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REVISED ECOLOGICAL ASSESSMENT

Lot 33 DP 1073293
Kirkwood Rd, Tweed Heads South

A Report Prepared for
Proportional Property Investments Ltd

AUGUST 2013

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1 INTRODUCTION

1.1 Background

James Warren and Associates have been commissioned by Michel Group Services Pty Ltd, on behalf of Proportional Property Investments Ltd atf PPI Wholesale Property Unit Trust No. 1. to complete an ecological assessment for Lot 33 DP 1073293, South Tweed Heads.

The assessment has involved the following:

- Mapping and ground truthing vegetation units and determining their conservation status with reference to the Comprehensive Regional Assessment completed for NSW Forest and Non-forest ecosystems as part of the Regional Forestry Agreement (RFA) process (CRA Unit 1999);
- Searching for and recording Threatened (*TSC Act 1995*), ROTAP (Briggs & Leigh 1996) and regionally significant plant species (Sheringham & Westaway 1995), and assessing the occurrence of Endangered Ecological Communities (EECs);
- Determining the suite of Threatened fauna (*TSC Act 1995*) that occurs in the Locality and assessing their potential occurrence in the Study area;
- Assessing habitat provided by the site in relation to adjacent habitat and making an assessment of the corridor value of the site;
- Addressing statutory requirements including *State Environmental Planning Policy No. 44 (SEPP 44 – Koala Habitat Protection)*, Section 5A of the *Environmental Planning & Assessment Act (1979)* and the *Commonwealth EPBC Act (1999)*; and
- Assessment of the conservation values of the SEPP 14 Wetland on the site.

