

## North Tuncurry

### *Ecological Constraints and Opportunities*

Landcom

0038915 Draft2

[www.erm.com](http://www.erm.com)

*Delivering sustainable solutions in a more competitive world*





# North Tuncurry *Ecological Constraints and Opportunities*

Landcom

October 2005

0038915

[www.erm.com](http://www.erm.com)

Approved by:	<u>Tessa Wilson</u>
Position:	Project Manager
Signed:	<u></u>
Date:	<u>20 October, 2005</u>
Partner:	<u></u>
	Steve O'Connor

Environmental Resources Management Australia Pty Ltd Quality System

This report has been prepared in accordance with the scope of services described in the contract or agreement between Environmental Resources Management Australia Pty Ltd ABN 12 002 773 248 (ERM) and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client and ERM accepts no responsibility for its use by other parties.

## CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	
1.1	SITE DESCRIPTION	1
1.2	SOIL LANDSCAPE	1
1.3	LEGISLATIVE REQUIREMENTS	2
<b>2</b>	<b>METHODOLOGY</b>	
2.1	LITERATURE AND DATABASE REVIEW	3
2.2	FLORA ASSESSMENT	4
2.3	FAUNA HABITAT ASSESSMENT	4
2.4	FAUNA SURVEYS	4
2.4.1	MICROCHIROPTERAN BAT SURVEY	5
2.4.2	SPOTLIGHTING AND GENERAL OBSERVATIONS	5
2.5	LIMITATIONS OF SURVEY	5
<b>3</b>	<b>SURVEY RESULTS</b>	
3.1	VEGETATION COMMUNITIES	6
3.1.1	HEATH	6
3.1.2	DRY BLACKBUTT	6
3.1.3	BLACKBUTT-BLOODWOOD AND/OR APPLE GUM	7
3.1.4	ENDANGERED ECOLOGICAL COMMUNITIES	7
3.1.5	THREATENED FLORA SPECIES	7
3.1.6	CONSERVATION SIGNIFICANCE OF VEGETATION COMMUNITIES	8
3.2	FAUNA HABITAT RESOURCES	9
3.2.1	DRY OPEN FOREST	9
3.2.2	CLOSED HEATH	9
3.2.3	MICROCHIROPTERAN BAT SURVEY	9
3.2.4	SPOTLIGHTING AND GENERAL OBSERVATIONS	9
3.3	THREATENED SPECIES RECORDED IN THE SITE AND ENVIRONS	10
3.3.1	THREATENED FLORA	10
3.3.2	THREATENED FAUNA	10
3.3.3	KEY THREATENING PROCESSES	16
<b>4</b>	<b>COMMONWEALTH THREATENED AND MIGRATORY SPECIES</b>	
<b>5</b>	<b>CONSTRAINTS AND OPPORTUNITIES</b>	
5.1	HABITAT LOSS	21
5.2	HABITAT FRAGMENTATION AND CORRIDORS	22
5.3	EDGE EFFECTS	23
5.4	INDIRECT IMPACTS	23
5.5	CUMULATIVE IMPACTS	24
5.6	CONSIDERATION OF THREATENED SPECIES	24

## CONTENTS

### REFERENCES

### LIST OF FIGURES

	<i>Follows Page No.</i>
<i>FIGURE 1.1 LOCALITY PLAN</i>	<i>1</i>
<i>FIGURE 2.1 THREATENED FLORA RECORDS</i>	<i>3</i>
<i>FIGURE 2.2 THREATENED FAUNA RECORDS</i>	<i>3</i>
<i>FIGURE 3.1 AERIAL PHOTO SHOWING VEGETATION COMMUNITIES</i>	<i>6</i>
<i>FIGURE 5.1 AERIAL PHOTO SHOWING HABITAT CORRIDORS, SEPP 14 WETLANDS AND ECOLOGICAL VALUE</i>	<i>22</i>

### LIST OF PHOTOGRAPHS

<i>PHOTOGRAPH 1 ABANDONED CAR ALONG DIRT TRACK WITHIN HEATH COMMUNITY</i>	<i>1</i>
<i>PHOTOGRAPH 2 LOOKING SOUTH ALONG ELECTRICITY EASEMENT</i>	<i>1</i>
<i>PHOTOGRAPH 3 HEATH COMMUNITY</i>	<i>6</i>
<i>PHOTOGRAPH 4 VIEW LOOKING SOUTH SHOWING ISOLATED PINE SPECIES NEAR GOLF COURSE</i>	<i>6</i>
<i>PHOTOGRAPH 5 DRY BLACKBUTT FOREST</i>	<i>7</i>
<i>PHOTOGRAPH 6 BLACKBUTT BLOODWOOD OPEN FOREST</i>	<i>7</i>

## INTRODUCTION

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Landcom to undertake a preliminary ecological assessment over crown land at North Tuncurry NSW (refer to *Figure 1.1*). This report aims to outline the ecological constraints and development potential of the site in accordance with State and Commonwealth legislation.

The purpose of this assessment is to:

- broadly define vegetation communities and fauna habitats;
- identify the conservation significance of vegetation communities and flora species, fauna habitats and fauna species;
- assess the type and degree of constraints posed by the flora, fauna and ecological communities on site; and
- provide mitigation measures to reduce the extent of impacts of any future development on all species and communities by identifying further targeted studies that need to be undertaken.

### 1.1

#### SITE DESCRIPTION

The site is approximately 432 hectares and is bounded by Tuncurry Road to the west, Nine Mile Beach to the east and rural residential properties to the south and part of the north. The remaining northern boundary of the site is bounded by crown land.

The vegetation is dominated by heath with scattered occurrences of Blackbutt forest and blackbutt bloodwood associations. A number of dirt tracks traverse the site that look to be well utilised by residents at the site. Rubbish dumping was evident within the site with a total of three cars dumped along the tracks (*photograph 1*).

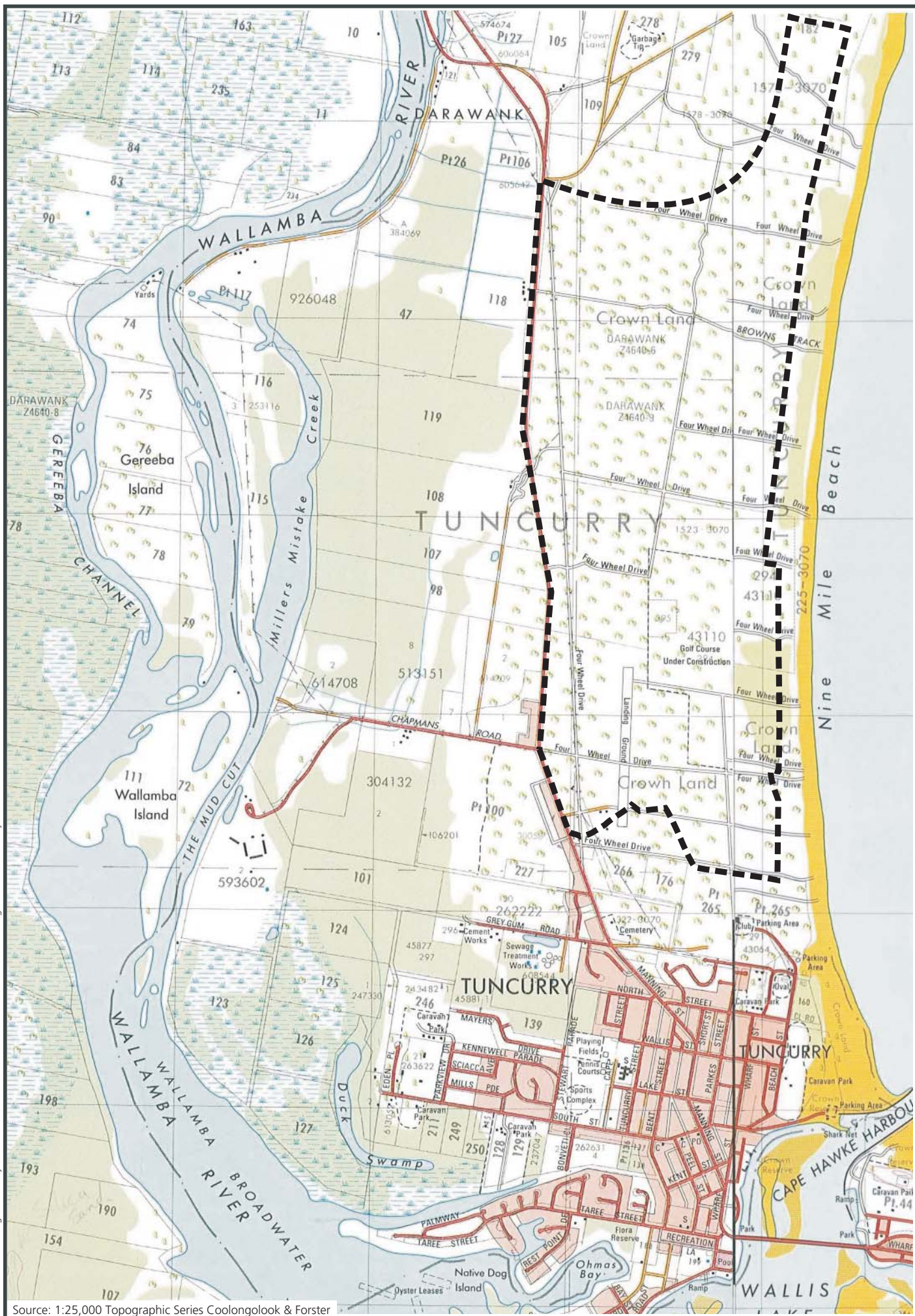
A golf course is located within a portion of the southern half of the site. An electricity easement runs parallel to The Lakes Way adjacent to the western boundary of the site (*Photograph 2*). The site was relatively flat with undulations increasing toward the eastern boundary of the site.

