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Ecological Framework, Warnervale Town Centre

Warnervale Strategic Planning
(Project No. 29-08)

Report prepared for:
Landcom

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Contents

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Executive Summary

This document, through a review process, has sought to identify ecological values for the Warnervale Town Centre study area. Identified values of note are:

- Landscape values (connectivity, integration of outcomes and offsetting),
- Vegetation values (EEC, Regionally Significant, Locally Significant),
- Threatened flora value (*Rutidosis heterogama*)
- Threatened fauna values (squirrel glider, eastern freetail bat, greater broad-nosed bat, masked owl, powerful owl, wallum froglet)
- Potentially Occurring Threatened Species (10 species)

We also identify gaps in knowledge for the ecological values. Investigating the linkages and barriers to squirrel gliders within 1.5km of the study area, is suggested as an alternative to genetic migration studies requested by DEC. Clarification as to whether a recent gazetted endangered ecological community will apply to Dooralong Spotted Gum-Ironbark Forest is also recommended. With the exception these items, and information on threatened bat and owl trees (which has already been commissioned), we believe there is sufficient knowledge of ecological values for the site.

Principles, issues and key outcomes are proposed for the identified values. It is recommended that the key outcomes be discussed with DEC and suggested as a way forward. We envisage two subsequent stages to this report, a Conservation Strategy and a Management Plan, where these key outcomes are implemented.

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1. Introduction

1.1 Description of Project

Eco Logical Australia was engaged by Landcom to provide advice on ecological issues for a site in the suburb of Warnervale, within the Wyong Shire Council Local Government Area (LGA). The site is identified for construction of a new train station, and for rezoning to permit the future Warnervale Town Centre (Woods Bagot 2001). Landcom prepared the draft Warnervale Town Centre Masterplan, and will participate in aspects of the future development.

This report seeks to identify the ecological values, principles and issues for the proposed Warnervale Town Centre site, and to provide a framework for a way forward which will seek to integrate both the development and conservation objectives.

The approach taken in this study was to:

1. Review available information
2. Seek to identify any gaps or uncertainty in current knowledge
3. Consultation with Landcom, Wyong Shire Council, DEC, Railways, and the authors of the prior flora and fauna study
4. Identify Values, Principles and Issues for the site
5. Provide recommendations on the way forward

1.2 Background

A flora and fauna investigation study was commissioned by Wyong Shire Council (FFS & EFS 2004). This study investigated the proposed site for the Warnervale Town Centre, and additional lands to the south and north (Figure 2). This report identified a number of ecological values and an initial assessment of impacts concluded that the draft Warnervale Town Centre Masterplan would cause significant impacts for six threatened species (as defined through the 8-part test process), and would also result in the loss of a small area of an endangered ecological community, and larger areas of regionally and locally significant vegetation communities.

The Department of Environment and Conservation (DEC) reviewed the Warnervale Town Centre Masterplan and flora and fauna study (FFS & EFS 2004), and made comments through two letters to Wyong Shire Council.

In summary, the initial correspondence (DEC 2004a) commented that:

- Lot 1 DP 357408 owned by Department of Industry Planning and Natural Resources (DIPNR) considered to be of high ecological value, particularly due to the presence of a large population of the threatened daisy *Rutidosis heterogama*
- That the DIPNR land should be protected and managed for conservation purposes
- There were a number of areas of moderate ecological value, with a range of values such as regionally and locally significant vegetation. threatened owl and bat resources, squirrel glider habitat and individuals, and connectivity.

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- Areas of moderate ecological value should be protected and managed for conservation purposes, which could allow for residential development within confined footprints
- Lack of information on whether subject site contains Aboriginal sites or areas of significance

Wyong Shire Council and Landcom subsequently met with DEC on 12/10/2004. DEC subsequently provided additional comments (DEC 2004b). This letter reiterated that the site had high conservation values. DEC noted that funding to be spent in the 2004-2005 financial year had been provided for the railway station and bus interchange, and with the scope for moving these proposed developments being limited. However, they stated that "*The DEC is also concerned that the proposal to progress the development application for the railway station and bus interchange prior to resolution of the development footprint for the remainder of the site is premature and will result in a piecemeal and sub optimal conservation outcome*" (DEC 2004b).

The DEC emphasised that all efforts should be taken to avoid, minimise and ameliorate impacts first, with offsets (through an offset strategy) considered as a last resort where no feasible alternative exist to the destruction of threatened species values (DEC 2004b). The possibility for biodiversity certification (under proposed amendments to the *Threatened Species Conservation Act 1995*) or assumed concurrence was raised. It was stated, however, that DEC would require additional information for the assessment of conservation values across the site. The information requested by DEC is discussed in the analysis of knowledge gaps (section 0).

Whilst the flora and fauna investigation by Forest Fauna Surveys Pty Ltd and Eastcoast Flora Survey (FFS & EFS 2004), which was commissioned by Wyong Shire Council, identified ecological issues, DEC clearly has concerns with regards to the draft Warnervale Town Centre Masterplan. As identified in section 1.1, this report summarises the process and recommendations on a way forward to consider and address ecological issues on the subject site for the Warnervale town centre, including DEC's concerns.

1.3 Study Area

The proposed site for the Warnervale Town Centre is approximately 114 ha in size, and is located 4.5 km nor-northeast of Wyong, 8.5 km to the west of the coast, and 3 km to the west and northwest of Budgewoi and Tuggerah Lakes respectively (Figure 1). The main northern railway line passes through the western portion of the site, and is a major feature, with cuttings or embankments on both sides of the line. The site is within the Wyong Shire Council Local Government Area.

Slopes on the site are 20% or less, and with a maximum height of 58m ASL (Woods Bagot 2001). There is vegetation across 57.6 % of the study site. The land is privately owned, except for: railway lands (Rail Infrastructure Corporation), Lot 1 DP 357408 to the west of the railway (DIPNR), and a disused quarry off Hakone Road (Wyong Shire Council). The land use zonings under the Wyong Local Environment Plan (LEP) were

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amended on 2/12/2003, and are now either 5(b) Railway Reservation Zone, or 10(a) Investigation Precinct.

The site is not subject to flooding, with the 1:100 year flood level occurring 250m or more to the southeast and south of the study site (FFS & EFS 2004).

The current land use on the site is primarily rural activities, but with 5 lots in the southeast portion of the study area cleared in 2003 (see Figure 3). In the surrounding land there has been residential development to the southwest, but with most current surrounding landuse being rural or rural residential. Wyrrabalong National Park is the closest conservation reserve and occurs approximately 7.5km to the southeast of the study site.

Drainage from streams in the northern half of the site flows into Wallarah Creek, and in the southern half of the site runoff flows through various intermediaries and then into the Wyong River.

The study area for FFS & EFS (2004) and for this report are shown in Figure 2. Note that the term 'study area' as used in this report refers to the Warnervale Town Centre study area (bordered in black in Figure 2).