1.2 Locality

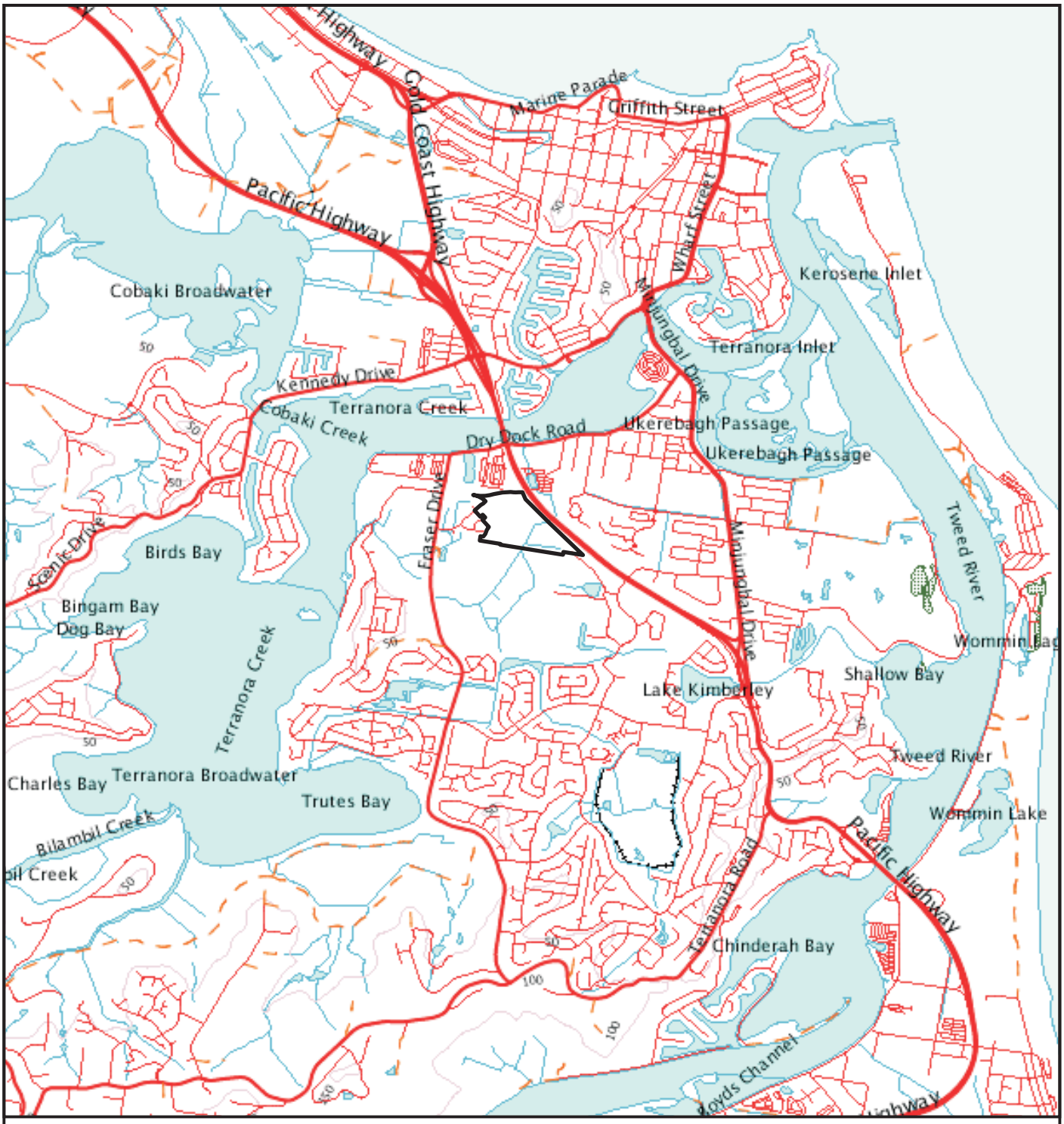
1.2.1 Introduction

The Locality is defined as the area within a 10 kilometre radius of the Subject site. The Locality therefore extends from Kingscliff in the south to Currumbin in the north and from Nicoll Scrub National Park in the west to the coastline in the east (**FIGURE 1**).

Prominent features in the Locality include the towns of Coolangatta, Tweed Heads and Fingal Head, the coastline, Tweed River and its tributaries and Ukerebagh Nature Reserve.

No SEPP (State Environmental Planning Policy) 26 Littoral Rainforest occurs on the site (**FIGURE 2).** An area of SEPP 14 Coastal Wetlands occurs on the eastern portion of the site (**FIGURE 3**).

SOURCE: Brisbane UBD SCALE: 1 : 20 000 @ A4 JWA PTY LTD Ecological Consultants	CLIENT Kirkwood Estates Pty Ltd PROJECT Ecological Assessment Lot 33 DP1073293 Kirkwood Road, Tweed Heads South, NSW Tweed Shire Council LGA	**FIGURE 1** PREPARED: BW DATE: 29 August 2013 FILE: N10017_Locality.cdr	TITLE **LOCALITY PLAN**



Legend

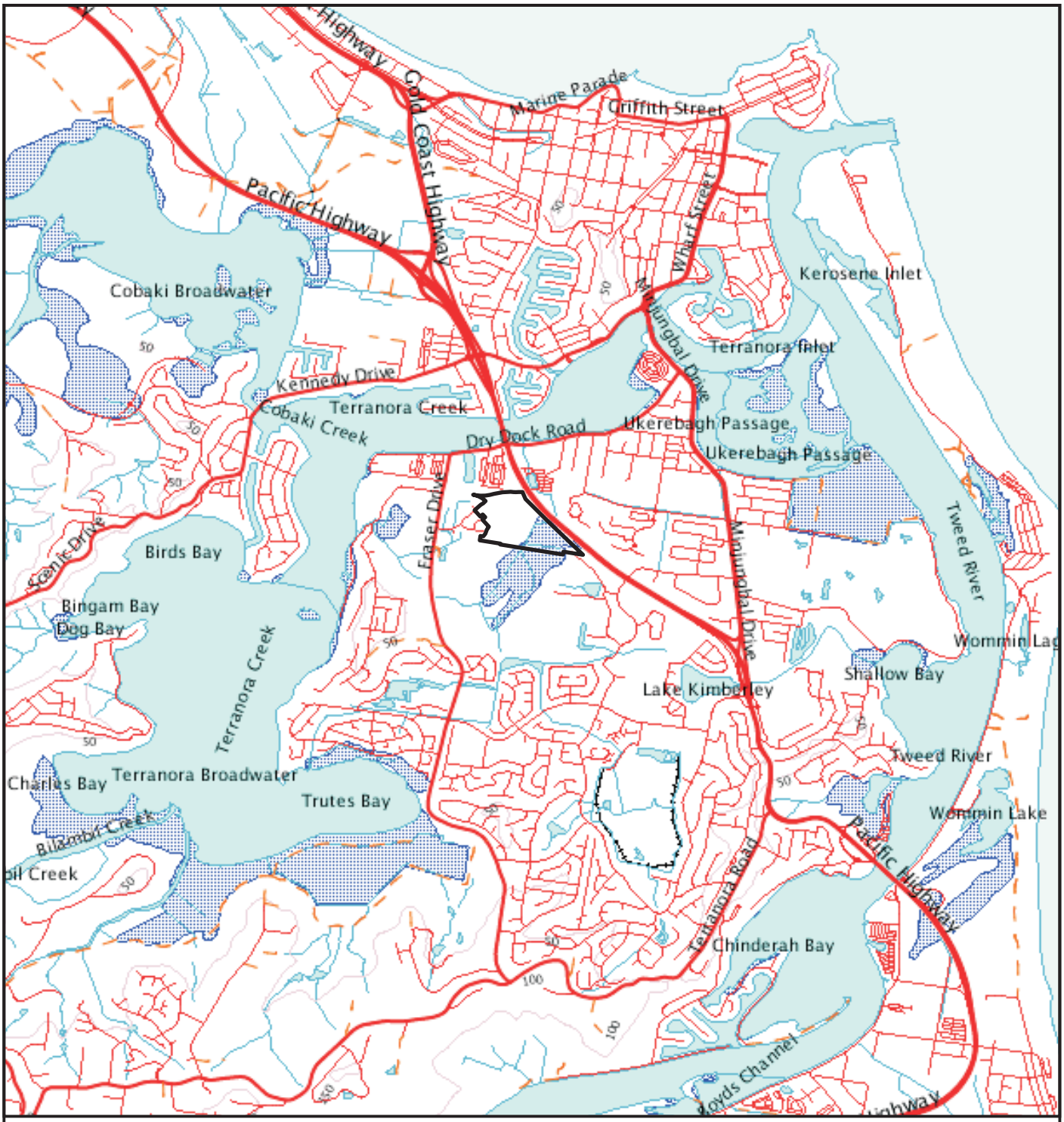
Littoral Rainforest (SEPP26)