### 1.2

#### SOIL LANDSCAPE

At present only draft digital format for the Buladelah 1:100 000 mapsheet is available and the associated book is not yet published (*pers comm.* Mark Young DIPNR). The site is predominantly within the Hawks Nest soil landscape a small area is within the frogalla swamp soil landscape.





Source: 1:25,000 Topographic Series Coolongolook & Forster



0 500m  
Approximate only



Site

Figure 1.1

Locality Plan





**Photograph 1**

Abandoned car along dirt track within heath community.



**Photograph 2**

Looking south along electricity easement.

## Photographs

Landcom - North Tuncurry

The Hawks Nest soils comprise well drained aeric podsols on older dunes with deep rudosols on younger seaward dunes. The slope gradient is 0-5 percent with local relief of 2 to 10 metres.

Frogalla swamp soils comprise poorly drained acid peats/siliceous sands or acid peat/humic gley intergrades. The slope gradient is less than 1 percent with local relief of less than 3 metres.

### 1.3 *LEGISLATIVE REQUIREMENTS*

When determining the potential impacts of any proposed urban development on native flora and fauna, a number of legislative requirements must be considered. These have been addressed in *planning advice* prepared for Landcom by ERM (*see planning advice letter, 2005*). This advice is not repeated in this report.



Direct and indirect methodologies were employed to describe the flora and fauna of the site and surrounding habitats. A two day site inspection was supplemented with searches of the Department of Environment and Conservation (DEC) and Department of Environmental and Heritage (DEH) databases, and a review of existing literature on flora and fauna in the local area. This investigation is preliminary in nature and designed to broadly define communities and habitats rather than identifying threatened species or flora assemblages.

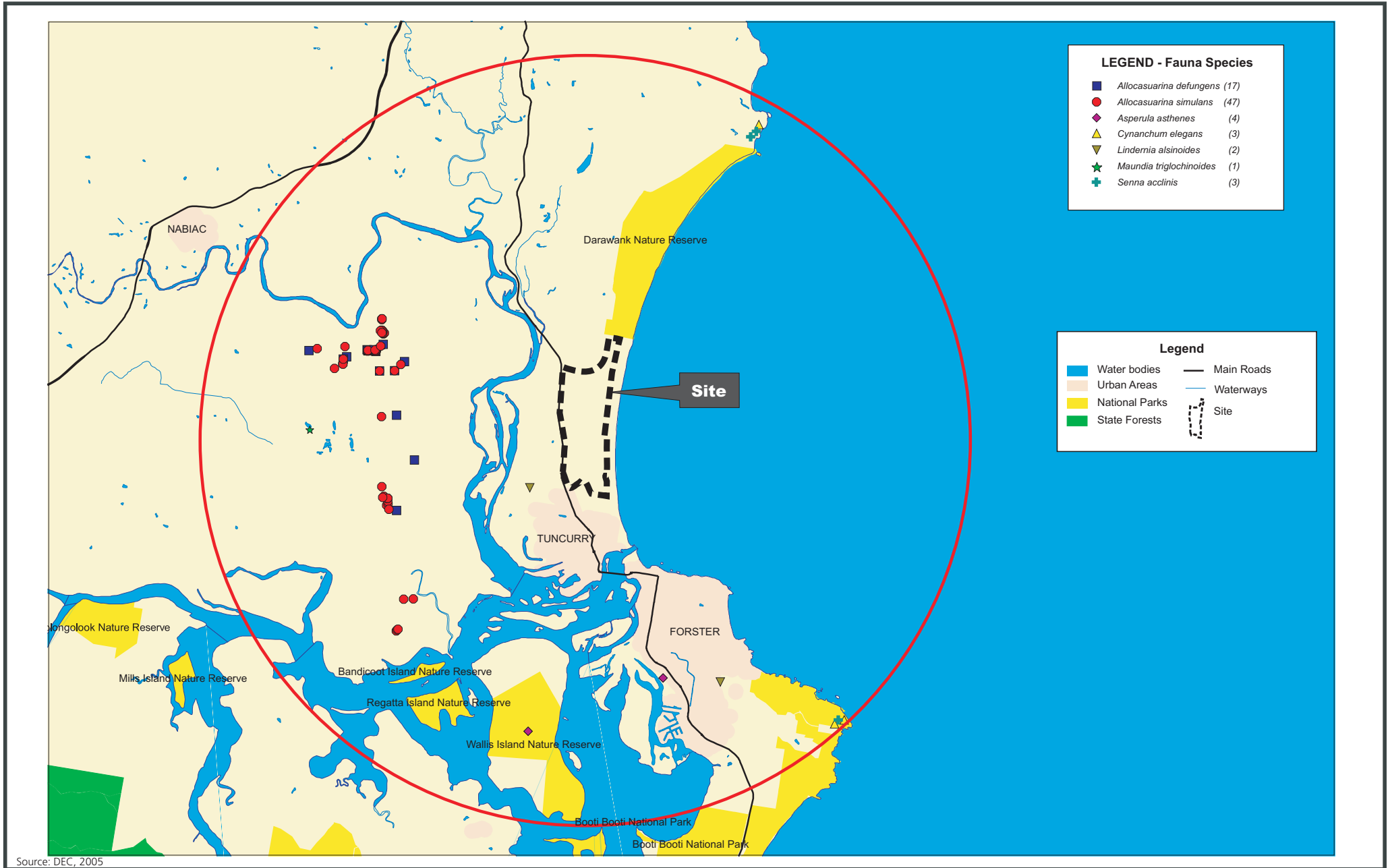
**2.1****LITERATURE AND DATABASE REVIEW**

Various sources of published information are available on flora and fauna within the site and locality. These were reviewed in the preparation of this report:

- Great Lakes Council (2003) Forster/Tuncurry Conservation and Development Strategy Volume 2;
- Draft Great Lakes Council Vegetation Strategy eastern portion, Volume 1, 2005;
- Draft Great Lakes Council Vegetation Strategy eastern portion, Volume 2, 2003; and
- Bell, M (2003) North Tuncurry and Chapmans Road Local Environmental Study.

A search of the DEC Wildlife Atlas database was conducted for all recent records of threatened flora and fauna within the locality (see *Figures 2.1* and *2.2*). This search revealed the presence of several threatened species within a 10 kilometre radius of the site. A search of the on-line database maintained by the Commonwealth Department of the Environment and Heritage (DEH) was completed to identify the presence of nationally listed threatened and migratory species in the locality. Each of these species has been assessed in *Chapter 3.3.2*.