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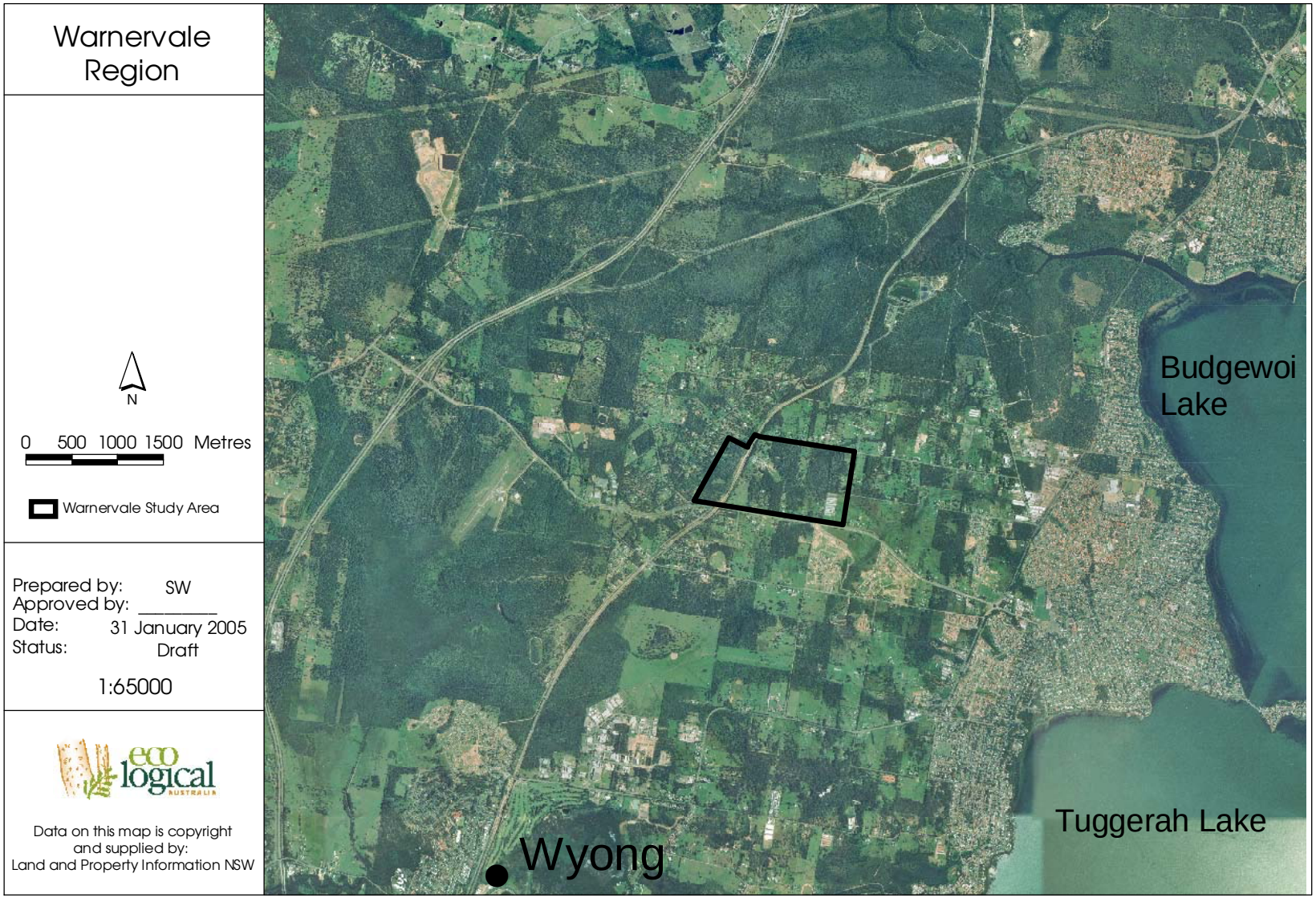

Figure 1. Regional context for the Warnervale Town Centre study area.

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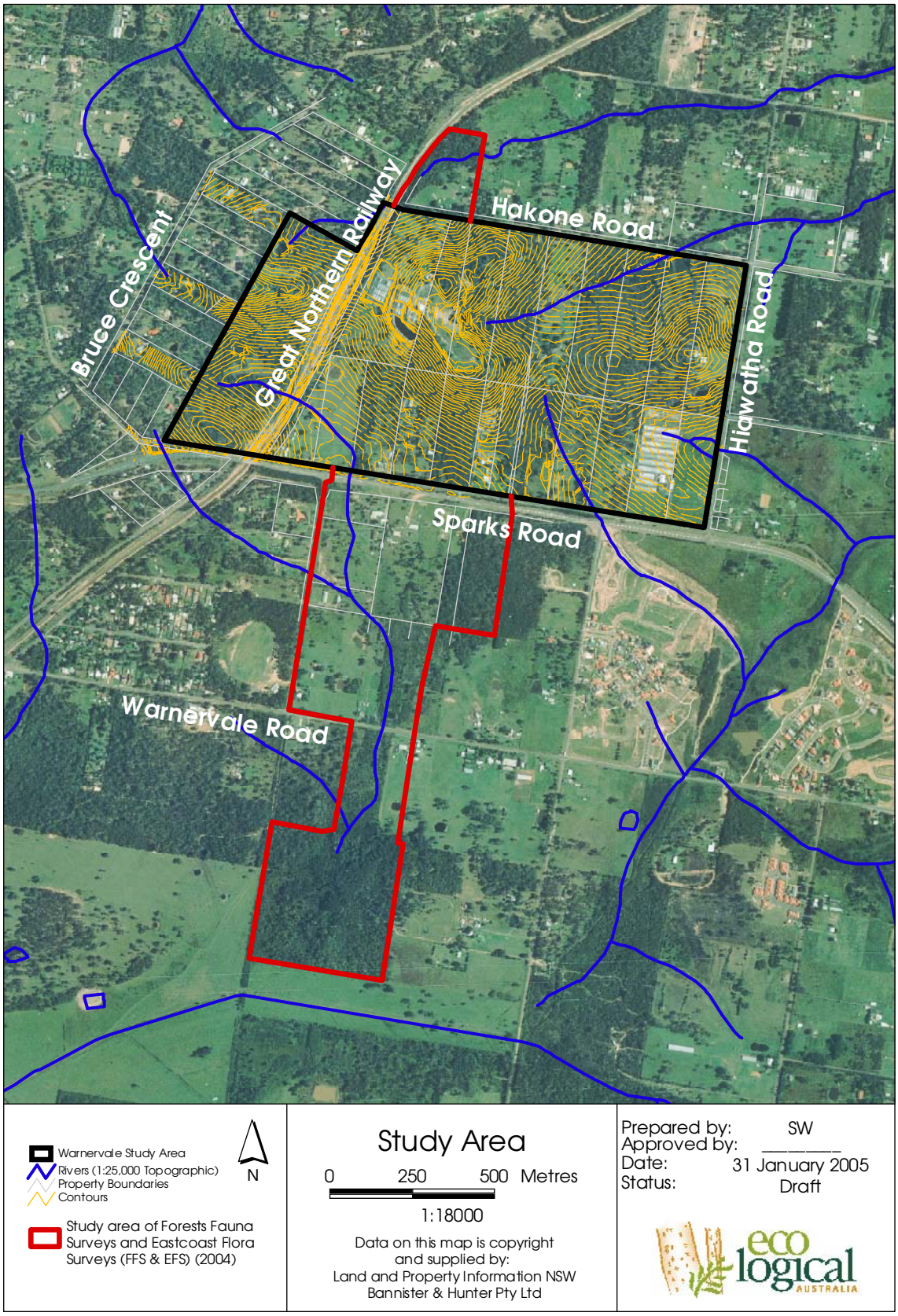

Figure 2. Warnervale Town Centre. Study area for this report is bordered in black. Study area for prior flora and fauna study (FFS & EFS 2004) is the regions bordered in both black and red.

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1.4 Legislative Requirements

1.4.1 Environment Protection and Biodiversity Conservation Act 1999

A number of species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) occur within the study area.

1.4.2 Threatened Species Conservation Act 1995

A number of species and one vegetation community listed under the *Threatened Species Conservation Act 1995* (TSC Act) occur within the study area.

1.4.3 Rivers and Foreshores Improvement Act 1948

The *Rivers and Foreshores Improvement Act 1948* (RFI Act) requires approval (a Part 3A permit), for any works within 40m of listed watercourses. Such watercourses occur within the study area and are shown in Figure 2.

1.4.4 Native Vegetation Conservation Act 1997

The *Native Vegetation Conservation Act 1997* (NVC Act) requires a permit, for any clearing greater than 1 ha in any one year, or clearing on State Protected Lands (20m from a watercourse or on slopes > 18°). Compliance with a Regional Vegetation Management Plan is required if a plan applies and has been gazetted, but no such plan applies to the study area.

The Native Vegetation Act 2003 will replace the NVC Act once the Draft Native Vegetation Regulation is enacted (this has not yet occurred). Even should the Native Vegetation Act apply, it is likely that a permit from the Department of Infrastructure, Planning and Natural Resources will be required.

1.4.5 Fisheries Management Act 1994

No species listed under the *Fisheries Management Act 1994* (FM Act) occur on the site, but policies generated under the FM Act requires that fish passage not be obstructed.

1.4.6 Rural Fires Act 1997

The *Rural Fires Act 1997* is enacted through the Planning for Bushfire Protection guidelines (NSW Rural Fire Service and Planning NSW 2001). These guidelines apply to the study and hence the requirements of the guidelines must be met and considered during the planning process.

1.4.7 Wyong LEP 1991

There are two zonings which apply to the study area. The 5(b) zoning aims to facilitate railway usage. The 10(a) Investigation Precinct zoning aims to prohibit premature or sporadic subdivision, or development likely to prejudice the present environmental quality of the land, and to protect native vegetation, maintain ecological processes and biological diversity within land that is under investigation for conservation purposes.