Subject Site

N

0 1km

SOURCE: NSW Natural Resource Atlas SCALE: 1 : 40 000 @ A4 JWA PTY LTD Ecological Consultants	CLIENT Kirkwood Estates Pty Ltd PROJECT Ecological Assessment Lot 33 DP1073293 Kirkwood Road, Tweed Heads South, NSW Tweed Shire Council LGA	**FIGURE 2** PREPARED: BW DATE: 29 August 2013 FILE: N10017_SEPP26.cdr	TITLE **SEPP 26 LITTORAL RAINFOREST**



Legend

Coastal Wetlands (SEPP14)

Subject Site

N

0 1km

SOURCE: NSW Natural Resource Atlas SCALE: 1 : 40 000 @ A4 JWA PTY LTD Ecological Consultants	CLIENT Kirkwood Estates Pty Ltd PROJECT Ecological Assessment Lot 33 DP1073293 Kirkwood Road, Tweed Heads South, NSW Tweed Shire Council LGA	**FIGURE 3** PREPARED: BW DATE: 29 August 2013 FILE: N10017_SEPP14.cdr	TITLE **SEPP 14 COASTAL WETLANDS**

1.2.2 The Subject site

The Subject site is described as Lot 33 DP 1073293, Parish of Terranora, County of Rous. The site is located approximately 1.5 kilometres to the south-west of Tweed Heads in the north-east of the Tweed Local Government area (**FIGURE 1**).

The property is approximately 18.02 hectares and is bounded by residential development to the west; Kirkwood Road, residential development, Tweed Heads Rowing and Aquatic Club Sports Centre and Tweed Heads Caravan Park to the north; the Pacific Highway to the east and grazing properties to the south. Terranora Creek is approximately 450 metres to the north of the site **(FIGURE 1).**

The site is characterised by two main terrain units:

- The flat, low lying south-eastern portion of the site is dominated by Paperbark forest; and
- The western and northern portion of the site rises moderately steeply away from the flats to a ridge crest at 40 metres AHD. The ridge is composed of metamorphosed Neranleigh – Fernvale meta-sediments which weather to produce Podzolic soils.

Vegetation is discussed in Section 2 of this report. An aerial photograph of the Subject site is provided in **FIGURE 4.**

1.2.3 The Study area

The Study area is defined as the Subject site together with any proximate areas that may be affected by the Proposed development. The Study area for this assessment was considered to be all areas within 50 metres of the pegged centreline of the Proposed alignment.

1.3 Land use Zones

Under the current Zoning (i.e. Tweed Local Environmental Plan 2000) the majority of the site is zoned 6(b) Recreation with a small area in the south western corner zoned 2(e) Residential Tourist (**FIGURE 5**). A section 88B instrument applies to the site, restricting the use of areas to which it applies (**FIGURE 5**).

