bearing trees.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of hollow-bearing trees
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)
- Removal of dead wood and dead trees

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.17 Phascolarctos cinereus (Koala)

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

R1 Residential

Removal / modification of approximately 0.03 ha of Secondary (A) Koala habitat. However, we did not record the species within this rezoning area during targeted spotlighting, scat and canopy searches. This indicates that if Koalas persist in the study area, they area at low density.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets.

This is considered to be a small area of habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 36.18 ha of Secondary (A) Koala habitat. However, we did not record the species within this rezoning area during targeted spotlighting, scat and canopy searches. This indicates that if Koalas persist in the study area, they area at low density.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also slightly fragment habitat for the species.

The Kempsey CKPoM requires that offsets be required to be obtained for the loss of Koala habitat within the study area. These offsets must be no less than two times the total area to

be affected by vegetation. For this rezoning area these offsets would need to be at least 72.36 ha.

Given that Koalas in the study area are likely to be at low density (if they still persist) and providing that the compensatory habitat measures outlined in the Kempsey CKPoM are implemented, we consider it unlikely that the proposal will have an adverse effect on the life cycle of this species such that a viable local population of this species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 1.64 ha of Secondary (A) Koala habitat and approximately 7.12 ha of Secondary (B) Koala habitat. However, we did not record the species within this rezoning area during targeted spotlighting, scat and canopy searches. This indicates that if Koalas persist in the study area, they area at low density.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

The Kempsey CKPoM requires that offsets be required to be obtained for the loss of Koala habitat within the study area. These offsets must be no less than two times the total area to be affected by vegetation. For this rezoning area these offsets would need to be at least 17.52 ha.

Given that Koalas in the study area are likely to be at low density (if they still persist) and providing that the compensatory habitat measures outlined in the Kempsey CKPoM are implemented, we consider it unlikely that the proposal will have an adverse effect on the life cycle of this species such that a viable local population of this species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 0.03 ha of Secondary (A) Koala habitat.

R5 Rural Residential
Removal / modification of approximately 36.18 ha of Secondary (A) Koala habitat.

IN1 Industrial
Removal / modification of approximately 1.64 ha of Secondary (A) Koala habitat and approximately 7.12 ha of Secondary (B) Koala habitat.

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may slightly fragment habitat for the species.

IN1 Industrial
The proposal may slightly fragment habitat for the species.

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

R1 Residential
The habitat to be removed is ranked as Secondary (A) Koala habitat. However, we did not record the species within this rezoning area during targeted spotlighting, scat and canopy searches. This indicates that if Koalas persist in the study area, they area at low density.

This is considered to be a small area of habitat for the species which appears to only occur at low density and as such, it is unlikely to be important to the long-term survival of the species in the locality.

R5 Rural Residential

The habitat to be removed is ranked as Secondary (A) Koala habitat. However, we did not record the species within this rezoning area during targeted spotlighting, scat and canopy searches. This indicates that if Koalas persist in the study area, they area at low density.

Given the lack of evidence of Koalas within this rezoning area it is unlikely that the habitat to be removed is of high importance to the long-term survival of the species in the locality.

IN1 Industrial

The habitat to be removed is ranked as Secondary (A) and Secondary (B) Koala habitat. However, we did not record the species within this rezoning area during targeted spotlighting, scat and canopy searches. This indicates that if Koalas persist in the study area, they area at low density.

Given the lack of evidence of Koalas within this rezoning area it is unlikely that the habitat to be removed is of high importance to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

A state recovery plan for forest owls has been prepared (Department of Environment and Climate Change 2008). The following recovery actions are recommended:

- Conserve koalas in their existing habitat
    - Identify and conserve habitat important for koala conservation
    - Assess the impact of habitat loss and fragmentation on koala populations
    - Integrate koala habitat conservation into local and state government planning processes
    - Develop appropriate road risk management in koala habitat
    - Implement strategies which minimise the impacts of dogs on koala populations
    - Develop and implement strategies to reduce the impact of fires on koala populations
- Rehabilitate and restore koala habitat and populations
    - Revegetate and rehabilitate selected sites
    - Make appropriate use of translocation
- Develop a better understanding of the conservation biology of koalas

- Ensure that the community has access to factual information about the distribution, conservation and management of koalas at a national, state and local level
    - Prepare and distribute educational material and involve the community in koala conservation
    - Understand the cultural significance of koalas
    - Manage captive, sick or injured koalas and orphaned wild koalas to ensure consistent and high standards of care
- Manage overbrowsing to prevent both koala starvation and ecosystem damage in discrete patches of habitat
- Coordinate, promote the implementation, and monitor the effectiveness of the NSW Koala Recovery Plan across New South Wales

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.18 *Petaurus australis* (Yellow-bellied Glider)

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

R1 Residential

Removal / modification of approximately 0.03 ha of marginal potential foraging habitat and one potential den tree (trees with medium hollows). However, no evidence of this highly vocal species was recorded during targeted spotlighting, call playback and Song Meter recording. Additionally, no characteristic feeding scars were observed. More suitable habitat occurs approximately 10 km to the north of the study area in the taller forests of Tamban State Forest and Ngambaa Nature Reserve.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets.

This is considered to be a small area of marginal habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 48.27 ha of marginal potential foraging habitat and six potential den trees (trees with medium hollows). However, no evidence of this highly vocal species was recorded during targeted spotlighting, call playback and Song Meter recording. Additionally, no characteristic feeding scars were observed.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also slightly fragment habitat for the species.