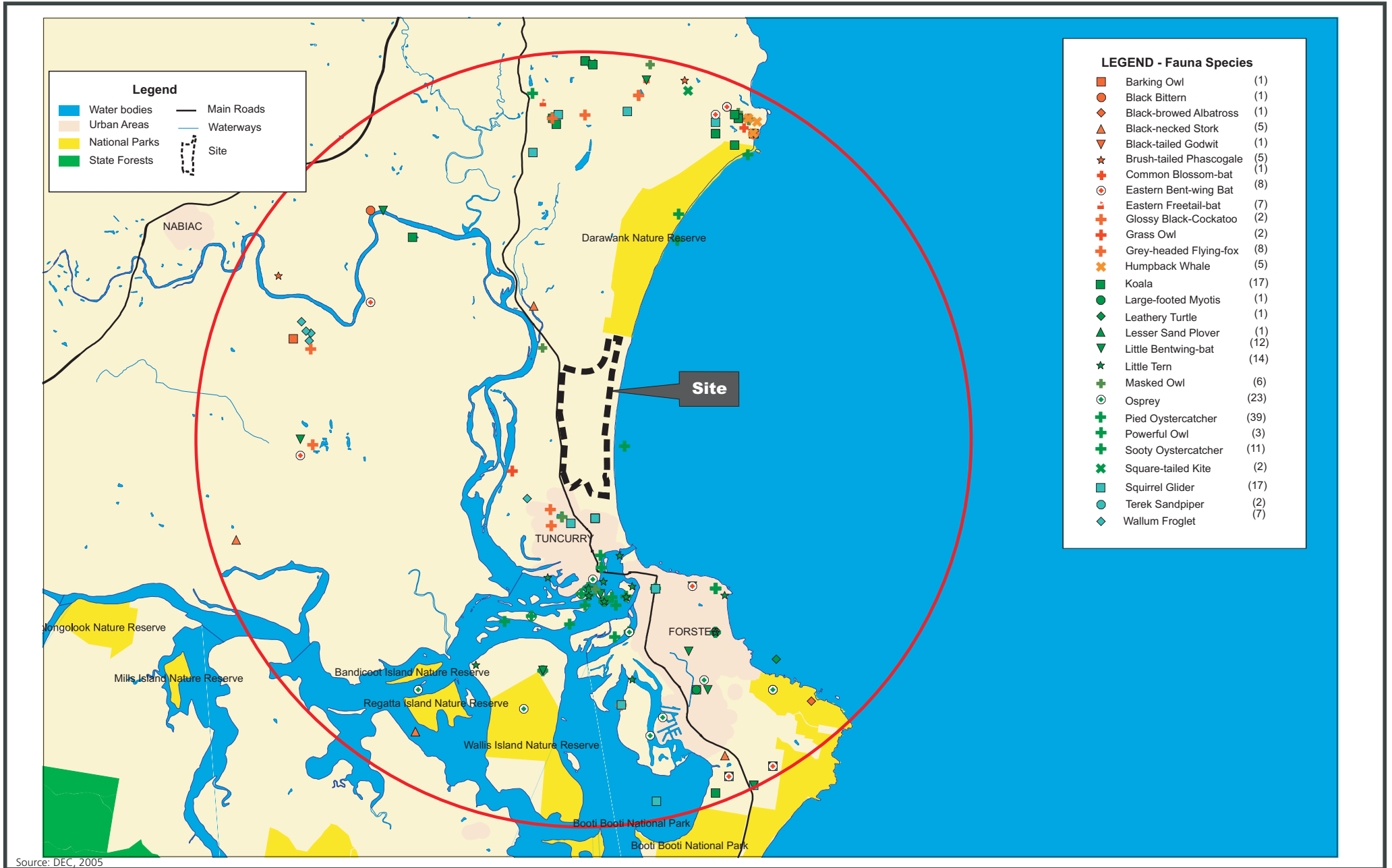
All flora and fauna database records were plotted using a geographic information system and were analysed to determine the likelihood that threatened flora and fauna could occur within habitats on site. The analysis entailed assessment of dates, source reliability and numbers of records to assess the accuracy and current relevance to the site. It should be noted that the DEH search is based on habitat requirements rather than actual records, and this assessment is based on those listed species considered likely to have habitat available on site.



Source: DEC, 2005

Figure 2.1 Threatened Flora Records in Vicinity of Site





Source: DEC, 2005

Figure 2.2 Threatened Fauna Records in Vicinity of Site



## 2.2

### *FLORA ASSESSMENT*

The vegetation mapping by Great Lakes Council (2003, 2005) was confirmed during the two day site inspection by visual assessment of dominant species. The vegetation communities were classified in accordance with descriptions provided in the Great Lakes Council Vegetation Strategy (2003, 2005). The vegetation community boundaries have been delineated from aerial photography. The conservation status of vegetation communities was assessed based on their condition, occurrence of threatened flora, and assessment of the distribution of the community.

The likelihood of endangered ecological communities (Schedule 1, Part 3 of the TSC Act) occurring on site was determined by considering the dominant plant species that comprise the vegetation communities, and the dominant soils present.

## 2.3

### *FAUNA HABITAT ASSESSMENT*

Vegetation maps, previous assessments and the site inspection were used to identify and assess the distribution of broad habitat types within the site. The following habitat features were recorded:

- presence of nesting/shelter/basking site such as tree hollows, leaf litter, bare ground, rocks, logs, vegetation, caves, rock outcrops, overhangs and crevices;
- presence of freshwater aquatic habitats such as streams, swamps and pools, noting their permanency (ie permanent, semi-permanent or ephemeral);
- extent of riparian vegetation;
- connectivity to adjacent areas of habitat; and
- the extent and nature of previous disturbances.

The presence of flowering eucalypts and other plants were noted as these may provide foraging resources for threatened species such as squirrel gliders and the regent honeyeater.

## 2.4

### *FAUNA SURVEYS*

An assessment of the known and potential presence of native fauna species on site was undertaken, based on database records, vegetation mapping and the habitat requirements of threatened species recorded in the locality. The occurrence of habitat resources and threatened species was assessed to identify potential ecological constraints to development of the site.

Opportunistic sightings of species and secondary indications (scats, scratches, diggings, tracks etc) of resident fauna were noted during the site inspection and included:

- searches for whitewash, prey remains and regurgitation pellets from owls;
- searches for chewed Allocasuarina cones from black-cockatoos;
- checks for obvious nests of raptors such as the osprey;
- investigation of any possible den site for the tiger quoll;
- checking trees for scratches consistent with arboreal mammals; and
- searches for characteristic scats, such as from the koala.

#### 2.4.1 *Microchiropteran Bat Survey*

One hand-held Anabat echolocation call detector was used to record bat calls during the spotlight survey. The Anabat unit remained stationary whilst the owl call playback was conducted. The bat survey commenced within one hour of dusk over 4 person hours.

#### 2.4.2 *Spotlighting and General Observations*

Spotlighting surveys involved two ecologists walking through the open forest and heath. Spotlighting commenced following the completion of the owl call playback census. The vegetation canopy, understorey and ground cover was illuminated with 50 watt hand-held spotlights to search for foraging arboreal and terrestrial fauna and nocturnal birds. All spotlighting was undertaken within the first three hours after dusk, on the evening of the 4<sup>th</sup> October 2005.

#### 2.5 *LIMITATIONS OF SURVEY*

No detailed flora or fauna surveys have been undertaken across the site. The site inspection provided only a preliminary assessment of habitat types available. Threatened flora and fauna species likely to occur on the site were extrapolated from the habitat assessment, database and literature review. All threatened species considered likely to utilise the resources on site have been considered within the assessment in *Section 4.1* of this report.

Targeted surveys will have to be undertaken prior to the design stage of any future development proposal to identify areas of conservation significance.



### 3.1 VEGETATION COMMUNITIES

Three vegetation communities have been identified on the site being Heath, dry blackbutt and blackbutt bloodwood and smooth barked apple in accordance with mapping carried out by Great Lakes Council (Figure 3.1). The presence of these communities on site was confirmed by ground truthing although community boundaries may differ.

#### 3.1.1 Heath

As described by Great Lakes Council (2003), the closed heath community comprises shrubs usually under two metres in height yet extending to four metres (Photograph 3). The upper storey is dominated by *Banksia* species and *Leptospermum* species with the shrub layer dominated by peas (*Pultenaea*, *Dillwynia* and *Daviesia* species) and epacrids with a sparse to absent herb understorey.

The heath community was dominated by *Leptospermum polygalifolium*, *Leptospermum laevigatum*, *Leptospermum polyanthum* and *Leucopogon ericoides*. *Banksia serrata* and *Banksia integrifolia* occurred throughout the community in scattered locations becoming denser towards the east of the site. Other shrubs relatively common in the heath community included *Ricinocarpos pinifolius*, *Persoonia oblongata* and *Dillwynia retorta* ssp. *penduncularis*.