1.4 Soils and Geology

The low-lying soils on the Subject site comprise sandy clay topsoils overlying marine sediments. The elevated western portion of the site consists of metamorphosed Neranleigh-Fernvale meta-sediments which weather to produce Podzolic soils.

1.5 The Proposed Development

The River Heights Tourist Park development, comprising 355 apartments is proposed for development on the site (**FIGURE 6**). The expected population of the site at maximum

LEGEND
Subject Site

0 100m
1 : 2500

SOURCE: 2011 Aerial - Michel Group Services (Ref: 8241-30A.pdf & 8241-28.pdf)

SCALE: 1 : 2500 @ A3

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FIGURE 4

PREPARED: BW
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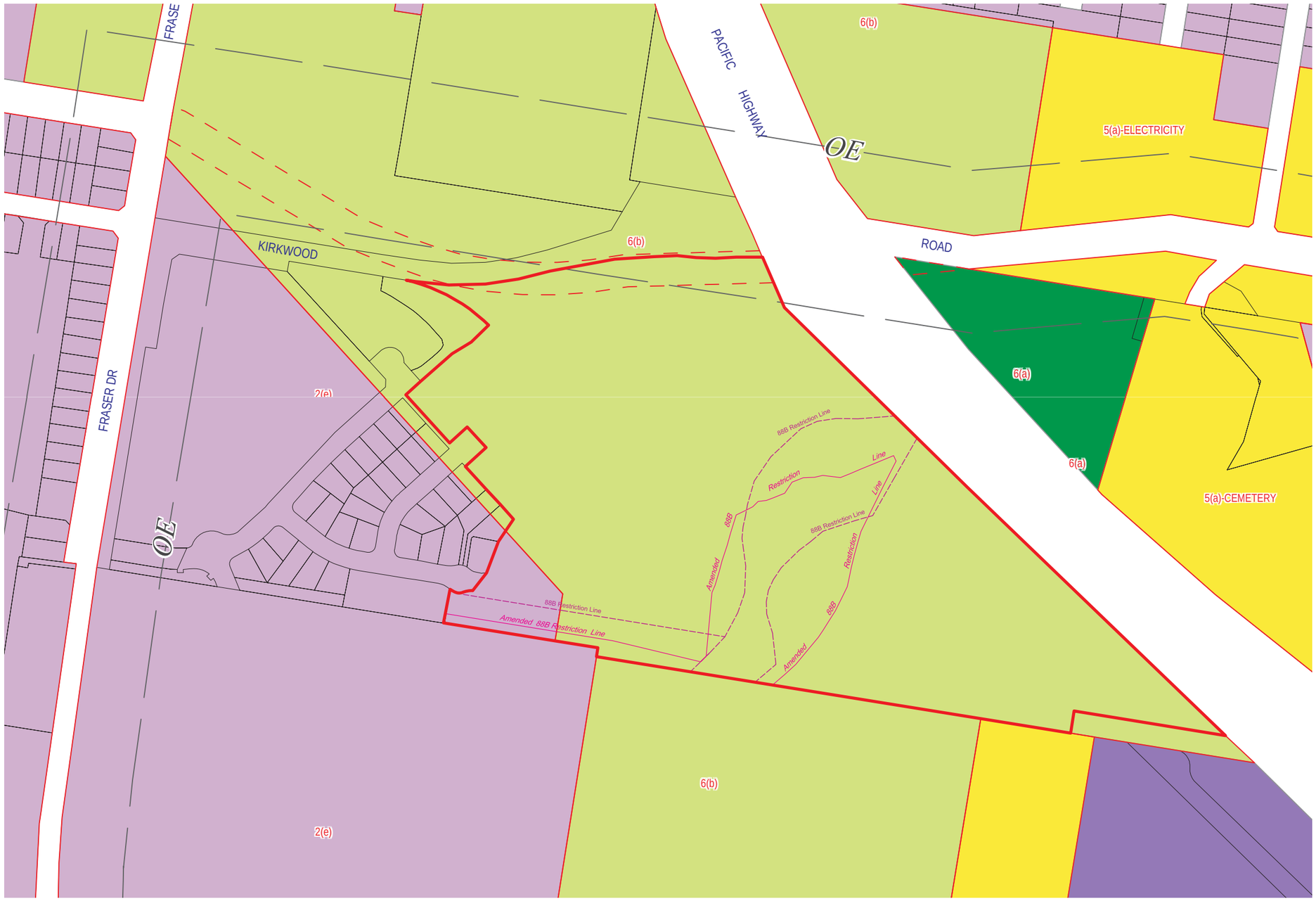
TITLE