This is considered to be marginal habitat for the species that appears to be unoccupied and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of this species is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 8.76 ha of marginal potential foraging habitat and seven potential den trees (trees with medium hollows). However, no evidence of this highly vocal species was recorded during targeted spotlighting, call playback and Song Meter recording. Additionally, no characteristic feeding scars were observed.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

This is considered to be marginal habitat for the species that appears to be unoccupied and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of this species such that a viable local population of this species is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 0.03 ha of marginal potential foraging habitat and one potential den tree (trees with medium hollows).

R5 Rural Residential
Removal / modification of approximately 48.27 ha of marginal potential foraging habitat and six potential den trees (trees with medium hollows).

IN1 Industrial
Removal / modification of approximately 8.76 ha of marginal potential foraging habitat and seven potential den trees (trees with medium hollows).

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may slightly fragment habitat for the species.

IN1 Industrial
The proposal may slightly fragment habitat for the species.

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

As these rezoning areas contain marginal habitat for the species and appear to be unoccupied, we consider that this habitat is unlikely to be important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Protect and maintain areas of high quality habitat, particularly mature forest occurring in high rainfall areas on nutrient rich soils, with tall trees bearing large hollows, sap-feeding trees and a diversity of winter flowering eucalypts for pollen and nectar. Sap-trees may be from a variety of species but are typically smooth-barked eucalypts. Protect areas of younger forest that will develop into suitable habitat for yellow-bellied gliders. Where possible negotiate conservation agreements with landholders, agreements should preferably be funded and in perpetuity.
- Undertake revegetation, using a mix of locally appropriate native species that will develop into high quality habitat. Revegetation should focus on expanding existing smaller (less than 30ha) areas of suitable habitat.
- Improve and maintain connectivity between patches of suitable habitat. Improve width and condition of existing habitat links either by natural regeneration or augmentation plantings of suitable native species. Establish corridors between isolated patches of known habitat. Corridors should be at least 50m wide, and any plantings should including potential food trees and hollow-developing species.
- Limit width of linear clearings through suitable habitat to ensure gliders can cross (distance depends on height of neighbouring vegetation and topography, but generally should be less than 100m). If necessary provide glider bridges or poles to allow gliders to cross.
- Retain and protect trees with feeding incisions, and species which are known food trees (including winter flowering eucalypts that provide pollen and nectar). Augment degraded habitat by planting food tree species.

- Retain and protect hollow-bearing trees in suitable habitat. Ensure hollow availability into the long term by protecting recruit trees, that is trees that will be able to provide hollows when current hollow-bearing trees have died and fallen.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of hollow-bearing trees

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.19 *Petaurus norfolcensis* (Squirrel Glider)

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

R1 Residential

Removal / modification of approximately 0.03 ha of potential foraging habitat and two potential den trees (trees with tiny or small hollows). *Petaurus norfolcensis* (Squirrel Glider) was not recorded near the R1 Residential rezoning area.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets.

This is considered to be a small area of marginal habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population of this species is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 48.27 ha of known foraging habitat and six potential den trees (trees with tiny or small hollows). We recorded *Petaurus norfolcensis* (Squirrel Glider) in four distinct locations either within this rezoning area or immediately adjacent. Therefore, we estimate that the proposal may affect at least four family groups.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also fragment habitat for the species.

Without any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the large amount of habitat to be removed (including hollow-bearing trees) that a significant impact may occur on a local population of *Petaurus norfolcensis* (Squirrel Glider).

IN1 Industrial
Removal / modification of approximately 8.76 ha of potential foraging habitat and 14 potential den trees (trees with tiny or small hollows). Proposal may affect at least one family group.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

Without any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the high number of hollow-bearing trees to be removed that a significant impact may occur on a local population of *Petaurus norfolcensis* (Squirrel Glider).

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 0.03 ha of potential foraging habitat and two potential den trees (trees with tiny or small hollows).

R5 Rural Residential
Removal / modification of approximately 48.27 ha of known foraging habitat and six potential den trees (trees with tiny or small hollows).

IN1 Industrial
Removal / modification of approximately 8.76 ha of potential foraging habitat and 14 potential den trees (trees with tiny or small hollows).

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may slightly fragment habitat for the species.

IN1 Industrial
The proposal may slightly fragment habitat for the species.

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

R1 Residential
Given the small area of habitat within this zone, we consider that the habitat to be removed or modified is of low importance to the long-term survival of the species in the locality.

R5 Rural Residential
The proposal will remove both known foraging habitat and potential breeding habitat. Based on the four distinct locations that we recorded the species, at least four family groups occur within or immediately adjacent to this rezoning area. There are large tracts of dry forest habitat suitable for the species in the local area. However, as it is unknown how large the local population is or how far the local population extends from the study area, we must assume that the study area is important to the long-term survival of the species in the locality.