Isolated occurrences of pine species were identified in the northern section of the site within close proximity to the golf course (Photograph 4). It is considered likely that these species were introduced to the area from the neighbouring golf course.

Climbers within the heath community comprised *Cassytha pubescens*.

#### 3.1.2 Dry Blackbutt

Great Lakes Council describes the dry blackbutt community as open to closed forest dominated by *Eucalyptus pilularis* (blackbutt) interspersed with the occasional stringybark (*E. eugenoides* or *E. agglomerata*). The shrub layer comprises xeric shrubs such as *Allocasuarina torulosa*, *Persoonia linearis* and *Acacia* species (*Acacia binervata*, *A. longissima* and *A. parramattensis*). The groundcover is dominated by a variety of grasses.

The understorey is dominated by *Pteridium esculentum* (Photograph 5) and occasional *Lomandra longifolia* and various grass species (*Imperata cylindrica*, *Entolasia stricta*, *Cynodon dactylon* and *Cymbopogon refractus*) and *Xanthorrhoea minor*. The shrub layer includes *Leptospermum laevigatum*, *Bossiaea rhombifolia* and *Acacia* species (*Acacia. suaveolens*, *A. longissima* and *A. ulcifolia*). The



Source: 1:25,000 Topographic Series Coolongolook & Forster



0 500m  
Approximate only

Figure 3.1

### Aerial Photo Showing Vegetation Communities

Landcom - North Tuncurry





**Photograph 3**  
Heath Community.



**Photograph 4**  
View looking south showing isolated pine species near golf course.

herbivorous layer was generally sparse comprising such species as *Pomax umbellata*, *Hibbertia diffusa*, *H. acicularis* and *H. obtusifolia*.

The midstorey was dominated by *Banksia serrata* to a height between four to six metres. The canopy was dominated by open *Eucalyptus pilularis* forest.

A number of climbers were evident within the community: *Billardiera scandens*, *Hardenbergia violaceae* and *Kennedia rubicunda*.

### **3.1.3 *Blackbutt-Bloodwood and/or Apple Gum***

Great Lakes Council identifies the dominant trees within this community as *E. pilularis* and *Angophora costata* (smooth-barked apple) with occasional occurrences of *Corymbia intermedia* (pink bloodwood) and *C. gummifera* (red bloodwood). The vegetation structure can be open or closed with open shrub layer comprising *Banksia serrata*, *Acacia longifolia* var. *sophorae*, *Dillwynia* and *Pultenaea* species.

This community is dominated by *Eucalyptus pilularis* (blackbutt) interspersed with the occasional *E. intermedia* (pink bloodwood).

The midstorey was dominated by mature *Banksia serrata* scattered throughout the open forest with thickets of *Leptospermum laevis* (Photograph 6).

The understorey was dominated by *Pteridium esculentum* and *Lomandra longifolia*. A number of grass species were also present in this community, *Panicum simile* and *Imperata cylindrica* var. *major* to name a few.

### **3.1.4 *Endangered Ecological Communities***

The vegetation communities mapped within the site do not form part of any endangered ecological communities listed under the TSC Act 1995.

### **3.1.5 *Threatened Flora Species***

Nine threatened flora species have been recorded within ten kilometres of the site being:

- *Allocasuarina defungens*;
- *Allocasuarina simulans*;
- *Asperula asthenes*;
- *Cynanchum elegans*;
- *Cryptostylis hunteriana*;
- *Senna acclinis*;



**Photograph 5**

Dry Blackbutt forest.



**Photograph 6**

Blackbutt bloodwood open forest.



- *Maundia triglochinos*;
- *Lindernia alsinoides*; and
- *Syzygium paniculatum*.

*Allocasuarina defungens* has the potential to occur within tall heath on sand and is also prevalent on clay and sandstone. Targeted surveys for this species will need to be undertaken during September to March.

*Allocasuarina simulans* prefers heath on coastal sands and has the potential to occur on heath within the site. Targeted surveys for this species can be undertaken at any time of the year.

*Asperula asthenes* occurs in damp sites usually near riverbanks. This species is not likely to occur within the site.

*Cynanchum elegans* is likely to occur in the ecotone between dry subtropical rainforest and sclerophyll forest and woodland. This species is not likely to occur within the site.

*Cryptostylis hunteriana* occurs in a variety of habitat including swamp-heath and woodland. Potential habitat is provided by the heath within the site. Targeted surveys should be undertaken from November to February.

*Senna acclinis* occurs on the edge of dry or subtropical rainforest. This species is not likely to occur at the site.

*Maundia triglochinos* prefers permanent swamp and wetland habitat and is not likely to occur at the site.

*Lindernia alsinoides* occurs in damp areas within coastal heath and sclerophyll forest. Targeted surveys should be undertaken from December to February.

*Syzygium paniculatum* prefers subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea. No targeted surveys are necessary given the lack of suitable habitat at the site.

### 3.1.6

#### *Conservation Significance of Vegetation Communities*

One vegetation community present on site has been identified as being of regional conservation significance in the Great Lakes Local Government Area based on natural rarity and historical extent of clearing. This is the heath community covering the majority of the site (Great Lakes Council, 2005).

## 3.2 FAUNA HABITAT RESOURCES

Vegetation maps and the brief site inspection were used to identify and assess the distribution of habitat types on site. The site contain two broad habitat types being dry open forest and closed heath. The distribution of the habitats generally correspond to the vegetation communities present. Isolated stands of blackbutt occur in pockets of the heath not identified on the vegetation mapping.

### 3.2.1 *Dry Open Forest*

Dry open forest occurs in scattered locations across the northern areas of the site. The myrtaceous species in the overstorey strata would provide seasonal foraging resources for nectivorous birds and mammals when flowering. The dominant tree species (*Eucalyptus pilularis*) within the open forest may provide feeding resources for koala whilst the understorey species (*Banksia serrata* and *Banksia integrifolia*) may provide feeding resources for the squirrel glider.

The grass species within the lower stratum would provide seed and stem resources for granivorous and herbivorous species.

Given the low occurrence of hollows and fallen trees, habitat for hollow dependent mammals, microchiropteran bat and bird species is limited.

### 3.2.2 *Closed Heath*

Closed heath occurs throughout the majority of the site. The myrtaceous species frequently present (*Banksia serrata* and *Banksia integrifolia*) in the overstorey would provide seasonal foraging resources for nectivorous birds and mammals when flowering.

The dense shrub layer dominated by Fabaceae species would provide suitable shelter and foraging habitat for nectivorous birds and other species. The leaf litter was generally shallow or absent within the closed heath.

### 3.2.3 *Microchiropteran Bat Survey*

No microchiropteran bats were recorded during the nocturnal survey.

### 3.2.4 *Spotlighting and General Observations*

One *Trichosurus vulpecula* (common brushtail possum) was observed within the canopy of a blackbutt during the spotlighting survey.

Diggings consistent with *Isoodon* sp. (bandicoot) were identified during the diurnal surveys.

### 3.3

#### *THREATENED SPECIES RECORDED IN THE SITE AND ENVIRONS*

Schedules 1 and 2 of the TSC Act list species, populations or ecological communities of native flora and fauna considered to be threatened in New South Wales. The status of species is assessed as either:

- Endangered (Schedule 1); or
- Vulnerable (Schedule 2).

No threatened populations or ecological communities currently listed on the TSC Act, 1995 were recorded, or considered likely to occur, on site.

#### 3.3.1

##### *Threatened Flora*

No threatened species were observed during site inspection however the following species have the potential to occur at the site; *Allocasuarina defungens*, *Allocasuarina simulans*, *Cryptostylis hunteriana* and *Lindernia alsinoides*.

#### 3.3.2

##### *Threatened Fauna*

No threatened fauna species were noted during the site inspection. Species likely to occur on site that may provide ecological constraints to any future development have been highlighted in *Table 3.1*. These species will have to be further assessed when a development or rezoning proposal has been finalised. This will require targeted field surveys as outlined in *Chapter 4*.

Marine mammals and birds were excluded from the threatened species assessment, as it is reasonable to assume that they are not present or dependant on habitats within the site.