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1.4.8 Wyong DCP 14 – Tree Management

This DCP aims to: ensure that trees and native vegetation are considered during development, retain viable representation samples of native vegetation, retain healthy trees of local aesthetic and amenity value, and facilitate weed removal.

Under Wyong DCP 14 clearing vegetation on any land, except minor clearing in urban zones, is prohibited, without first obtaining a consent from Council. However, clearing works necessary to carry out an approved development, do not require additional consent.

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2. Methods

2.1 Literature Review

The background documents that were reviewed (author and short title) during the preparation of this document were:

- Bell (2002). The Natural vegetation of the Wyong Local Government Area.
- Bell and Driscoll (2004). *Rutidosis heterogama* study.
- DEC (2004a). Comments on Local Environment Plan (8/9/2004 Letter).
- DEC (2004b). Comments on Warnervale Town Centre Masterplan (26/10/2004 Letter).
- Ecotone Ecological Consultants (2004). Flora and Fauna Impact Assessment for proposed Rail Works.
- Ecotone Ecological Consultants (2005). Flora and Fauna Impact Assessment for proposed Transport interchange at North Warnervale.
- Fanning *et al.* (2003). Wyong Ground Orchid Survey.
- Forest Fauna Surveys Pty Ltd and Eastcoast Flora Survey (FFS & EFS) (2004). Draft Flora and fauna Investigations for Warnervale Town Centre.
- NSW Scientific Committee (2001). Final determination to list Sydney Coastal Estuary Swamp Forest Complex.
- NSW Scientific Committee (2004a). Final determination to list Swamp Sclerophyll Forest.
- NSW Scientific Committee (2004b). Preliminary determination to list Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion.
- Payne (2002). Wildlife Corridors Strategy – Field Evaluation
- Smith (2002a). Effects of Clearing and Fragmentation on the Squirrel Glider
- Smith (2002b). Squirrel Glider Conservation Management Plan.
- Smith and Murray (2002). Habitat requirements of Squirrel Glider.
- Smith *et al.* (2002). Fauna Habitat Modelling and Wildlife Linkages.
- Woods Bagot (2001). Warnervale District Planning Strategy. Joint Issues Paper.

Four documents, Bell and Driscoll (2004), Ecotone Ecological Consultants (2004 and 2005), and FFS & EFS (2004), were considered to have flora and fauna studies that directly targeted the site, and are reviewed in section 3. The other documents listed were inspected and are referred to in this document where relevant.

2.2 Derivation of Values

The values for the site were derived through the literature review, with particular attention to the directly relevant flora and fauna studies reviewed in section 4. This process identified vegetation, flora and fauna values. Landscape values are considered to be the value of the study area in a broader context, for example in providing linkages between important areas of habitat found outside of the study

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area. These values were identified though the inspection of regional studies and aerial photography. Gaps in knowledge of values were also identified.

Data layers used in the maps were provided by Stephen Bell (Eastcoast Flora Survey), Michael Murray (Forest Fauna Surveys Pty Ltd), Wyong Shire Council, and Rail Corporation New South Wales (work performed by Ecotone Ecological Consultants and Bannister & Hunter).

2.3 Derivation of Principles, Issues, Key Outcomes

Principles are considered to be broad assumptions that guide decision making processes for each identified ecological value. Issues are the main potential barriers to implementing the principles for each ecological value whilst achieving the Warnervale Town Centre development. Key Outcomes are the recommendations on a way forward to clarify and/or progress potential conflicts between the identified issues. The 'Key Outcomes' aim to provide sufficient information and prioritisation of values to facilitate the integration of ecological values with the revised Warnervale Town Centre Masterplan.

It is acknowledged that not all ecological principles and/or development goals will be able to be met on the site. The identification of the values, principles, issues and key outcomes aims to clarify the ecological values and needs of the regions within the site.

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3. Literature Review

This section presents key points for the background, findings and recommendations, from a review of four documents directly relevant to the Warnervale study area. Two of these documents are for works associated with the rail upgrade, occurred on adjacent study areas with very similar findings, and hence are reviewed together (Ecotone Ecological Consultants 2004, 2005). Knowledge gaps are covered in section 4.4.

3.1 Forest Fauna Surveys Pty Ltd and Eastcoast Flora Survey (FFS & EFS) (2004)

- Draft Flora and Fauna report on Warnervale Town Centre Masterplan, commissioned by Wyong Shire Council, which sought to identify any actual or potential constraints to development of the Warnervale Town Centre
- Six threatened species were considered to be significantly impacted by the original masterplan under the EPBC Act and/or TSC Act:
    - *Rutidosis heterogama*
    - Masked Owl
    - Powerful Owl
    - Squirrel Glider
    - Eastern Freetail Bat
    - Greater Broad-nosed Bat

3.2 Bell and Driscoll (2004)

- Regional study of *Rutidosis heterogama*
- Additional surveys in Wyong LGA are recommended, although reason is unclear
- Authors suggest that loss of any plants means a significant impact and hence an SIS is required
- Research on genetics / biology of the daisy is recommended.

3.3 Ecotone Ecological Consultants (2004 and 2005)

- Two flora and fauna impact assessments: for proposed rail works (Ecotone Ecological Consultants 2004) and for proposed transport interchange (Ecotone Ecological Consultants 2005)
- Performed survey of extent of *Rutidosis heterogama* within report's study area. Flagged extent of plants observed which were then surveyed by Bannister & Hunter.
- Two species additional to those as moderate or greater in FFS & EFS (2004), listed as 'moderate' likelihood of occurrence or as a potential subject species for the study areas:
    - *Grevillea parviflora* subsp. *parviflora*
    - Eastern false pipistrelle
- The presence on-site of some tree species listed as keystone species or of local conservation significance under Wyong DCP 14 – Tree Management.

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- Recommendations include:
  - Conservation of land between the railway corridor, Bruce Crescent, Sparks Road, and as far north as the population of *Rutidosis heterogama* extends be set aside for conservation purposes
  - Vegetation Management Plan for the site be prepared
  - Management of runoff
  - Consideration an alternatives to Harkone Road for construction access, with the proviso that this does not disturb *Rutidosis heterogama* habitat

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4. Ecological Values

This section identifies the ecological values for the Warnervale Study Area. It is split into five headings, with the headings utilised again in section 5 and 6 for continuity. The headings are described briefly below:

- Vegetation communities – Vegetation on the study site
- Flora – Plant species listed under the TSC Act, EPBC Act, or as a Rare or Threatened Australian Plant
- Fauna - Animal species listed as threatened under the TSC Act or EPBC Act
- Connectivity – Connectivity within and outside the study site for other ecological values
- Facilitating Ecological Outcomes – Processes which will facilitate ecological outcomes.

4.1 Vegetation Communities

Vegetation communities were identified and mapped by FFS & EFS (2004). The distribution of these communities across the study area is shown in Figure 3, and details are summarised in Table 1.

Table 1. Summary table for vegetation within study area. Conservation targets are from Bell (2002).

No.[1]	Name	Vegetation Community Value	Conservation Target	Area (ha)		
				Disturbed[2]	Other	Total (% site)
14	Freshwater Wetlands (old farm dams)	Unknown	-	-	0.49	0.49 (0.4%)
20	Alluvial Floodplain Shrub Swamp Forest	Endangered Ecological Community (EEC)	100%	-	0.09	0.09 (0.08%)
27	Narrabeen Coastal Blackbutt Shrubby Forest	Regionally and Locally Significant	100%	0.22	6.68	6.90 (5.8%)
28	Narrabeen Buttonderry Footslopes Forest	Locally Significant	90%	16.7	8.74	25.44 (21.3%)
30	Dooralong Spotted Gum-Ironbark Forest [3]	Locally Significant, Preliminary EEC listing	Unknown	1.62	11.11	12.73 (10.7%)
Xr	Unspecified regrowth	Unknown	-	21.06	-	21.06 (17.6%)
Xs	Unspecified– canopy only	Unknown	-	1.99	-	1.99 (1.7%)
-	Unmapped (cleared or scattered trees only)	Low	-	50.6	-	50.60 (42.4%)
		Total		92.19	27.11	119.30 (100%)

1 = Map unit number from FFS & EFS (2004).
2 = The communities mapped as disturbed subcommunities as indicated by a label of Xr, Xs or Xx after community name.
3 = Listed as "Local Significance" in FFS & EFS (2004).

Cleared or scattered trees occupies 50.6 ha, or 42.4%, of the study area. A total of 68.6 ha of vegetation remains (including wetlands), and of this, 41.59 ha or 60.6 %, were mapped as disturbed (Table 1).