IN1 Industrial

The proposal will remove both potential foraging and breeding habitat. At least one family group is likely to use the rezoning area. There is also a high density of hollow-bearing trees within this rezoning area. There are large tracts of dry forest habitat suitable for the species in the local area. However, as it is unknown how large or how far the local population extends from the study area, we must assume that the study area is important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where it is under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Raise public awareness of the importance of large old trees (living and dead), which provide important hollow and food resources. Protect large old trees and ensure their continued presence in the landscape by retaining medium sized trees, facilitating regeneration, and undertaking replanting. Large old trees within, adjacent to, or connecting vegetation remnants are particularly important.
- Protect, manage and restore habitat, prioritising sites within a region that may better function as drought refuges. Encourage the retention of a floristically and structurally diverse understorey, and raise public awareness of the damage caused to food resources by slashing/underscrubbing and over-grazing
- Identify important populations and engage stakeholders in the development and implementation of a local area management plan (a map based document detailing the works necessary to secure the long term viability of the population). Undertake baseline studies to support the preparation of local area management plans (LAMPs).
- Ensure populations remain connected by avoiding gaps greater than 50m between habitat patches and along linear remnants. Eliminate gaps through revegetation or the installation of crossing structures (e.g. rope bridges, glide poles), focusing on important movement pathways. Investigate the influence of habitat fragmentation on gene flow in different landscapes across the species' distribution.
- Identify sites where hollows are limiting and develop and implement strategies to increase hollow availability that have clear objectives and include monitoring, maintenance, and reporting requirements. Actions include nest box installation, the

humane control of introduced species, and the protection of trees having the potential to develop hollows.

- Reduce direct mortality due to entanglement on barbed wire, vehicle collisions, and predation by cats and dogs. Encourage the use of plain wire fencing and the covering of barbed wire with polypipe. At sites with a high risk of vehicle collision, install crossing structures (e.g. rope bridges, glide poles) and/or reduce the canopy gap through revegetation. Confine cats and dogs at night.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of hollow-bearing trees
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.20 Hollow-dependent microbats

- *Mormopterus norfolkensis* (East Coast Freetail-bat);
- *Chalinolobus nigrogriseus* (Hoary Wattled Bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);

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

<u>R1 Residential</u>
Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential roost trees (trees with tiny hollows or cracks).

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets.

This is considered to be a small area of habitat for the species and as such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of potential foraging habitat and 18 potential roost trees (trees with tiny hollows or cracks).

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also fragment habitat for the species.

Without further surveys to determine the importance of the rezoning area to these species, any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the large amount of habitat to be removed (including hollow-bearing trees) that a significant impact may occur on a local population of these hollow-dependent microbat species.

IN1 Industrial
Removal / modification of approximately 9.02 ha of potential foraging habitat and 13 potential roost trees (trees with tiny hollows or cracks).

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

Without further surveys to determine the importance of the rezoning area to these species, any intended protection of hollow-bearing trees within this rezoning area or the provision of local offset sites, we must adopt the precautionary principle and assume that due to the high number of hollow-bearing trees to be removed that a significant impact may occur on a local population of these hollow-dependent microbat species..

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 1.64 ha of potential foraging habitat and two potential roost trees (trees with tiny hollows or cracks).

R5 Rural Residential
Removal / modification of approximately 48.27 ha of potential foraging habitat and 18 potential roost trees (trees with tiny hollows or cracks).

IN1 Industrial
Removal / modification of approximately 9.02 ha of potential foraging habitat and 13 potential roost trees (trees with tiny hollows or cracks).

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may slightly fragment habitat for the species. However, they are highly mobile so this impact will be small.

IN1 Industrial
The proposal may slightly fragment habitat for the species. However, they are highly mobile so this impact will be small.

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

R1 Residential

Given the small area of habitat within this zone, we consider that the habitat to be removed or modified is of low importance to the long-term survival of the species in the locality.

R5 Rural Residential

The proposal will remove both potential foraging and breeding habitat. There are large tracts of similar dry forest habitat that is more intact and suitable for the species in the local area. Our surveys were undertaken during winter, a time when microbats are generally less active, and as such it is difficult to determine how important this rezoning area is to these species. Without further surveys to determine the importance of the rezoning area to these species and due to the presence of both foraging and roosting habitat, we must assume that the study area is important to the long-term survival of the species in the locality.

IN1 Industrial

The proposal will remove both potential foraging and breeding habitat. There are large tracts of similar dry forest habitat that is more intact and suitable for the species in the local area. Our surveys were undertaken during winter, a time when microbats are generally less active, and as such it is difficult to determine how important this rezoning area is to these species. Without further surveys to determine the importance of the rezoning area to these species and due to the presence of a high density of hollow-bearing trees, we must assume that the study area is important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for these species. A targeted strategy for managing this species has been developed under the Saving Our Species program where they are under the 'landscape species' management stream. *Chalinolobus nigrogriseus* (Hoary Wattled Bat) has been assigned to the 'Partnership species' management stream.

The actions provided to guide management at a site, regional or state scale for *Mormopterus norfolkensis* (East Coast Freetail bat) are:

- Raise public awareness of the importance of hollow-bearing trees and promote strategies for retaining these in the landscape. Facilitate regeneration or undertaking replanting at sites where they presently occur. Protect recruit trees that will be able to provide hollows in the future.
- Negotiate agreements with relevant landholders (particularly in-perpetuity covenants or stewardship agreements) that promote the retention, connectivity,

restoration and sensitive management of suitable habitat including remnant vegetation and forested areas with hollow-bearing trees, especially in productive landscapes, as well as vegetation buffers around wetlands, estuaries, alluvial flats along creeklines and coastal lagoons.