**Table 3.1 Likelihood of Threatened Species Occurring on site**

Common Name Scientific Name	Legislative Status		Habitat Requirements	Presence and Habitat Use	Targeted Surveys Required?
	TSC Act	EPBC Act			
<b>Flora</b>					
<i>Cynanchum elegans</i>	E	E	Mainly at the ecotone between dry subtropical rainforest and sclerophyll forest communities.	No suitable habitat available within the site.	No
<i>Cryptostylis hunteriana</i>	-	V	Prefers a variety of habitat including swamp-heath and woodland.	Potential habitat available within the site.	<b>Yes</b> November to February
<i>Allocasuarina defungens</i>	E	E	Mainly in heath and dry sclerophyll forest typically with sand and sandy clay soils, often with ironstone gravels.	Potential habitat available within heath.	<b>Yes</b> September to March
<i>Allocasuarina simulans</i>	V	V	Prefers heath on coastal sands.	Potential habitat available within heath.	<b>Yes</b> All year
<i>Senna acclinis</i>	E	-	Grows on the edge of dry or subtropical rainforest.	No suitable habitat available to support rainforest cassia.	No
<i>Maundia triglochinos</i>	V	-	Swamps, shallow freshwater or creeks.	No wetland habitat supported on the site.	No
<i>Asperula asthenes</i>	V	V	Damp site usually along river banks. Found within grassy woodlands, wet sclerophyll forest, freshwater wetlands and rainforest.	No suitable habitat supported within the site.	No
<i>Lindernia alsinoides</i>	E	-	Damp areas within coastal heath and sclerophyll forest.	Potential habitat available within heath community at the site.	<b>Yes</b> December to February
<i>Syzygium paniculatum</i>	V	V	Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea. Near creeks or moist slopes.	No suitable habitat supported at the site.	No

Common Name Scientific Name	Legislative Status		Habitat Requirements	Presence and Habitat Use	Targeted Surveys Required?
	TSC Act	EPBC Act			
<b>Ecological Communities</b>					
Swamp sclerophyll forest on coastal floodplains	E	-	Occurs on humic clay loams and sandy loams on waterlogged or periodically inundated alluvial flats and drainage lines.	No waterlogged areas or drainage lines were observed at the site. This community is not likely to occur.	No
Freshwater wetlands on coastal floodplains	E	-	Occurs in coastal areas periodically flooded by freshwater for part of the year in most years.	Lack of flooding or evidence of previous inundation at the site means this community is not likely to occur at the site.	No
<b>FAUNA</b>					
<i>Crinia tinnula</i> (wallum froglet)	V	-	Shallow acid paperbark swamps and sedge swamps in wallum country	No suitable swamp habitat supported at the site.	No
<i>Litoria aurea</i> (green and golden bell frog)	E	V	Swamps, lagoons, streams and ponds with emergent vegetation.	No suitable swamp habitat supported at the site	No
<i>Mixophyes balbus</i> (Southern barred frog)	V	V	Typically found in association with permanent streams through temperate and sub-tropical rainforest and wet sclerophyll forest, rarely in moist gullies in dry forest.	No suitable aquatic habitat supported at the site	No
<i>Mixophyes iteratus</i> (giant barred frog)	E	E	Rivers and creeks in rainforest, wet sclerophyll and eucalypt forests.	No suitable aquatic habitat supported at the site	No
<i>Pandion haliaetus</i> (Osprey)	V	-	Forages on intertidal sand and mudflats in estuaries, and roosts in tall dead trees or artificial structures ie. power lines.	Absence of tall dead trees available at the site. No habitat on the site.	No
<i>Charadrius mongolus</i> (lesser sand plover)	V	M	Prefer mudflats, beaches, estuaries and tidal areas in mangroves.	No suitable habitat available at the site.	No
<i>Ephippiorhynchus asiaticus</i> (black-necked stork)	E	-	Prefer permanent freshwater wetlands and occasionally estuary or intertidal areas.	No suitable habitat available at the site.	No
<i>Haematopus fuliginosus</i> (Sooty oystercatcher)	V	-	Foraging occurs on rocky headlands, muddy estuaries and rock pools.	Preferred habitat is not provided in the site.	No



Common Name Scientific Name	Legislative Status		Habitat Requirements	Presence and Habitat Use	Targeted Surveys Required?
	TSC Act	EPBC Act			
<i>Haematopus longirostris</i> (pied oystercatcher)	V	-	Preferred habitat ocean beaches, estuarine sand, mudflats and saltings nesting in sand or shingle on estuarine or coastal beaches.	No suitable habitat available within the site.	No
<i>Ixobrychus flavicollis</i> (black bittern)	V	-	Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation.	No suitable habitat available within the site.	No
<i>Sterna albifrons</i> (little tern)	E	-	Prefers sheltered coastal habitat nesting on beaches, estuary mouths or coastal lakes.	No suitable habitat available within the site.	No
<i>Limosa limosa</i> (black-tailed godwit)	V	-	Wading species prefers estuaries, lagoon and intertidal mudflats.	No suitable habitat available within the site.	No
<i>Xenus cinereus</i> (terek sandpiper)	V	-	Coastal mudflats, lagoons, creeks and estuaries and roosts in dead trees within mangroves.	No suitable habitat available within the site.	No
<i>Ninox strenuata</i> (powerful owl)	V	-	Ranges of habitats, especially tall open forest and open forest in less rugged regions. Roosts in dense canopy, such as rainforest.	Isolated areas of potential foraging habitat available at the site. Absence of suitable nesting trees.	<b>Yes</b>
<i>Tyto capensis</i> (grass owl)	V	-	Swampy grassland, heath and sedgeland.	Potential habitat available in heathlands.	<b>Yes</b>
<i>Tyto novaehollandiae</i> (masked owl)	V	-	Nests in mature large hollow-bearing eucalypts and forages in drier forests with an open understorey and a mosaic of dense and sparse ground cover.	Potential foraging habitat available in isolated sections of blackbutt open forest.	<b>Yes</b>
<i>Petaurus norfolcensis</i> (squirrel glider)	V	-	Woodlands and forest with abundant tree hollows for breeding; a mix of eucalypts, acacias and banksias that provide nectar, pollen, flowers, acacia gum, and insects for foraging.	Potential foraging habitat provided by flowering Myrtaceous species.	<b>Yes</b>
<i>Phascolarctos cinereus</i> (koala)	V	-	Eucalypt forest and woodland with preferred <i>Eucalyptus</i> sp. for foraging.	Blackbutt species may provide feeding resources for the koala.	<b>Yes</b>

Common Name Scientific Name	Legislative Status		Habitat Requirements	Presence and Habitat Use	Targeted Surveys Required?
	TSC Act	EPBC Act			
<i>Pteropus poliocephalus</i> (grey-headed flying-fox)	V	V	Rainforest, woodland and forest with <i>Eucalyptus</i> , <i>Melaleuca</i> and <i>Banksia</i> nectar and pollen, fruits of rainforest trees and vines for foraging and breeding (camp site).	Suitable foraging habitat available within the site.	Yes
<i>Mormopterus norfolkensis</i> (eastern freetail-bat)	V	-	Tree hollows, crevices, under bark, caves and buildings for roosting, eucalypt wet and dry forest, woodland and rainforest for foraging.	Suitable foraging habitat available within the site.	Yes
<i>Miniopterus australis</i> (little bentwing-bat)	V	-	Caves for breeding; a range of eucalypt forest and woodland for foraging.	Suitable foraging habitat available within the site.	Yes
<i>Miniopterus schreibersii oceanensis</i> (eastern bentwing-bat)	V	-	Mainly caves for breeding (also man-made structures such as culverts); a range of eucalypt forest and woodland for foraging.	Suitable foraging habitat available within the site.	Yes
<i>Chalinolobus dwyeri</i> (large-eared pied bat)	V	V	Drier habitats such as dry sclerophyll forests and woodland, however the species has been recorded in tall open eucalypt forest with an understorey of scattered small trees and palms. Roosts in caves and mine tunnels.	Suitable foraging habitat available within the site.	Yes
<i>Dasyurus maculatus</i> (spotted-tailed quoll)	V	E	Nesting habitat includes caves, rock crevices and hollow logs in a wide range of habitats.	No suitable nesting habitat provided however potential foraging habitat available at the site.	Yes
<i>Potorous tridactylus tridactylus</i> (long-nosed potoroo)	V	V	Prefers coastal heath, wet or dry sclerophyll forest supporting dense understorey species.	Suitable heath habitat available at the site.	Yes
<i>Lathamus discolor</i> (swift parrot)	E	E,M	Migratory species frequenting eucalypt forest and woodland following winter flowering eucalypts. Breeds in Tasmania.	Suitable foraging habitat available within the site.	Yes
<i>Rostratula australis</i> (Australian painted snipe)	V	V, M	Prefers swamp fringes, marshes, dams well vegetated with grasses, low shrub or timber.	No suitable habitat available within the site.	No