Only a small area (0.09 ha) of an endangered ecological community is present. This community was mapped by FFS & EFS (2004) as Alluvial Floodplain Shrub Swamp Forest, and was noted as being consistent with the endangered ecological community Sydney Coastal Swamp Forest Complex. The listing for this community

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has since changed to Swamp Sclerophyll Forest (NSW Scientific Committee 2004a). This area is isolated and in poor condition, and the 8-part test performed (FFS & EFS 2004) found that the loss of this area would not be a significant impact.

Three vegetation communities that occur in the study area were proposed as being locally or regionally significant in Bell (2002), which was prepared as part of the Wyong Conservation Strategy. The regionally significant community, Narrabeen Coastal Blackbutt Shrubby Forest, was assigned a 100% conservation target. The Narrabeen Buttonderry Footslopes Forest a 90% conservation target.

The Dooralong Spotted Gum-Ironbark Forest was identified as being significant in previous investigations and FFS & EFS (2004) due to high fauna and aesthetic values, but no conservation target is supplied in Bell (2002). This community may meet the Scientific Committee definition of Lower Hunter Spotted Gum – Ironbark Forest, which has recently been listed as an endangered ecological community (NSW Scientific Committee 2004b). Unpublished data collected and analysed by Stephen Bell (pers. comm. 28/1/05) suggests that Dooralong Spotted Gum-Ironbark Forest in the Warnervale region is a distinct subgroup of this community, although further work would be required to confirm this. Thus, the conservation value of this community is not currently clear, and may merit a higher ranking than local conservation significance.

Three vegetation types are not listed as endangered ecological communities, regionally or locally significant: unspecified regrowth (Xr), unspecified canopy-only (Xs), and freshwater wetlands (14). However, these communities may have some value for fauna. For example. the freshwater wetlands community occurs in a total of five dams within the study area (Figure 3), and could potentially be habitat for two threatened fauna species, the green and golden bell frog and the Australasian Bittern (see Table 4).

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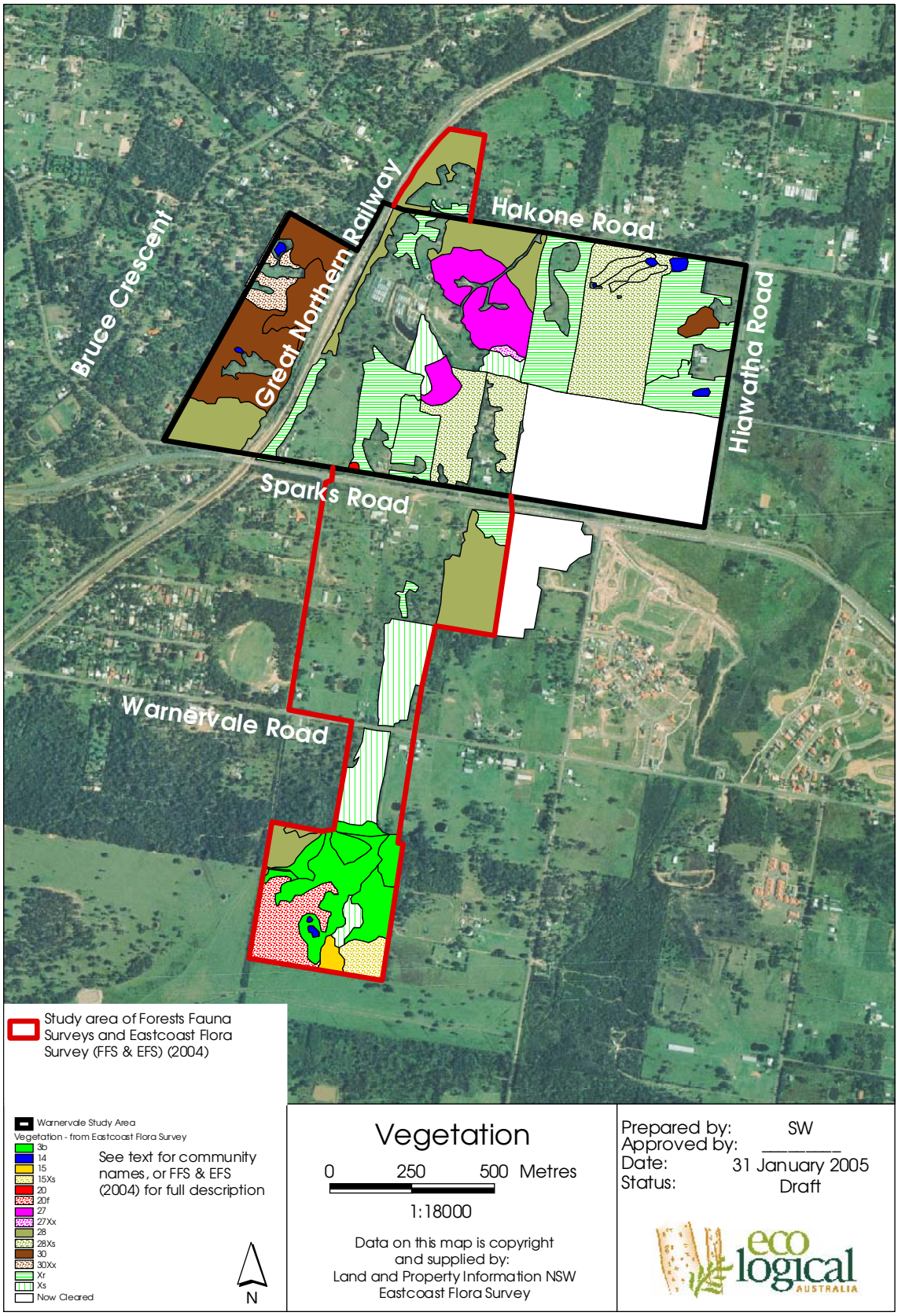

Figure 3. Vegetation for study area from FFS & EFS (2004). Note that the numbers in Table 1 refer to vegetation within the study area, as marked with the thick black line.

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4.2 Flora

The occurrence of known and potential threatened flora species was considered in FFS & EFS (2004). Threatened species which had a moderate or greater likelihood of occurrence are listed in Table 2.

Table 2. Summary table for threatened flora rated as a moderate or higher likelihood of occurrence in FFS & EFS (2004).

Common Name	Scientific Name	Likely	TSC Listing	EPBC Listing	Habitat †	Notes	Recovery Plan **
Daisy	*Rutidosis heterogama*	Recorded	V	V	Variety of habitats, but known to occur in the west of the Warnervale Town Centre study area	Very high conservation significance	No
Black-eyed Susan	*Tetratheca juncea*	Moderate	V	V	28	Plant clumps are known from other locations in Warnervale, and potentially could occur in the study area (FFS & EFS 2004). If present it is likely numbers would be low (Bell pers. comm.)	No
Paperbark	*Melaleuca biconvexa*	Moderate (south of site)	V	V	Swamp communities	Not known to occur in Warnervale Town Centre study area.	No
Cycad	*Macrozamia flexuosa*	Recorded	None, but ROTAP: 2K	-	28, and other communities	Two specimens located south of Hakone Road, immediately north of Mary Mackillop College	n/a
-	*Grevillea parviflora* subsp. *parviflora* *	Low - Moderate	V	V	28, sedgeland	A number of records in close proximity to the study site (within 2km). Low likelihood of occurrence in study area (Bell pers. comm.)	No

TSC = NSW *Threatened Species Conservation Act 1995*
EPBC = Federal *Environment Protection and Biodiversity Conservation Act 1999*
V = Vulnerable
ROTAP: 2K = Rare or Threatened Australian Plant, conservation risk code 2K, poorly known species with a distributional range of less than 100 kilometres
* This species was not listed in FFS & EFS (2004), but was listed in Ecotone Ecological Consultants (2004 and 2005), but was not assessed as a "subject species".
** = Status of recovery plan for Sydney or northern NSW regions as listed in NPWS (2003)
† = Numbers relate to vegetation communities as described in FFS & EFS (2004), and listed in Table 1

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FFS & EFS (2004) lists some orchids listed in Table 6, which shows flowering periods, but these species are not considered as potentially occurring in Table 26. Ecotone Ecological Consultants (2004, 2005) reviewed records and potential of occurrence for plant species, with no orchids listed as more than low likelihood of occurrence, although those reports covered only lands in the vicinity of the railway. The Wyong orchid survey (Fanning *et al.* 2003), does not appear to indicate any potential orchid habitat for orchid species listed under the TSC Act within the Warnervale Town Centre study area. It is thus assumed that threatened orchid species are unlikely to occur.