- Raise public awareness of the damage that can be caused to habitat by slashing, underscrubbing, thinning, weed encroachment and inappropriate grazing. Encourage land managers to retain natural tree density and a floristically and structurally diverse and spatially variable mid and understorey.
- Identify sites where exotic species are inhibiting native tree recruitment or changing the vegetation structure. Implement a bush regeneration strategy targeting the removal of weeds significantly compromising habitat values, especially in riparian zones, and restore native vegetation. Care should be taken to avoid widespread removal of beneficial exotic woody vegetation without replacement and avoid non-target impacts of herbicides.
- Liaise with relevant landholders or land managers responsible for artificial light sources close to key roosting or foraging areas, to encourage reduction or modification of light impacting on known habitat to reduce levels of disturbance.
- Liaise with relevant authorities or land managers to ensure that the location and sensitivity of key foraging or roosting habitat areas are known prior to any hazard reduction burns. Where maternity roost sites are known to occur, burning should not take place during breeding (November to January). Fire in suitable habitat areas should be managed to promote a mosaic of vegetation structures and high intensity fires that remove hollow-bearing trees should be avoided where possible.
- Where maternity or other roost site locations are known to occur, raise awareness amongst landholders in close proximity (approximately 15km radius) of the potential impacts of using harmful pesticides and other chemicals; discourage their use in or adjacent to suitable habitat and monitor and maintain water quality in systems known to be used for foraging. In other high quality foraging habitat areas, particularly in low-elevation productive landscapes, raise public awareness of the potential impacts of pesticide and chemical use and discourage their use in riparian zones around waterways such as wetlands, swamps, estuaries, rivers, creeks, lakes and dams.
- Conduct targeted research into the species biology, particularly in relation to habitat use in various densities of urbanisation and in agricultural landscapes. For example, investigation of prey availability and disturbance (noise and lighting) in productive floodplain areas over a gradient of urbanisation, and research that investigates what key elements make agricultural landscapes suitable for the species.

The actions provided to guide management at a site, regional or state scale for *Chalinolobus nigrogriseus* (Hoary Wattled bat) are:

- Ensure the largest hollow bearing trees are given highest priority for retention when undertaking PVP assessments (offsets should include remnants in old growth forest) or other land assessment tools.

- 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.
- Investigate the effectiveness of logging prescriptions.
- Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes.
- Identify the effects of fragmentation on the species in a range of fragmented landscapes such as the farmland/forest interface and the urban/forest interface. For example movement and persistence across a range of fragment sizes.
- Study the ecology, habitat requirements and susceptibility to logging and other forestry practices of this little-known species.
- Determine the viability of populations and extent of use of remnant vegetation and revegetation in areas abutting coastal developments.
- Assess the habitat requirements and susceptibility to logging and other forestry practices.
- Long-term monitoring of populations cross tenure in conjunction with other forest bat species to document changes.
- Identify areas of private land that contain key habitat (e.g. old growth forest dominated by Spotted Gum, box and ironbark) for the species as areas of high conservation value to use in planning instruments and land management negotiations.
- Promote the conservation of private land areas with key habitat using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means.
- Develop and promote bat awareness programs for schools, CMAs, landholders and industry groups etc.
- Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes, such as revegetating and installing bat boxes.
- Research to quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops. .
- Ensure the Code of Practice for private native forestry includes adequate measures to protect large, hollow-bearing trees, viable numbers of recruit trees and provide protection for streamside vegetation. .
- Identify important foraging range and key habitat components for this species.
- 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.
- Identify the susceptibility of the species to pesticides.
- Better define the species' distribution in far north-eastern NSW through survey on- and off-reserve.
- Research the effect of different burning regimes.

The actions provided to guide management at a site, regional or state scale for *Scoteanax rueppellii* (Greater Broad-nosed Bat) are:

- Identify sites, particularly in riparian zones, where hollows are limiting due to exotic species inhibiting recruitment and changing the vegetation structure. Ensure the future replacement of large old trees by facilitating regeneration or undertaking replanting at sites where they presently occur. Protect recruit trees that will be able to provide hollows in the future.
- Encourage land managers to enter into land management agreements that protect and restore key areas such as riparian habitat and including the retention of suitable hollow bearing trees and recruitment trees in these areas.
- Raise awareness amongst landholders in close proximity (approximately 15km radius) to maternity or roost sites, of the potential impacts of using harmful pesticides and other chemicals and discourage their use in or adjacent to foraging habitat particularly in riparian zones around waterways such as rivers, creeks, lakes and dams.
- Liaise with agricultural landholders to promote land management that minimises disturbance to waterways likely to be foraging habitat (e.g. restore riparian vegetation and carefully manage stormwater and polluted run-off)
- Control or remove exotic weeds, particularly in riparian zones, that degrade habitat and alter the structure of the vegetation community in areas of the species distribution. Ensure that such weed control work be undertaken in a staged manner and minimises disturbance to the habitat of the species. Develop and implement a bush regeneration strategy (which includes monitoring and reporting requirements) targeting the removal of weeds significantly compromising habitat values such as the repression of future hollow-bearing trees. Care should be taken to avoid widespread removal of vegetation without replacement. Manual weed removal is preferable and the use of herbicides should avoid non-target impacts. Leave dead trees standing. Encourage land managers and bushcare groups to undertake weed control.
- Undertake restoration and augmentation planting and/or direct seeding, including species from the ground layer and understorey in areas of degraded and/or potentially suitable habitat particularly in riparian zones. Revegetation should focus on expanding existing smaller areas of suitable habitat and connecting areas of suitable habitat to create corridors for movement. A diversity of local native species should be planted. Dead trees should not be removed.
- Manually remove and appropriately dispose of invasive aquatic weeds from waterways in foraging areas.
- Liaise with relevant authorities or land managers to ensure that the location and sensitivity of roost sites (such as trees bearing small hollows) and key foraging areas are known prior to any hazard reduction burns. Ensure that areas immediately surrounding maternity and roost sites are identified as an important biodiversity asset in any relevant fire planning and have a 100m buffer zone applied. Planned fires near maternity or roosting sites should not be undertaken during the breeding