Common Name Scientific Name	Legislative Status		Habitat Requirements	Presence and Habitat Use	Targeted Surveys Required?
	TSC Act	EPBC Act			
<i>Xanthomyza phrygia</i> (regent honeyeater)	E	E, M	Eucalypt woodland and open forest. Nomadic species following rich sources of nectar primarily winter flowering species (eg. swamp mahogany in coastal areas).	Suitable feeding habitat available in parts of the site.	<b>Yes</b>
<i>Monarcha melanopsis</i> (black-faced monarch)	-	M	Species prefers rainforest, wet sclerophyll and denser eucalypt forests, damp gullies and mangroves.	No suitable habitat available within the site.	No
<i>Monarcha trivirgatus</i> (spectacled monarch)	-	M	Similar habitat to black-faced monarch preferring mangroves and wet forest.	No suitable habitat available within the site.	No
<i>Myiagra cyanoleuca</i> (satin flycatcher)	-	M	Species prefers forest, particularly thick gullies.	Potential foraging habitat available within the site.	<b>Yes</b>
<i>Rhipidura rufifrons</i> (rufous fantail)	-	M	Prefers rainforest.	No suitable habitat provided within the site.	No
<i>Gallinago hardwickii</i> (Latham's snipe)	-	M	Prefers marsh habitat supporting moderate cover.	No suitable habitat supported within the site.	No
<i>Lophoictinia isura</i> (square tailed kite)	V	-	Inhabits a variety of habitat from dry woodland to open forest occupying a large hunting range 100km <sup>2</sup> .	Foraging habitat supported in open forest areas of the site.	<b>Yes</b>
<i>Calyptorhynchus lathamii</i> (glossy black cockatoo)	V	-	A range of eucalypt dominated forests with a lower canopy dominated by mature <i>Allocasuarinas</i> and <i>Casuarinas</i> , which are its primary foraging source	Preferred feed resources not supported within the site. Species not expected.	No

1. Legislative Status: E = Endangered; V = Vulnerable, M = Migratory.

### 3.3.3 Key Threatening Processes

Schedule 3 of the *TSC Act 1995* lists key threatening processes that will have to be assessed against any future development proposals as detailed in *Table 3.3*.

**Table 3.3 Key Threatening Processes Listed in Schedule 3 of the TSC Act**

Threatening Process	Applicable to Project
Alteration of habitat following subsidence due to longwall mining	No
Alteration of natural flow regimes.	No
Bushrock removal resulting in the removal and/or disturbance of habitat for native species that may find shelter in or under rocks, use rocks for basking, or which grow in rocky areas.	No
Clearing of native vegetation.	Yes
Competition and grazing by the feral European rabbit ( <i>Oryctolagus cuniculus</i> ).	No
Competition and habitat degradation by feral goats.	No
Competition from feral honeybees <i>Apis mellifera</i> .	No
Death or injury to marine species following capture in shark control programs on ocean beaches.	No
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments.	No
Feral pigs - predation, habitat degradation, competition and disease transmission.	No
Herbivory and environmental degradation caused by feral deer.	No
High frequency fire resulting in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition.	Yes
Human caused climate change.	Yes
Importation of red imported fire ants into NSW.	No
Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations).	No
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis.	No
Infection of native plants by <i>Phytophthora cinnamomi</i> .	No
Introduction of the large earth bumblebee ( <i>Bombus terrestris</i> )	No
Invasion of native plant communities by bitou bush and boneseed	Yes
Invasion of native plant communities by exotic perennial grasses.	Yes
Invasion of the yellow crazy ant	No
Loss and/or degradation of site used for hill-topping by butterflies.	No
Predation by mosquito fish ( <i>Gambusia holbrooki</i> ).	No
Predation by feral cat ( <i>Felis catus</i> ).	Yes
Predation by fox ( <i>Vulpes vulpes</i> ).	Yes
Predation by ship rat ( <i>Rattus rattus</i> ) on Lord Howe Island.	No
Removal of dead wood and dead trees.	Yes

Threatening processes that are considered relevant to the site are briefly discussed below with regard to the ecological constraints of any future development proposal:

### *Clearing of native vegetation*

Future urban development of the site is likely to result in the removal of native vegetation. Any future development proposal should aim to maximise the amount of retained vegetation, particularly given its habitat value to a number of threatened flora and fauna species.

### *High frequency fire resulting in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition*

A bushfire hazard assessment would have to be undertaken for any future urban development or rezoning proposals.

### *Anthropogenic climate change*

The development of the site will not in itself contribute to anthropogenic climate change. The implementation of energy minimisation in the planning of any infrastructure would aim to limit greenhouse emissions in the short and long-term.

### *Invasion of native plant communities by bitou bush (*Chrysanthemoides monilifera*)*

Bitou bush is present immediately beyond the eastern boundary of the site. Consideration should be given to the implementation of a weed management plan for disturbed areas. The plan would aim to remove any noxious weeds, and reduce the risk of their spread during the construction and post-construction phases of any future urban development.

### *Invasion of native plant communities by exotic perennial grasses*

Exotic perennial grasses are present in disturbed areas within the site, predominantly along the access tracks. Implementation of a weed management plan for disturbed areas should be considered. The plan would aim to remove exotic grasses within the retained habitats, and reduce the risk of their spread during the construction phase and post-construction phases of any proposed urban development.

### *Predation by the feral cat and fox*

Future urban development of the site may increase predation on fauna by cats and foxes. However, this impact may be ameliorated by the retention of adequate habitat connections.

### *Removal of dead wood and dead trees*

Clearance of any vegetation within the site is likely to remove dead wood and dead trees. Some dead trees may contain hollows suitable as roost and den site for fauna such as the squirrel glider and microchiropteran bats. During the design phase of any future urban development on site, consideration should be given to the retention of the maximum amount of native vegetation.



The Commonwealth EPBC Act requires approval for actions that may have a significant impact on matters of national environmental significance or Commonwealth land. There are no World Heritage properties, natural heritage places, Ramsar wetlands, Commonwealth marine areas or nuclear actions on or near the site. There are no Commonwealth listed ecological communities however there are Commonwealth listed threatened species and migratory species recorded or likely to occur on the site.

Five fauna species and three flora species listed as threatened in the EPBC Act have the potential to occur on site (see *Table 4.1*).

**Table 4.1** *Matters of National Environmental Significance*

Species	Status	Likelihood of Occurrence
<b>FAUNA</b>		
<i>Lathamus discolor</i> (swift parrot)	E	Migratory species frequenting eucalypt forest and woodland following winter flowering eucalypts. <b>Moderate likelihood of occurrence.</b>
<i>Xanthomyza phrygia</i> (regent honeyeater)	E, M	Suitable foraging habitat available within the site. <b>Moderate likelihood of occurrence.</b>
<i>Rostratula australis</i> (Australian painted snipe)	V, M	Prefers swamp fringes, marshes, dams well vegetated with grasses, low shrub or timber. Not likely to occur.
<i>Gallinago hardwickii</i> (Latham's snipe)	M	No suitable habitat supported within the site. Not likely to occur.
<i>Litoria aurea</i> (green and golden bell frog)	E	No suitable swamp habitat supported at the site. Not likely to occur.
<i>Mixophyes balbus</i> (Southern barred frog)	V	No suitable aquatic habitat supported at the site. Not likely to occur.
<i>Mixophyes iteratus</i> (giant barred frog)	E	No suitable aquatic habitat supported at the site. Not likely to occur.
<i>Chalinolobus dwyeri</i> (large-eared pied bat)	V	Suitable foraging habitat available within the site. <b>Moderate likelihood of occurrence.</b>
<i>Dasyurus maculatus</i> (spotted-tailed quoll)	E	Suitable foraging habitat available within the site. <b>Moderate likelihood of occurrence.</b>
<i>Potorous tridactylus tridactylus</i> (long-nosed potoroo)	V	No suitable nesting habitat however suitable foraging habitat available at the site. Low to moderate likelihood of occurrence.
<i>Pteropus poliocephalus</i> (grey-headed flying-fox)	V	Suitable foraging habitat available within the site. <b>Moderate likelihood of occurrence.</b>
<i>Monarcha melanopsis</i> (black-faced monarch)	M	No suitable habitat available within the site. Not likely to occur.
<i>Monarcha trivirgatus</i> (spectacled)	M	No suitable mangrove or wet forest habitat available within the site. Not likely to occur.