The identified population of the daisy, *Rutidosis heterogama*, was considered to be of high value (Bell and Driscoll 2004, Ecotone Ecological Consultants 2004 and 2005). Bell and Driscoll (2004) mapped the extent of observed specimens of the daisy, which was later checked and revised by Ecotone Ecological Consultants (2004 and 2005), except for a small patch to the southwest of the Warnervale Town Centre study area. This patch was on an embankment of Sparks Road, with <5 individuals observed (Bell pers. comm.). This daisy can appear in different locations in different years, but the variation is over a distance of <1m (Bell pers. comm.).

A regional study for this species was conducted (Bell and Driscoll 2004), and some key findings were:

- 13 known populations in Lower Hunter and Central Coast region (12 populations found only recently
- Up to 30,000 plants in Lower Hunter and Central Coast region
- Estimated ~2,000 plants in Wyong LGA
- Wyong LGA populations are disjunct from others and at limit of known range, therefore considered to be highly significant
- Few populations in conservations reserves
- Seeds disperse short distances (likely <10m)
- Seeds likely to survive <4 months in seed bank
- Self-incompatible for seeding
- Thus, need large populations for populations to persist
- Translocations with closely related plant species from different populations (to increase chance of cross-pollination) have resulted in genetic abnormalities due to loss of locally adapted genetics
- Suggests that species listing should perhaps be upgraded from vulnerable to endangered

4.3 Fauna

The occurrence of known and potential threatened fauna species was considered in FFS & EFS (2004). Different terminology for vegetation communities was used for the description of fauna habitat. The relationship between these descriptions is summarized in Table 3. Details for threatened species which were considered by FFS & EFS (2004) to have a moderate or greater likelihood of occurrence are summarised in Table 4.

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Table 3. Relationship between fauna vegetation terminology and mapped vegetation communities in FFS & EFS (2004).

Fauna Vegetation Term	Vegetation No.	Vegetation Name	On-site *
Dams	14	Freshwater Wetlands (old farm dams)	Yes
Swamp Forest	3b	Estuarine Swamp Oak Forest	No
	20	Alluvial Floodplain Shrub Swamp Forest	Yes
Low Swamp Woodland	20	Alluvial Floodplain Shrub Swamp Forest	Yes
Open Forest (Blackbutt Angophora Open Forest)	27	Narrabeen Coastal Blackbutt Shrubby Forest	Yes
Open Forest (Smooth-baked Apple Red Bloodwood Forest)	28	Narrabeen Buttonderry Footslopes Forest	Yes
Open Woodland (Smooth-baked Apple Woodland)	28	Narrabeen Buttonderry Footslopes Forest	Yes
Open Forest (Spotted Gum Ironbark Open Forest)	30	Dooralong Spotted Gum-Ironbark Forest	Yes
Open Grassland	-	Cleared areas	Yes
None	15b	Alluvial Redgum Footslopes Forest	No
	Xr	Unspecified regrowth	Yes
	Xs	Unspecified canopy-only	Yes

* = On-site refers to whether the mapped vegetation community occurs within this report's study area.

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Table 4. Summary table for threatened fauna rated as a moderate or higher likelihood of occurrence in FFS & EFS (2004).

Common Name	Scientific Name	Likely	TSC Listing	EPBC Listing	Vegetation Community No's*	Recovery Plan **	Habitat
Green and Golden Bell Frog	*Litoria aurea*	Moderate	V	V	14, Creeklines	In prep.	Small dams / aquatic habitat (where mosquito fish are absent)
Wallum Froglet	*Crinia tinnula*	Recorded	V	-	Southwest Creekline	No	Acid water conditions (pH <6.0), particularly acid paperbark swamps.
Australasian Bittern	*Botaurus poiciloptilus*	Moderate, species cryptic	V	-	14	No	Densely vegetated dams. Unlikely to occur in Warnervale Town Centre given small size of dams.
Glossy Black Cockatoo	*Calyptorhynchus lathami*	Moderate	V	-	Unclear	No	Allocasuarina and Casuarina trees key foraging resource, but extensive areas occur in the west of the Wyong Shire
Masked Owl	*Tyto novaehollandiae*	High	V	-	All, particularly 27, 28, 30	In prep.	Foraging habitat - areas with small terrestrial mammals and birds. Nest trees - large hollows in Forests
Powerful Owl	*Ninox strenua*	Recorded	V	-	All, particularly 27, 28, 30	In prep.	Foraging habitat – areas with small to medium terrestrial mammals and birds. Nest trees – large hollow in high tree.
Eastern Bent-wing Bat	*Miniopterus schreibersii*	High	V	-	27, 28, 30	No	Foraging habitat - open forest /woodland and open spaces adjoining remnant forest. Roosting – caves, culverts
Eastern False Pipistrelle †	*Falsistrellus tasmaniensis*	Moderate	V	-	All, particularly 27, 28, 30	In prep.	Foraging habitat – variety of vegetated habitats Roosting – hollows
Eastern Freetail Bat	*Mormopterus norfolcensis*	High	V	-	20, 27, 28, 30 (particularly 30)	No	Foraging – open forest and woodland. Roosting – large mature trees with hollows
Large-footed Myotis	*Myotis adversus*	Moderate - High	V	-	20, 27, 28, 30	No	Foraging habitat – open water (streams, dams, lakes). Roosting – caves, mines, tunnels, bridges, buildings, dense foliage, tree hollows
Little Bent-wing Bat	*Miniopterus australis*	High	V	-	27, 28, 30	No	Foraging habitat - open forest /woodland and open spaces adjoining remnant forest. Roosting – caves, culverts
Greater Broad-nosed Bat	*Scoteanax rueppellii*	High	V	-	27, 28, 30	In prep.	Foraging habitat - open forest and woodland. Roosting – trees with hollows, roof cavities
Grey-headed Flying-fox	*Pteropus poliocephalus*	High	V	V	20, 27, 28, 30	No	Foraging habitat - blossoms of eucalypts, angophoras, figs, palms, etc.
Koala	*Phascolarctos cinereus*	Recorded	V	-	Small patch just north of Sparks Road, 20 ††	Draft	Woodland / forest with koala food trees. The presence of food trees is not clearly described, but primary food trees do occur in community 28 and a small patch north of Sparks Road
Squirrel Glider	*Petaurus norfolcensis*	Recorded	V	-	Optimal - 30 Moderate – 27††, 28 Unsuitable – 20, Xr†† Unknown – Xs	No	Foraging habitat – certain eucalypts, banksias and wattles for foraging Nest trees – large hollows

* = Numbers relate to vegetation communities as described in FFS & EFS (2004), and listed in Table 1
** = Status of recovery plan for Sydney or northern NSW regions as listed in NPWS (2003)
† = This species was not listed in FFS & EFS (2004), but was listed in Ecotone Ecological Consultants (2004 and 2005) as a "subject species".
†† = No association with these vegetation communities is specifically stated in FFS & EFS (2004), hence the association is a likely relationship based on interpretation of the description of the community and the species habitat preferences.
TSC = NSW *Threatened Species Conservation Act 1995,* EPBC = Federal *Environment Protection and Biodiversity Conservation Act 1999* V = Vulnerable

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4.4 Connectivity

Connectivity of habitat is important to most flora and fauna species, yet development often leads to fragmentation of habitat. Corridors to mitigate this fragmentation are now being incorporated into planning processes in many areas.

A number of studies have considered corridor connections within the Wyong Shire. Smith *et al.* (2002) described a six stage procedure for the selection and design of corridors within the Wyong Shire, with stages one to three implemented using the squirrel glider as an indicator species. Payne (2002) further advanced this work, and ground-truthed many of the proposed corridors, with recommendations based on this work. However, steps five and six recommended by Smith *et al.* (2002), selection of preferred corridors, and corridor protection and management, respectively, do not appear to have yet been implemented. It is also unknown if indicator species and targets for corridor design other than the squirrel glider were selected.

Payne (2002) shows a roughly north-south corridor through the Warnervale Town Centre study area which was classed as investigated but not favoured due to ecological & development constraints. A sub-regional corridor and a broad regional wildlife pathway were, however, identified approximately 0.75km to the west of Bruce Crescent (running roughly north south), and approximately 1.2km to the north of Hakone Road (running east–west direction), respectively (Payne 2002). Payne (2002) also noted that 60% of corridors will require "embellishment" through replanting and restoration, and major changes to road design for 32% of sites, including culverts for fauna movements.