season, i.e. December to January, or overwintering period if bats are in residence. Hazard reduction burns should be of low intensity and in dry open forest and woodland habitat should not occur more than once every 7-30 years, in swamp forest not more than once every 7-35 years. Fires should be conducted in a mosaic manner to allow areas of refuge to remain undamaged. Liaise with the Rural Fire Service, National Parks and Wildlife Service, or relevant land manager.

- Undertake research into habitat use and roost ecology and regional movements in order to better understand and protect habitat for the species.
- Raise awareness among landholders about the importance of retaining large live and standing dead hollow-bearing trees in the landscape as habitat for the species.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss of hollow-bearing trees
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.21 Cave-roosting bats

- *Miniopterus australis* (Little Bentwing-bat);
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat);

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

<u>R1 Residential</u>

Removal / modification of approximately 1.64 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading. These species breed in large maternity roosts that do not occur within the study area.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets.

This is considered to be a small area of habitat for the species, with no potential roosting habitat within the rezoning area. As such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 48.27 ha of potential foraging habitat. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading. These species breed in large maternity roosts that do not occur within the study area.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. The proposal may also fragment habitat for the species.

While the proposal will modify a large area of foraging habitat for these species, no breeding habitat would be disturbed. In addition, these species are recorded from urban areas and appear to be urban-tolerant, meaning that it is likely that the rezoning area will continue to provide habitat for the species. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 9.02 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading. These species breed in large maternity roosts that do not occur within the study area.

There is the potential for the indirect impact for the proposal to slightly fragment habitat for the species.

While the proposal will modify an area of foraging habitat for these species, no breeding habitat would be disturbed. In addition, these species are recorded from urban areas and appear to be urban-tolerant, meaning that it is likely that the rezoning area will continue to provide habitat for the species. Therefore, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

<u>R1 Residential</u>
Removal / modification of approximately 1.64 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading. These species breed in large maternity roosts that do not occur within the study area.

<u>R5 Rural Residential</u>
Removal / modification of approximately 48.27 ha of potential foraging habitat. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading. These species breed in large maternity roosts that do not occur within the study area.

<u>IN1 Industrial</u>
Removal / modification of approximately 9.02 ha of potential foraging habitat. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading. These species breed in large maternity roosts that do not occur within the study area.

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
The proposal may slightly fragment habitat for the species. However, they are highly mobile so this impact will be small.

IN1 Industrial
The proposal may slightly fragment habitat for the species. However, they are highly mobile so this impact will be small.

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

R1 Residential
Given the small area of habitat within this zone, we consider that the habitat to be removed or modified is of low importance to the long-term survival of the species in the locality.

R5 Rural Residential
The foraging habitat to be removed is not unique in the local area. Large areas of more intact dry forest habitat occur nearby. It is unlikely that the foraging habitat present within this rezoning area is highly important to the long-term survival of the species in the locality.

IN1 Industrial
The foraging habitat to be removed is not unique in the local area. Large areas of more intact dry forest habitat occur nearby. It is unlikely that the foraging habitat present within this rezoning area is highly important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for these species. A targeted strategy for managing this species has been developed under the Saving Our Species program where they are under the ‘landscape species’ management stream.

The actions provided to guide management at a site, regional or state scale for *Miniopterus australis* (Little Bentwing Bat) are:

- Liaise with relevant authorities or land managers to ensure that the location and sensitivity of key foraging areas are known prior to any hazard reduction burns. Also ensure that areas immediately surrounding maternity/nursery caves are identified as an important biodiversity asset in any relevant fire planning and have a 100m buffer zone applied. Planned fires near maternity or roosting site should not be undertaken during the breeding season (August to early April), during winter when bats are in residence, or when the wind direction is likely to blow heavy smoke or flames into the cave. Undertake research into the effects of fire on the species.

- Encourage land managers to enter into land management agreements that protect and restore key areas particularly swamps and habitat adjacent to caves and other roost sites.
- Undertake restoration and augmentation planting and/or direct seeding , including species from the ground layer and understorey in areas of degraded and/or potentially suitable habitat where weeds can be effectively managed. Revegetation should focus on expanding existing smaller areas of suitable habitat and connecting areas of suitable habitat to create corridors for movement. A diversity of local native species should be planted.
- Check that cave entrances are not blocked in a way that prevents easy continual access by bats. Monitor the density of vegetation (native or exotic) at the entrance to any active or potential maternity or hibernation roost cave and manually remove (do not use chemicals) as necessary to ensure bats have ready access year round.