Species	Status	Likelihood of Occurrence
monarch)		
<i>Myiagra cyanoleuca</i> (satin flycatcher)	M	Potential foraging habitat available within the site. Low to moderate likelihood of occurrence.
<i>Rhipidura rufifrons</i> (rufous fantail)	M	No suitable habitat provided within the site. Not likely to occur.
<b>FLORA</b>		
<i>Allocasuarina defungens</i>	E	Potential habitat available within heath. <b>Moderate to high likelihood of occurrence.</b>
<i>Allocasuarina simulans</i>	V	Potential habitat available within heath. <b>Moderate to high likelihood of occurrence.</b>
<i>Asperula asthenes</i>	V	No suitable habitat supported within the site. Not likely to occur.
<i>Cryptostylis hunteriana</i>	V	Potential habitat available within the site. Low to moderate likelihood of occurrence.
<i>Cynanchum elegans</i>	E	No suitable habitat supported at the site. Not likely to occur at the site.
<i>Syzygium paniculatum</i>	V	No suitable habitat supported at the site. Not likely to occur at the site.
1. Legislative Status: E = Endangered; V = Vulnerable, M = Migratory.		

Provided the environs continue to function as a wildlife corridor and winter flowering resources are retained, the future urban development of the site may not cause detrimental impact upon the health of the remaining vegetation. The flora and fauna assessment and eight part test will need to consider the impact on the threatened species considered to have a moderate to high likelihood of occurrence. Any assessment of the impact on threatened and migratory species must include whether the proposal would:

- decrease the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population;
- adversely affect critical habitat;
- disrupt the breeding cycle of a population;
- affect the availability or quality of habitat to the extent that the species is likely to decline;
- result in harmful invasive species becoming established on site;
- interfere with the recovery of the species;
- substantially modify, destroy or isolate an area of important habitat of the migratory species; or

- disrupt the life cycle of an ecologically significant proportion of a population of the species.

If the impacts are found to be significant then a referral to the Commonwealth Minister for the Environment would be required as it could constitute a “controlled action”.

The extent of ecological constraints and opportunities on site is based on several factors including:

- presence or likely occurrence of threatened plant species; and
- extent and quality of habitat resources for threatened fauna species.

The site provides habitat for a number of threatened flora and fauna species (*Table 3.1*). These will need to be assessed during further investigations through undertaking targeted surveys.

### 5.1

#### *HABITAT LOSS*

Any future development of the site will result in the loss of at least some native vegetation and hollow bearing trees.

The natural process of creating tree hollows is called 'cavitation'. With the increasing age of a tree and increasing diameter of the trunk and boughs, comes an opportunity for the entrance of fungi or invertebrates. Fungal infection of dead heartwood is quite common, with eventual softening of this tissue and then its long term removal by infiltrating rainwater or by ant or termite colonisation. Larvae of wood-boring insects (ie beetles and moths) may initiate the entrance of fungal spores, which begin to rot the interior. It is therefore not surprising that hollows within trees take considerable time to form and that large hollow bearing trees are usually old. Once a cavity has begun to form, it is sometimes enlarged by fire which, whilst it may not always destroy the tree, can burn out the central section by charring and 'chimneying' (Bird Observers Club, 2004)

There is a growing shortage of tree hollows in Australia, which are suitable for the nesting, roosting and denning requirements of native fauna. Availability of nest hollows may be one of the factors limiting distribution and density of some species. Substantial clearing of this habitat resource has the potential to push many of the local species below threshold levels at which populations can be sustained.

It is therefore recommended that as many as possible of the hollow bearing trees be retained within any future urban development proposal.

## 5.2

*HABITAT FRAGMENTATION AND CORRIDORS*

Habitat corridors are integral to providing linkages to remnant areas of vegetation while also contributing to essential ecosystem functioning required for sustaining biodiversity. Corridors promote opportunities for fauna movement and long term viability of species as they minimise the effect of isolation of small remnant patches of vegetation.

**Table 5.1** *Summary of Ecological Constraints in the Study Area*

Habitat Type	Conservation Value	Threatened Fauna Species Habitat	Corridor Function
H	High	Moderate-High	Moderate
DB	Moderate-High	Moderate-High	High
BB	Moderate-High	Moderate-High	High

H: Heath  
 DB: Dry Blackbutt open forest  
 BB: Blackbutt Bloodwood/Apple Gum

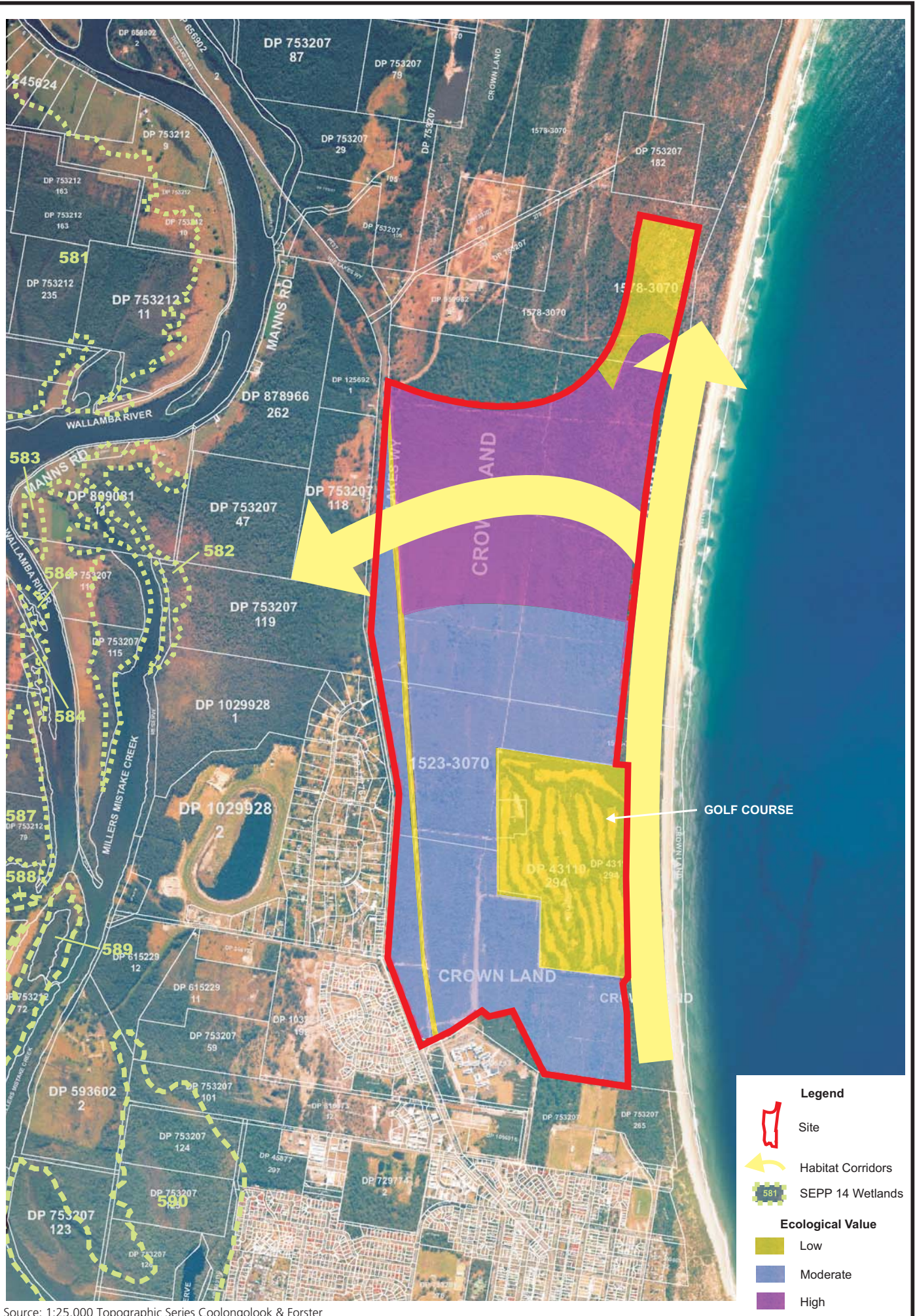
The ecological value of the site has been summarised above (*Table 5.1*) and is based on the conservation value and habitat value of the community as assessed by Great Lakes Council (Vegetation Strategy Volume 2, 2003). The ecological value of the site has been assessed based on the above constraints in addition to the location of communities with regard to significant vegetation corridors immediately beyond the site boundary. The northern area of the site is ranked as high ecological value based on its connectivity to vegetation beyond the eastern and western boundaries of the site and connectivity of open forest habitat within the site.