There have also been recommendations for corridors within, or related to, the Warnervale Town Centre study area:

- Two "secondary vegetation corridors" were recommended in Payne and Murray (2001): one running north-south through the centre of the site, and the other approximately following the stream in the central north region of the study area, running to the east / northeast,
- Woods Bagot (2001) identified and mapped a number of vegetation corridors for Warnervale which were 20 to 40 metres in width, following drainage lines. This recommendation was envisioned as providing limited wildlife corridor functions, but also for recreation and aesthetic appeal.
- Payne (2002) recommended a "*secondary corridor of at least 100m width*" to "*circumnavigate Warnervale City*" and link fauna reserves at Porters Creek Wetland and the future Bushells Ridge Conservation Area. The proposed location is shown in Figure 3 of Payne & Murray (2001).
- FFS & EFS (2004) considered that *"a functional wildlife corridor was not a viable option through the Warnervale District area"* and recommended the incorporation of "passive corridors" into the design of the Town Centre to retain important remnants of native vegetation.

Previous studies are thus not unanimous, with some concluding that connectivity within or beyond the study area was desirable, and others concluding that corridors of various types were not practical for the study area given the future development of the Warnervale Town Centre.

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Given the uncertainty of the value of connectivity within, or beyond, the study area Eco Logical Australia reviewed the vegetation, flora and fauna values for the site, as summarised in sections 4.1, 4.2, and 4.3 of this report, and considered which ecological values we believe to be a priority for connectivity either within, or beyond the site, based on the characteristics of the various species and communities.

Based on this review, the ecological values of priority for connectivity were:

- Squirrel glider – connect to larger populations (or areas of habitat) outside of the study site
- Daisy (*Rutidosis heterogama*) – connections between mapped populations within the study area
- Wallum Froglet – connect known population on site to other populations outside of the study site (along watercourse).
- Riparian corridors for broader flora and fauna connectivity

It is noted that if we achieve the connectivity priorities suggested above, connectivity for many other species occurring on the site would occur. There is the potential that vegetation linkages to the west of the study site, as suggested by Payne (2002), could be supported in some fashion as an offset.

4.5 Facilitating Ecological Outcomes

4.5.1 Integration of Outcomes

Although this is not a value, it is a key process in achieving practical landscape outcomes. Implementation requires the recognition of the importance of this process, and consideration in many aspects of planning and design. Hence, though not a true ecological value, it is discussed in this context to facilitate the way forward.

It is increasingly recognised that effective retention and management ecological values requires integration with other required outcomes. For example, the primary purpose of bushfire asset protection zones is for the protection of human life and property. Whilst some asset protection zones can have ecological value, some values, such as, for example a highly flammable understorey species, may not be compatible with bushfire control measures. Identifying both the ecological and other outcomes required and integrating them, will eliminate or reduce conflict between differing purposes.

Areas of note for the Warnervale Town Centre where integrating outcomes should be a priority are:

- Locations of buildings and other services (transport, sewerlines, etc.)
- Bushfire
- Stormwater management
- Sediment control
- Outdoor recreation facilities

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4.5.2 Offsetting

As for integration of outcomes (section 4.5.1), this is not a value, but is a key process in achieving practical landscape outcomes, and is discussed to facilitate the way forward.

Revision of the masterplan will provide opportunity for negotiation and integration of ecological recommendations from this study. It is, however, recognised that that through a negotiated process a number of objectives may not be met, including ecological objectives. Where unavoidable loss of ecological values is likely to occur the Warnervale Town Centre project's contribution to sustainable biodiversity outcomes may need to be achieved through offsetting those values.

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5. Ecological Values Knowledge Gaps

Some potential gaps in knowledge have been raised during the review of the values (section 4). This section reviews the survey effort of FFS & EFS (2004), together with previous comments, to identify knowledge gaps. Knowledge gaps are summarised after the review of survey effort and DEC's questions, under the same headings as used for ecological values.

5.1 FFS & EFS (2004) Study Survey Effort

The FFS & EFS (2004) study's techniques and effort are summarized in Table 5. The effort expended was compared against the DLWC (1999) guidelines.

Stratification of survey effort to cover the range of habitats available is a critical step during the design of a field sampling program. The DLWC (1999) guidelines provide guidance on effort required, for various sizes of one stratification unit. Thus, a small area of a stratification unit will require less effort than a large area of a stratification unit.

Table 5. Summary of Survey Effort as from FFS & EFS (2004) with modifications.

Group	Subgroup	No. Sites	Survey Method	Total Survey Effort	Adequacy *
Flora	Targeted	-	Random Meander, targeted orchid / cryptic species survey	14 days between Aug 2003 – Feb 2004	Yes
	Plots	18	0.04ha quadrats	18 quadrats, Nov – Dec 2003	Yes
Amphibians	-	6 dams	30min Nocturnal searches of specific habitats (dams, creek lines)	2.5 hours	No. Weather conditions unknown. Results unclear.
Birds	Diurnal	?	20 minute morning or evening census. Owl pellet search	Unknown	Unknown
	Nocturnal	?	Stag watching & call playback	Unknown	Unknown
Mammals	Bats	5	2 Harp trap nights per site	10 harp trap nights	No
			2 all night Anabat recordings per site x 2 sample periods	20 Anabat nights	No
	Small	5	25 Elliott A traps / night for 3 nights	375 trap nights	No
	Larger	4	2 Cage traps / site for 3 nights	24 trap nights	No
	Arboreal	4	10 Elliott B (arboreal) traps / site for 3 nights	120 trap nights	n/a
		5	30mins Spotlight Search per site (Oct, Nov)	6.0 hours	No
Reptiles	-	5	1 hr Diurnal searches per site	5 hours	Yes, if conducted on 2 separate days

* = Adequacy was compared to DLWC (1999) interim guidelines.

From our review of the FFS & EFS (2004) study we made the following conclusions, although it should be noted that this is a draft document:

- Flora survey generally comprehensive
- Regrowth and "canopy only" areas on site do not appeared to have been sampled for fauna (see Table 3).

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- Although amphibian survey effort does not meet the DLWC (1999) guidelines for survey effort, the amount of survey is probably reasonable for the size of the site.
- Although mammal survey effort does not meet the DLWC (1999) guidelines for survey effort, the amount of survey is probably reasonable for the size of the site.
- Reptile survey appears to be reasonable.

5.2 Information Requested by DEC

DEC (2004b) requested additional information for the assessment of conservation values across the site, with the following investigations listed, and noted to be considered as *"highest in priority"* (DEC 2004b):

- *"surveys to clarify the exact location and size of the* Rutidosis heterogama *population on the site;*
- *population studies establishing movement patterns across the site between sub-populations of Squirrel Gliders, (or alternatively, genetic studies that show patterns of gene flow between sub-populations); and*
- *mapping of habitat trees across the site, including identification of any Powerful Owl (and Masked Owl) nest trees, and Powerful Owl, Masked Owl and threatened bat roost trees."*

Two surveys are of relevance to the questions raised for the daisy, *Rutidosis heterogama*: a regional survey, population count and assessment by Bell and Driscoll (2004), and a survey of the extent of individuals by Ecotone Ecological Consultants (2004).

Bell and Driscoll (2004) found a total of 13 *Rutidosis heterogama* populations in their study, 12 of which were previously unknown. Three populations occurred in the Wyong Shire, of which one (W1) occurred within the Warnervale Town Centre study area. This "population" was not continuous, but appeared to occur in approximately 4 subgroups, and was estimated through a distance sampling methodology to consist of 900 plants (Bell & Driscoll 2004). The two other Wyong Shire populations, W2 and W3, consisted of 300 and 600 individuals respectively, with both to the east of the Warnervale Town Centre study area, and 2km or more from population W1. All 3 populations were considered to be highly significant, but development pressures were noted for populations W2 and W3 (Bell and Driscoll 2004).

Ecotone Ecological Consultants (2004) conducted an intensive search within their study area in October of 2004, whilst the daisy was flowering. No population assessment was performed in this study. A small additional group to those mapped by Ecotone Ecological Consultants, occurs to the southwest, outside of the Warnervale study area (Bell & Driscoll 2004).

Squirrel glider population studies have not been conducted in the Warnervale Town Centre study area. However, studies on this species have been conducted for the Wyong Shire (Smith 2002a, b, Smith & Murray 2002).