- Identify important maternity or hibernation roost sites (e.g. caves, tunnels, bridges, drains, culverts) and negotiate with relevant landholders or land managers to enter into an agreement that protects these sites from disturbance or degradation. This should include provision to check and seek expert advice if the bats are present prior to undertaking maintenance works.
- Discourage recreational users from roosting areas such as caves, culverts, and stormwater drains by erecting signs or blocking preventing human access whilst still allowing access to bats. In caves where public access is permitted, restrict access during breeding season (November-March) and winter to approved scientific research only and provide information in the form of brochures and signage about appropriate care and behaviour whilst at the site. Provide this information to caving, climbing, abseiling and bushwalking groups.
- Raise awareness amongst landholders in close proximity (approximately 15km radius) to maternity or hibernation roost caves, of the potential impacts of using harmful pesticides and other chemicals and discourage their use in or adjacent to habitat areas.
- Monitor the species at a number of sites, including the single known breeding colony in NSW, to keep watch on the potential introduction of pathogens such as white-

nosed fungus. Restrict use of known important maternity or hibernation roost caves during the breeding and overwintering period to those undertaking approved management or scientific research. Disseminate brochures and liaise with recreational caving, bushwalking, abseiling and climbing groups to highlight the risks of disease spread and also describe appropriate hygiene protocols for use on site.

- Liaise with relevant authorities and/or land managers to discourage the destruction of caves. If mine sites are to be closed or previously abandoned mines reopened, they should first be checked for the presence of bats (during summer) and access should still be provided for the bats to safely enter and leave. Closure technique should be discussed with relevant microbat experts to ensure that possible habitat for bats is maintained. If gates are used, they should be bat friendly with horizontal bars at last 15cm apart and preferably with a larger gap across the top. Bats should be excluded prior to closure (and this should not occur during the breeding season from August to early April or winter). The impact of closure on bat usage should be monitored for several seasons.
- Undertake research to understand the effects of fragmentation on the species.
- Liaise with relevant authorities and/or land managers to ensure that the location and sensitivity of roosting and key foraging areas are known and encourage that existing lighting impacting on these areas be modified and that any future lighting avoid spilling onto these areas where possible.
- Investigate wintering roosts including whether the species use banana trees and tree hollows in order to understand species habitat.

The actions provided to guide management at a site, regional or state scale for *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) are:

- Prevent human access to roost and maternity caves and the areas immediately around cave entrances during winter and the breeding season, through the erection of signage, or the removal of access tracks and paths.
- Remove vegetation encroaching on cave entrances, with a minimum of disturbance.
- Initiate a caver education program promoting awareness of the threat of pathogens to microbats, and providing information on appropriate hygiene, and where appropriate decontamination, protocols. Program should particularly target people likely to come into contact with pathogens overseas and who may introduce them to Australia.
- Protect and maintain high quality foraging habitat in the vicinity of maternity caves. Target high productivity habitats, primarily riparian areas, wetlands, and other areas of native vegetation associated with high moisture status and fertility. Where possible negotiate conservation agreements with landholders; agreements should preferably be funded and in perpetuity.
- Undertake revegetation, using a diverse mix of locally appropriate native species. Revegetation should focus on areas of good moisture and fertility, particularly

riparian areas and wetlands. Priority should be given to expanding existing small habitat patches.
- Restrict physical cave entrance closures to situations where there is a real hazard to public health and safety, and where the risk cannot be dealt with by other means (for example removing access tracks). Where closures are required, closures should be undertaken in a manner that continues to allow safe access for bats, and that does not influence the cave's microclimate.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.22 *Myotis macropus* (Southern Myotis)

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

R1 Residential
While the species may occur in adjacent areas, this species is unlikely to use dams within zone. No potential roosting habitat was identified within the zone. Suitable habitat within the study area occurs along the major watercourses (Macleay River and Christmas Creek) and large farm dams on these floodplains. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

There is the potential for the indirect impact an increase in the competition and predation in adjacent areas by exotic animals and domestic pets. Additionally, there are possible hydrological impacts, eutrophication of adjacent low-lying habitats.

As no habitat will be removed as a result of the proposal and any upgrading of culverts would need to be surveyed and assessed separately, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

R5 Rural Residential

The removal or modification of a number of small farm dams may occur within the zone. However, these areas represent marginal habitat for the species as they are located in an elevated area away from large natural waterbodies and wetlands. Suitable habitat within the study area occurs along the major watercourses (Macleay River and Christmas Creek) and large farm dams on these floodplains.No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

As only marginal foraging habitat will be removed as a result of the proposal and any upgrading of culverts would need to be surveyed and assessed separately, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

IN1 Industrial

The removal or modification of a number of small farm dams may occur within the zone. However, these areas represent marginal habitat for the species as they are located in an elevated area away from large natural waterbodies and wetlands. Suitable habitat within the study area occurs along the major watercourses (Macleay River and Christmas Creek) and large farm dams on these floodplains. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

There are possible hydrological impacts, eutrophication of adjacent low-lying habitats.

As only marginal foraging habitat will be removed as a result of the proposal and any upgrading of culverts would need to be surveyed and assessed separately, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential

While the species may occur in adjacent areas, this species is unlikely to use dams within zone. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

R5 Rural Residential

The removal or modification of a number of small farm dams may occur within the zone. However, these areas represent marginal habitat for the species as they are located in an elevated area away from large natural waterbodies and wetlands. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

IN1 Industrial

The removal or modification of a number of small farm dams may occur within the zone. However, these areas represent marginal habitat for the species as they are located in an elevated area away from large natural waterbodies and wetlands. No potential roosting habitat was identified within the zone. However, nearby potential roosting habitat in road culverts may be disturbed if roads require upgrading.