Moderate ecological value is assigned to the fragmented dry blackbutt community along the western boundary of the site and isolated areas of dry blackbutt community near the southern boundary of the site. The golf course is highly disturbed and is therefore allocated low ecological value. The heath habitat on the northern tip of the site is also disturbed and fragmented and is allocated low ecological value.

The site forms part of a vegetated corridor between shoreline habitat beyond the eastern boundary and forested land between The Lakes Way and two waterbodies Wallamba River and Millers Mistake Creek beyond the western boundary of the site.




Any future development of the site should retain a habitat corridor (*Figure 5.1*) between the coastal vegetation along the east through open forest and heath on site to riparian vegetation beyond the western boundary of the site.








Source: 1:25,000 Topographic Series Coolongolook & Forster

**Legend**

-  Site
-  Habitat Corridors
-  SEPP 14 Wetlands

**Ecological Value**

-  Low
-  Moderate
-  High




0 500m  
Approximate only

Figure 5.1 **Habitat Corridors, SEPP 14 Wetlands & Ecological Value**

The corridor will link coastal vegetation to vegetation of high ecological value within the site (*Figure 5.1*). The high ecological value vegetation will be linked to vegetation immediately west of the site boundary that is associated with Wallamba River and Millers Mistake Creek.

The corridor should be at least 200 metres wide, which is generally accepted as a minimum corridor width to assist in minimising edge effects and other disturbance. This is consistent with advice from DEC for other similar coastal sites.

Additional issues in regards to habitat corridors that should be considered in the design phase of any future urban development include;

- minimise interface to development;
- minimise disruption to corridor continuity;
- the retained vegetation should be bounded by hard edges (eg) roads rather than backyards to prevent encroachment and the narrowing of this habitat corridor; and
- fencing or other barriers to faunal movement should not be placed within the corridors.

### 5.3 *EDGE EFFECTS*

Edge effects would be minimised by the inclusion of a 50 metre wide buffer around any threatened species habitats. Most edge effects disappear over the first 50 metres into a remnant of native vegetation (Murcia 1995). Physical changes that have the potential to occur at the interface between any urban development and natural bushland include changes in soil and water conditions and potentially an increase in light penetration to the understorey. However, this can be prevented through effective rehabilitation and ongoing monitoring and management of the reserves.

### 5.4 *INDIRECT IMPACTS*

Edge effects such as weed incursion and encroachment were evident within the site, particularly where previous disturbances have occurred. Weed invasion into low nutrient environments is a potential issue. It is recommended that a weed management plan be produced for the construction and post-construction phases of any urban development on site.

The site will have to have adequate sediment, erosion and stormwater management measures implemented within the construction and post construction phases of any urban development to ensure that the nearby SEPP



14 wetland (Darawakh Creek and Froggalla Swamp wetland) is not indirectly affected.

Bushfire asset protection zones would also be required from the areas of vegetation recommended for retention.

## 5.5 *CUMULATIVE IMPACTS*

It is difficult to assess the impact of cumulative effects although the clearing of vegetation on site would be recognised as contributing to the reduction of potential habitat attributes within the locality.

## 5.6 *CONSIDERATION OF THREATENED SPECIES*

One of the principle aims of this report was to identify the urban development potential of the site. Restriction of any urban development to avoid direct disturbance of key fauna habitat elements reduces the impact on threatened species identified or likely to occur within the site. Significant fauna habitat elements include habitat trees, winter nectar resources, preferred koala feed trees and wildlife corridors.

It is recommended that;

- a habitat corridor should be protected between the northern and timbered section of the eastern site boundary to retain connection with similar habitat types to the north, east and west. This corridor should be at least 200 metres wide, which is generally accepted as a minimum corridor width to assist in minimising edge effects and other disturbance; and
- threatened species and their habitats recorded within the site following further survey work should be retained where possible.

In order to accurately determine the areas of high conservation significance and the most suitable areas for future urban development the following surveys should be conducted prior to the design stage of any future development or rezoning proposals;

- targeted searches for threatened flora species during the flowering periods as set out in Chapter 3.1;
- terrestrial mammal trapping survey targeting small and medium terrestrial mammals such as the tiger quoll;
- arboreal mammal trapping survey targeting the squirrel glider;
- further surveys for microchiropteran bats (anabat call detection and harp trapping) over three nights during the warmer months;

- further spotlighting surveys over three nights targeting the squirrel glider and grey-headed flying-fox;
- seasonal avifauna surveys (winter and summer); and
- owl call playback.

Following the additional surveys, an eight part test would need to be undertaken to assess the impact of any future urban development to determine whether the development is likely to have any impact on threatened species listed in the TSC Act.

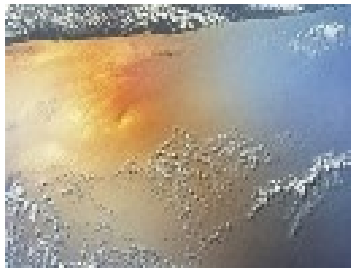
The southern area of the site has the greatest development potential. This area of the site is already disturbed by an existing golf course and associated road accessing the course. Any threatened fauna or flora observed during further field investigations may alter the development footprint.

The northern area of the site is highly constrained by the 200 metre habitat corridor joining the coastal vegetation beyond the eastern boundary of the site with the vegetation associated with neighbouring watercourses (Wallamba River and Millers Mistake Creek) beyond the eastern boundary of the site.

## REFERENCES

- Bennett A F, Lumsden L F, Alexander J S A, Duncan P E, Johnson P G, Robertson P and Silveira C E (1991) **Habitat use by arboreal mammals along an environmental gradient in north-eastern Victoria.** *Wildlife Research* 19: 125-146.
- Davey, S.M. (1993) **Notes on the Habitat of Four Australian Owl Species.** In *Australian Raptor Studies.* Ed. P. Olsen. Australian Raptor Association, Royal Australian Ornithologists Union, Melbourne. pp. 126-142.
- Debus, S.J.S and Rose, A.B. (1994) **The Masked Owl *Tyto novaehollandiae* in New South Wales.** *Australian Birds (supplement)* 28: 40-64.
- Harden G J (Ed.) (2000) **Flora of New South Wales. Volume 1, Revised Edition.** New South Wales University Press.
- Harden G J (Ed.) (2002) **Flora of New South Wales Volume 2, Revised Edition.** New South Wales University Press.
- Harden G J (Ed.) (1992) **Flora of New South Wales. Volume 3.** New South Wales University Press.
- Harden G J (Ed.) (1993) **Flora of New South Wales. Volume 4.** New South Wales University Press, Sydney.
- Lunney, D., Phillips, S., Callaghan, J., and Coburn, D. (1998) **Determining the distribution of koala habitat across a shire as a basis for conservation: a case study from Port Stephens,** New South Wales. *Pacific Conservation Biology* 4: 186-196.
- Menkhorst, P.W., Weavers, B.W., and Alexander, J.S.A. (1988) **Distribution, Habitat and Conservation Status of the Squirrel Glider, *Petaurus norfolcensis* (Petauridae: Marsupialia) in Victoria.** *Australian Wildlife Research* 15: 59-71.
- Murcia, C. (1995) **Edge effects in fragmented forests: implications for conservation.** *Trends in Ecology and Evolution* 10: 58-62
- Murray, M., Bell, S., Hoye, G. (2002) **Flora and Fauna Survey Guidelines: Lower Hunter Central Coast Region 2002.** Lower Hunter and Central Coast Regional Environmental Management Strategy, Callaghan.
- NPWS (2000) **Threatened species of the Lower North Coast of New South Wales.**

ERM consulting services worldwide [www.erm.com](http://www.erm.com)



***Environmental Resources Management Australia***

53 Bonville Ave

Thornton NSW 2322

Telephone (02) 4964 2150

Facsimile (02) 4964 2152