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The squirrel glider population is more abundant in the Wyong Shire than elsewhere in NSW, and is a large population (~5000), and is considered to be of State and National significance (Smith 2002b). The density averages 0.46 animals per ha, but varies from 0 to 1.9 depending on habitat quality. Squirrel glider density was found to be positively related to den tree density, although foraging resources (including understorey) are also important (Smith 2002b). Habitat clearing and fragmentation are threats to squirrel gliders, particularly when a gap is too large to permit movement between trees by gliding. Whilst the distance that can be covered by gliding is a maximum in the order of 30-50m, gliders can move on the ground, although this has a high level of risk (roadkill, predation, etc). Smith (2002b) considered habitat fragments separated by more than 75m as having a high probability of being isolated.

Smith (2002b) also considered the question of minimum viable population size for squirrel glider populations in the Wyong Shire, and from modelling concluded that remnants with an effective habitat area of >250 ha (or >90 individuals), should have close to a 100% probability of surviving over the short term (40-60 years). This conclusion was then used to assist in setting "thresholds", relating to management intervention, of 20 and 100 ha patches of effective squirrel glider habitat. That is, it was considered that an isolated area less than the lower threshold (20 ha) would require intensive & impractical levels of management, and areas greater than the upper threshold (100 ha) would be likely to not require management intervention. Patches between 20 and 100ha were noted as "*should be considered viable over the short term with an appropriate level of management intervention*" (Smith 2002b). Although details are difficult to discern due to the large-scale nature of mapping in Smith (2002b), four patches of squirrel glider habitat between 20 and 100 ha appear to have been mapped within the Warnervale Town Centre study area.

No studies on movement patterns, or genetic studies on gene flow between sub-populations of squirrel gliders have been performed on the study site. Whilst such research may technically be possible, it would likely be both costly and take a lengthy period of time. Moreover, limitations to squirrel glider movement (ie. breaks between canopy trees) are known. Hence, it is unlikely that these studies would provide information vital to an assessment of impact, or in a consideration of options which could be employed to reduce the impact upon squirrel gliders.

At this stage mapping of Powerful Owl, Masked Owl and threatened bat nest or roost trees has not occurred, but will be undertaken in the near future by Forest Fauna Surveys Pty Ltd.

5.3 Vegetation Communities Knowledge Gaps

- Whether the Dooralong Spotted Gum-Ironbark Forest qualifies as Lower Hunter Spotted Gum – Ironbark Forest endangered ecological community (NSW Scientific Committee 2004b).

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5.4 Flora Knowledge Gaps

- Daisy *(Rutidosis heterogama)* – number of individuals required in a population for long-term conservation security

5.5 Fauna Knowledge Gaps

- Squirrel glider – value of canopy only areas (Xs) is unknown
- Glossy black cockatoo – location of potential habitat unclear
- Green and golden bell frog – amount and location of potential habitat is unknown
- Threatened owl and bat nest or roost trees are currently an unknown, but will be clarified soon by Forest Fauna Surveys

5.6 Connectivity Knowledge Gaps

- Potential linkages for squirrel gliders to habitat outside of the study area is currently unknown. We suggest the information requested by DEC is not required, but that investigation of habitat for potential linkages within 1.5km of the study area is warranted. Such investigations could also include looking at barriers to movement, as works to improve linkages could be an offset for the project

5.7 Facilitating Ecological Outcomes Knowledge Gaps

- Offsetting (to be examined in stage 2)
    - What will need to be offset
    - Method to achieve offsetting (eg. improvement of conservation security, improvement of connectivity, or other)
    - How much offset will be required
    - Where offsets will be located (ie. sites available)

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6. Principles, Issues, Key Outcomes

This section seeks to identify the principles, issues and key outcomes, as described in section 2.3, for the identified values (or group of values with similar requirements) from section 4. Values addressed are:

- Vegetation
  - EEC
  - Regionally Significant
  - Locally Significant
- Flora species
  - Daisy (*Rutidosis heterogama*) - as original proposal assessed as having a significant impact by FFS & EFS (2004)
  - Other Flora Species (*Tetratheca juncea* and the cycad *Macrozamia flexuosa*)
- Fauna species
  - Squirrel Glider
  - Bat Species (Eastern Freetail Bat, Greater Broad-nosed Bat
  - Owl Species (Masked Owl, Powerful Owl)
  - Wallum Froglet
  - Potentially Occurring Threatened Fauna – koala included in this group as FFS & EFS (2004) suggests few preferred tree species are present.
- Connectivity
- Facilitating Ecological Outcomes
  - Integration of Outcomes
  - Offsetting

6.1 Vegetation

6.1.1 EEC - Sydney Coastal Estuary Swamp Complex

Principles:

- Protect and enhance where possible
- Ownership and management

Issues:

- Significance of the occurrence as it is small and isolated
- Maintenance of water quality and hydrological behaviour with upstream development
- Likelihood of recreating the EEC/enhancing given site conditions.
- Potential habitat for threatened species

Key Outcomes:

- Integrate into other ecological outcomes, such as connectivity (eg. riparian corridor)
- Locate stormwater controls outside EEC if possible to protect it and downstream values
- Enhance where possible
- Consider offsetting any loss

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6.1.2 Vegetation Value: Regionally Significant - Narrabeen Coastal Blackbutt Shrubby Forest (unit 27)

Principles:

- Protect and enhance regionally significant vegetation
- 100% conservation target in DRAFT Wyong Conservation Strategy
- Define a manageable boundary
- Seek to minimise edge effects (impacts)
- Provide certainty of protection and management into the future

Issues:

- No statutory backing for significance (assumed classification and targets have a sound basis)
- Meeting ecological, visual, recreational & other goals
- Integrating bushfire requirements
- Identify appropriate future ownership / management

Key Outcomes:

- Protect regionally significant vegetation
- Integrate into other ecological outcomes of connectivity, habitat provision etc (i.e. this vegetation to provide multiple ecological outcomes).
- Enhance where possible
- Design for the long term management
- APZs used to protect significant vegetation and provide for other design outcomes, such as recreation
- Design an appropriate buffer where APZs are not required
- Consider offsetting loss, if any

6.1.3 Locally Significant Vegetation Communities

- Narrabeen Buttonderry Footslopes Forest (unit 28)
- Dooralong Spotted Gum-Ironbark Forest (unit 30)

Principles:

- Protect and enhance where possible
- Lower order priority than regionally significant
    - An endangered ecological community listing may apply to the Dooralong Spotted Gum-Ironbark Forest (unit 30), so may merit a higher ranking
- Integrate into plan and design
- Identified as an 90% conservation target in DRAFT Wyong Conservation Strategy

Issues:

- No statutory backing for significance (assumed classification and targets have a sound basis)
- Preliminary EEC listing for Dooralong Spotted Gum-Ironbark Forest (unit 30)
- Integrating other requirements – located at key asset locations
- Identify appropriate future ownership / management

Key Outcomes:

- Consider aiming to conserve Dooralong Spotted Gum-Ironbark Forest (unit 30) as it were an EEC (ie. 100% target), to seek to avoid delays should the preliminary determination apply

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- Protect locally significant vegetation where it achieves multiple objectives – e.g. protection of the daisy
- The balance is unlikely to be able to be protected
- Design for the long term management of protected areas
- Bushfire controls used to protect vegetation and provide for other design outcomes.
- Consider offsetting loss

6.2 Flora

*6.2.1 Daisy (*Rutidosis heterogama*)*

Principles:

- Population has particular value for conservation of the species
- Protect a viable population on the site
- Retain proximal potential habitat where possible
- Provide certainty of protection and management into the future
- Connectivity between mapped populations within the study area

Issues:

- Need to conserve large population for viability as self-incompatible for seeding
- Question over what size of population will be viable
- Locations along railway line and at the proposed station are likely to be lost
- Who shall own and manage the land
- Management and monitoring needs resources into the long term
- Certainty of translocation is unknown - range of habitat types in the locality

Key Outcomes:

- Minimise loss of plants through design of station, track widening, and any associated facilities
- Maximise the retained area of the population
    - Allow for long-term certainty of protection, security, management and monitoring into the future
    - Seek to design 'reserve' to allow for expansion of population and connectivity between mapped areas
- Consider possibility of translocating individuals to be lost
- Consider offsetting provisions such as funding research and/or security of sites elsewhere in the vicinity

6.2.2 Other Flora Species

- *Tetratheca juncea* – potential occurrence
- Cycad (*Macrozamia flexuosa*)