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

The proposal is unlikely to fragment or isolate habitat for this species as the rezoning areas are all located in more elevated positions that are generally not used by this species.

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

The small number of farm dams that may be removed or modified as a result of the proposal are marginal habitat for the species, occurring in more elevated locations. Therefore, these habitats are unlikely to be important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where they are under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Retain and protect live and standing dead trees likely to contain suitably sized hollows, or that have the potential to develop these in the future (e.g. through the loss of limbs) particularly in riparian zones. Ensure the largest hollow-bearing trees, including dead trees, are given highest priority for retention in property vegetation plan assessments. Offsets should include remnants in high productivity and riparian zones. Raise public awareness of the importance of hollow-bearing trees and promote strategies for retaining these in the landscape.
- Identify sites, particularly in riparian zones, where hollows are limiting due to exotic species inhibiting recruitment and changing the vegetation structure. Ensure the future replacement of large old trees by facilitating regeneration or undertaking replanting at sites where they presently occur. Protect recruit trees that will be able to provide hollows in the future.
- Liaise with the Roads and Maritime Authority and other relevant authorities and land managers regarding wooden bridges, wharves, tunnels, aqueducts and other structures acting as bat habitat. When undertaking any major works, replacing wooden bridges with concrete bridges or upgrading wharves, this be done at a time outside of the breeding (October-February) and overwintering period. A wooden structure should be placed under new bridges or wharves where bats are known to provide a roost.
- Encourage land managers to enter into land management agreements that protect and restore key areas such as riparian habitat and including the retention of suitable hollow-bearing trees and recruitment trees in these areas.

- Check that in caves utilised by bats, entrances are not blocked in a way that prevents easy continual access by bats. Monitor the density of vegetation (native or exotic) at the entrance to any active or potential maternity or hibernation roost cave and manually remove (do not use chemicals) as necessary to ensure bats have ready access year-round.
- Discourage recreational users from roosting areas such as caves, culverts, and storm water drains by erecting signs or blocking preventing human access whilst still allowing access to bats. In caves where public access is permitted, restrict access during breeding season (November-March) and winter to approved management and scientific research only. Provide information to users in the form of brochures and signage about appropriate care and behaviour whilst at the site. Provide this information to caving, climbing, abseiling and bushwalking groups.
- Promote roosting habitat in new artificial structures within the species' range and monitor their use.
- Raise awareness amongst landholders in close proximity (approximately 15km radius) to maternity or roost sites, of the potential impacts of using harmful pesticides and other chemicals and discourage their use in or adjacent to foraging habitat, particularly in riparian zones around waterways such as rivers, creeks, lakes and dams.
- Liaise with agricultural landholders to promote land management that minimises disturbance to waterways likely to be foraging habitat (e.g. restore riparian vegetation and carefully manage stormwater and polluted run-off). Monitor and maintain adequate water quality in water systems known to be used for foraging. Liaise with relevant authorities with respect to limiting the impacts of waste disposal and runoff in these systems.
- Control or remove exotic weeds, particularly in riparian zones, that degrade habitat and alter the structure of the vegetation community in areas of the species' distribution. Ensure that such weed control work be undertaken in a staged manner and minimises disturbance to the habitat of the species. Develop and implement a bush regeneration strategy (which includes monitoring and reporting requirements) targeting the removal of weeds significantly compromising habitat values such as the repression of future hollow-bearing trees. Care should be taken to avoid widespread removal of vegetation without replacement. Manual weed removal is preferable and the use of herbicides should avoid non-target impacts. Leave dead trees standing. Encourage land managers and bushcare groups to undertake weed control.
- Undertake restoration and augmentation planting and/or direct seeding, including species from the ground layer and understorey in areas of degraded and/or potentially suitable habitat particularly in riparian zones. Revegetation should focus on expanding existing smaller areas of suitable habitat and connecting areas of suitable habitat to create corridors for movement. A diversity of local native species should be planted. Dead trees should not be removed.

- Manually remove and appropriately dispose of invasive aquatic weeds in waterways in foraging areas (weeds inhibit the species' ability to forage over water).
- Liaise with relevant authorities and/or land managers to discourage the destruction of caves. If mine sites are to be closed or previously abandoned mines reopened, they should first be checked for the presence of bats (during summer) and access should still be provided for the bats to safely enter and leave. Closure technique should be discussed with relevant microbat experts to ensure that possible habitat for bats is maintained. If gates are used, they should be bat friendly with horizontal bars at least 15cm apart and preferably with a larger gap across the top. Bats should be excluded prior to closure (and this should not occur during the breeding season from October to February or in winter). The impact of closure on bat usage should be monitored for several seasons.

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)
- Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

2.23 *Pteropus poliocephalus* (Grey-headed Flying-fox)

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

<u>R1 Residential</u>

Removal / modification of approximately 0.03 ha of foraging habitat. No camps were recorded within the zone.

This is considered to be a very small area of habitat for the species, with no camps found to occur within of adjacent to the rezoning area. As such, the proposal is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

R5 Rural Residential

Removal / modification of approximately 48.27 ha of high quality foraging habitat (two highest ranking categories for nectar reliability and quantity by Eby and Law (2008)). No camps were recorded within the zone.