Principles:

- Seek to retain potential habitat, where possible
- Management
- Connectivity may be desirable

Issues:

- Lack of certainty for *Tetratheca juncea*
    - Likelihood of occurrence

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- Potential habitat

Key Outcomes:

- Seek to retain significant habitat and connectivity through achieving other ecological outcomes
- Identify suitable potential management measures

6.3 Fauna

6.3.1 Squirrel Glider

Principles:

- Seek to retain habitat, particularly preferred / significant habitat
- Seek to maintain / improve connectivity where important
- Provision for management of retained lands

Issues:

- Significance of canopy only areas to squirrel gliders is unknown
- Regional context study mapping (Smith 2002b) suggests there is habitat present on site sufficient for squirrel gliders to be viable over the short term with management intervention
- Connectivity – large regional corridor with large areas of squirrel glider habitat less than 1km to north of site
- Fragmentation of habitat due to barriers (Sparks Rd & Railway)
- Appropriate Management

Key Outcomes:

- Seek to retain significant habitat through achieving other ecological outcomes
- Seek to improve connectivity to north, on both sides of railway line, adjacent to rail corridor and riparian vegetation in two creeklines
  - Seek to provide certainty, funding and management for corridors
- Seek to retain hollow bearing trees
- Planting a range of endemic tree and shrub species including squirrel glider feed trees in landscaped areas (where appropriate)
- Staged clearing of site
- Consider offsetting provisions such security of sites and/or improving connectivity elsewhere in the vicinity

6.3.2 Bat Species (Eastern Freetail Bat, Greater Broad-nosed Bat)

Principles:

- Seek to retain hollow-bearing trees, roost-trees, maternity sites
- Seek to retain foraging habitat
- Management

Issues:

- Loss of roost-trees / maternity sites
  - Identify and retain large mature trees
    - Note: may also use flaking bark or buildings
  - Identify and retain maternity sites (if present)
- Loss of foraging habitat (open forest / woodland to wet forest)

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Key Outcomes:

- Seek to retain significant habitat through achieving other ecological outcomes
- Seek to retain significant bat trees
- Consider offsetting provisions for eastern freetail bat and greater broad-nosed bat such as funding research and/or security of sites elsewhere in the vicinity

6.3.3 Owl Species (Masked Owl, Powerful Owl)

Principles:

- Seek to retain nest-trees and buffer
- Management

Issues:

- Loss, impacts or disturbance to nest-trees (being mapped)
- Loss of foraging habitat & suitable prey in study area – not known what threshold of foraging habitat is important for the owls in this vicinity
- How to protect nest tree(s) and integrate into design

Key Outcomes:

- Identify nest trees
- Seek to maintain nest trees and appropriate buffer
- Integrate nest tree and foraging habitat outcomes with other outcomes for regionally significant vegetation and connectivity, etc

6.3.4 Wallum Froglet

Principles:

- Seek to retain habitat
- Connectivity
- Management, particularly:
    - Hydrology
    - Water quality

Issues:

- Small area of habitat
- Connectivity along watercourse
    - Riparian corridor
- Integrate ecological objectives into water management
    - Specialises in acid water conditions

Key Outcomes:

- Provision of connectivity along the creek where froglet recorded
- Adequate stormwater controls and design to protect or create habitat in a riparian corridor downstream
- Daisy 'reserve' will protect some habitat (note controls on northern side of creek – integrate creek buffer and flooding requirements - stormwater design)

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6.3.5 Potentially Occurring Threatened Fauna

- Green and golden bell frog
- Glossy black cockatoo
- Eastern bent-wing bat
- Eastern false pipistrelle
- Grey-headed flying fox
- Large-footed Myotis
- Little bent-wing bat
- Koala

Principles:

- Seek to clarify if present and/or where habitat occurs
- Seek to retain potential habitat, where possible
- Management
- Connectivity may be desirable

Issues:

- There may be lack of certainty for some species
    - Likelihood of occurrence
    - Potential habitat
- Gaps in knowledge
- Identifying appropriate level of conservation and management given that there are knowledge gaps

Key Outcomes:

- Clarification of significant habitat (where necessary)
- Seek to retain significant habitat and connectivity through achieving other ecological outcomes
- Identify suitable potential management measures

6.4 Connectivity

Principles:

- Enhance connectivity
- Function / role of a corridor needs to be identified on local & regional scales
- Corridors designed to meet the identified function / role
- Provide certainty of protection and management into the future

Issues:

- Identification of function / role
    - Gene transfer
    - Dispersal / re-establishment of populations
    - Target species / communities
    - Riparian buffer
- Design dependent on function / role
    - Width, and length of corridor
    - Location and orientation in landscape
    - Type and/or diversity of ecosystems in corridor
    - Target species / communities
    - Edges
- Meeting ecological, visual, recreational & other goals
    - APZ's

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- Identify appropriate future ownership / management

Key Outcomes:

- Consult with DEC on their view of priority species, and once priorities are agreed, also consult on:
    - What are each species likely or practically able to connect to
    - What the requirements of each species are
- Once agreement with DEC is reached, design corridor(s)
- Integrate with other requirements (i.e. multiple outcomes achieved in one area)
- Integrate with urban planning and design
- APZ's used to protect significant vegetation and provide for other design outcomes, such as recreation

6.5 Facilitating Ecological Outcomes

6.5.1 Integration of Outcomes

Principles: (note discussed as a 'value' to facilitate a way forward)

- Integrate identified ecological values and principles with:
    - Water Management
    - Bushfire Management
    - Urban Design

Issues:

- Seek to integrate the masterplan elements with ecological principles to:
    - Identify conflicts
    - Seek to resolve or minimise conflicts

Key Outcomes:

- This is addressed in stage 2 during the revised master planning process.

6.5.2 Offsetting

Principles: (note discussed as a 'value' to facilitate a way forward)

- Seek to offset like for like
- Close proximity
- Improve security and condition of areas

Issues:

- Finding a suitable site
- Cost of private land to provide offset action

Key Outcomes:

- Identify what is lost and what order of offset is required
- Initiate discussions
- Develop 'offset plan' as part of environmental management plan

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7. Recommendations on Way Forward

This document, through a review process, has sought to identify values for the Warnervale Town Centre study area. Whilst the identification of values is a critical step, and we have sought to identify areas where there is a lack of knowledge or uncertainty, we also identify principles, issues, and key outcomes for each value.

There are some items that are either unknown or unclear. The location of threatened owl and bat nest or roost trees, is to be gathered. The adequacy of linkages for squirrel gliders to habitat outside of the study area is currently unknown. An investigation of both linkages and barriers within 1.5km of the study area, and consideration of works to improve squirrel glider connectivity as an offset, is suggested as an alternative to studies requested by DEC.

A recently gazetted endangered ecological community listing, as Lower Hunter Spotted Gum – Ironbark Forest, may apply to the Dooralong Spotted Gum-Ironbark Forest. It is likely this could be resolved through additional work by Stephen Bell examining field data, and consultation with Department of Environment and Conservation.

However, with the items above, there is sufficient knowledge for ecological values to input into the Warnervale Town Centre Masterplan, which is to be revised. For items that are currently unclear, these could likely be resolved through consultation (if necessary), and management of these values using the landscape and vegetation community principles.

A number of key outcomes are recommended, and are provided in detail in section 6. It is recommended that these key outcomes be discussed with DEC and suggested as a way forward. We then envisage two subsequent stages to this report (which we consider to be stage 1), where these key outcomes are implemented:

- Stage 2 Conservation Strategy – Collect any additional data required by the agencies where it facilitates the planning process and decisions on the masterplan; eg habitat trees, offsetting, Squirrel Glider population dynamics. Integrate findings into planning objectives and criteria as well as bushfire requirements. Develop a footprint and strategy that seeks the maintenance and improvement of key ecological values whilst delivering appropriate social and urban planning outcomes. This is an iterative process with the various specialists.

- Stage 3 Management Plan – The scope and content is dependent on the requirements from the various agencies but we recommend at a minimum that the following issues are addressed: offsetting plan, ownership, legal mechanism/s, governance, funding (capital and recurrent), monitoring/auditing, plan review. Once the approach to management is agreed to then a comprehensive plan of management can be prepared post rezoning. It is important to note that there are interdependencies between Stages 2 and 3.

We note that there is the potential for a conservation area for the daisy to also retain habitat for other species, and as such could be a multipurpose conservation area.

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