There is the potential for the indirect impact of slight habitat fragmentation. However, the species is highly mobile so the impact is considered to be low.

The proposal will result in the removal of a large area of foraging habitat for the species. However, this species is highly mobile and large tracts of similar vegetation occur nearby. Therefore, the removal of this habitat alone is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

IN1 Industrial

Removal / modification of approximately 8.76 ha of high quality foraging habitat (two highest ranking categories for nectar reliability and quantity by Eby and Law (2008)). No camps were recorded within the zone.

There is the potential for the indirect impact of slight habitat fragmentation. However, the species is highly mobile so the impact is considered to be low.

The proposal will result in the removal of an area of foraging habitat for the species. However, this species is highly mobile and large tracts of similar vegetation occur nearby. Therefore, the removal of this habitat alone is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

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

N/A

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

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

N/A

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

N/A

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

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

R1 Residential
Removal / modification of approximately 0.03 ha of foraging habitat. No camps were recorded within the zone.

R5 Rural Residential
Removal / modification of approximately 48.27 ha of high quality foraging habitat (two highest ranking categories for nectar reliability and quantity by Eby and Law (2008)). No camps were recorded within the zone.

IN1 Industrial
Removal / modification of approximately 8.76 ha of high quality foraging habitat (two highest ranking categories for nectar reliability and quantity by Eby and Law (2008)). No camps were recorded within the zone.

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

R1 Residential
The proposal is unlikely to fragment or isolate habitat for the species.

R5 Rural Residential
There is the potential for the indirect impact of slight habitat fragmentation. However, the species is highly mobile so the impact is considered to be low.

IN1 Industrial

There is the potential for the indirect impact of slight habitat fragmentation. However, the species is highly mobile so the impact is considered to be low.

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

R1 Residential

Given the small area of habitat within this zone, we consider that the habitat to be removed or modified is of low importance to the long-term survival of the species in the locality.

R5 Rural Residential

While the foraging habitat to be removed within this rezoning area is of high quality in terms of nectar resources, it is semi-cleared and there are large areas of similar dry forest habitats nearby. Additionally, no camps are known to occur nearby. As the species is highly mobile, we consider it unlikely that the study area alone is highly important to the long-term survival of the species in the locality.

IN1 Industrial

While the habitat to be removed within this rezoning area is of high quality in terms of nectar resources, it is semi-cleared and there are large areas of similar dry forest habitats nearby. Additionally, no camps are known to occur nearby. As the species is highly mobile, we consider it unlikely that the study area alone is highly important to the long-term survival of the species in the locality.

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

Critical habitat as listed under the *TSC Act* does not occur in the study area or locality.

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

Recovery plans or threat abatement plans have not been prepared for this species. A targeted strategy for managing this species has been developed under the Saving Our Species program where they are under the 'landscape species' management stream.

The actions provided to guide management at a site, regional or state scale are:

- Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring through dedicated habitat creation and restoration using guides published by OEH (in preparation).
- Negotiate agreements with landholders, particularly in-perpetuity covenants or stewardship agreements that promote the protection and retention of high quality foraging habitat and roost sites for grey-headed flying-foxes.

- Rehabilitate degraded flying-fox roost sites through weed management, planting new roost trees, managing understorey vegetation to maintain suitable microclimate conditions, establishing buffers between roost camps and nearby human settlements to minimise conflict.
- Conduct dedicated engagement programs in communities affected by flying-fox roost sites, building the capacity of all stakeholders to engage in the process of decision-making and developing camp management plans. Provide information about mitigating the impacts of flying-foxes on nearby residences and businesses such as strategic vegetation management, and structural modifications like double-glazing, air conditioning and shade cloths.
- Distribute public education materials to land managers and local community groups working with contentious flying-fox roost sites highlighting species status, reasons for being in urban areas, reasons for decline etc.
- Develop site-based heat stress response protocols for camps likely to be affected by heat stress events. Protocols should be based on best practice guidelines (http://www.environment.nsw.gov.au/animals/flying-fox-heat.htm), and should be implemented by licensed fauna rehabilitators. Data should be recorded to inform future management of heat stress events (http://www.environment.nsw.gov.au/resources/animals/150725-flying-fox-heat-data.docx).

The proposal is in accordance with these management actions.

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

Relevant KTPs to this species that may increase slightly as a result of the proposal (see Appendix G for full KTP assessment) are:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)

These KTPs are considered likely to already be occurring within the study area. The proposal may increase the operation of these KTPs slightly.

3.0 REFERENCES

Department of Environment and Climate Change. 2008. Recovery plan for the koala (*Phascolarctos cinereus*). Department of Environment and Climate Change, Sydney South.

Department of Environment and Conservation. 2006. Recovery Plan for the Large Forest Owls: Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*). Department of Environment and Conservation, Sydney, NSW.

Eby, P. and B. Law 2008. Ranking the feeding habitats of Grey-headed flying foxes for conservation management. Department of Environment and Climate Change (NSW) and Department of Environment Water Heritage and the Arts, Hurstville.

Saunders, D. L. and C. L. Tzaros. 2011. National Recovery Plan for the Swift Parrot *Lathamus discolor*. Birds Australia, Melbourne, Australia.