AERIAL PHOTOGRAPH



LEGEND

- 2(e) Residential Tourist
- 4(a) Industrial
- 5(a) Special Uses
- 6(a) Open Space
- 6(b) Recreation
- 88B Restriction Line
- Amended 88B Restriction Line
- Subject Site

0 50m 100m

1 : 4000

SOURCE: Tweed LEP 2000 Zoning Plans 6 & 10 Michel Group Services (Ref: 8241-33.pdf)

SCALE: 1 : 4000 @ A3

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FIGURE 5

PREPARED: BW
DATE: 29 August 2013
FILE: N10017_Zones.cdr

TITLE

EXISTING ZONING

LAYOUT LEGEND

TYPE A	1 BED DWELLING - 2 STOREYS
TYPE RV A	1 BED RV SPACE DWELLING - 2 STOREYS
TYPE B	2 BED DWELLING - 2 STOREYS
TYPE RV B	2 BED RV SPACE DWELLING - 2 STOREYS
TYPE C	2 BED DWELLING (ALTERNATIVE DESIGN) - 2 STOREYS
TYPE D	1 BED DISABLED DWELLING - 1 STOREY
TYPE E	2 BED DUPLEX DWELLING - 3 STOREY
B2	ROOFED REFUSE STORE / PICK-UP

DEVELOPMENT DATA

LOT Type	LOT no.s	Dwellings Per Lot	Total
Type A	71	2	142
Type B	32	2	64
Type C	16	2	32
Type D	5	1	5
Type RV-A	22	2	44
Type RV-B	7	2	14
Type E	9	6	54
		TOTAL	355

2 x HOUSES - BAL 19 CONSTRUCTION

TYPICAL BIN ENCLOSURE

0 50m

1 : 1500

SOURCE: Paul Ziukelis Architects
(Ref: Plot_Kirk_A01_Siteplan_09.pdf)

SCALE: 1 : 1500 @ A3

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FIGURE 6

PREPARED: BW
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TITLE

PROPOSED DEVELOPMENT LAYOUT

capacity is 1,038 people. Landscape recreation provisions include communal facilities (BBQ areas, pools etc.), parks (varying sizes) and walking tracks. Two bio-retention basins have been proposed, with one to be situated in the northwest corner of the site and the other to the east of the development within the outer Asset Protection Zone (APZ). Amendments have been proposed for the 88B restrictions as part of the Proposed development (**FIGURE 5**).

1.6 Literature Review

A number of Flora and Fauna Reports and other sources of information were reviewed in the course of this assessment. These include:

- James Warren and Associates (1998) Flora and Fauna Assessment. Lot 9 DP 822830 Fraser Drive Tweed Heads South;
- James Warren and Associates (2010) Constraints Analysis. Lot 33 DP 1073293 Kirkwood Road, Tweed Heads South, NSW;
- Carlile, P. & Mjatelski, P. (2012) River Heights Tourist Accommodation, Kirkwood Road Tweed Heads – Statement of Landscape Intent; and
- Paul Ziukelis Architects River Heights Tourist Accommodation – Concept Design.

2 FLORA ASSESSMENT

2.1 Introduction

This section discusses the methods used in the vegetation assessment and presents the results of the assessment.

2.2 Methods

2.2.1 NPWS Database search

Searches of Wildlife databases (NPWS & DEHWA) were completed (20th July 2012) to generate records of State and Commonwealth Threatened species[1] within a 10 kilometre radius of the Subject site.

2.2.2 Site survey

A survey was completed at the Subject site on the 17th June 2010. Two scientists were present on the site for ½ a day.

All vegetated areas of the Subject site were traversed in a random fashion and a plant species list was compiled. Plant communities were mapped with the aid of an aerial photograph and hand held GPS.

Targeted searches were completed for all Threatened flora species known from the Locality (as recorded in the NPWS database search and literature review) and considered potential occurrences on the site.

2.3 Results

2.3.1 NPWS Database search

A search of the NPWS Database revealed twenty nine (29) Threatened flora species within 10 kilometres of the Subject site (**TABLE 1)**.

TABLE 1
RECORDS OF THREATENED FLORA RECORDED WITHIN 10 KMS OF THE SUBJECT SITE

SPECIES	COMMON NAME	TSC Act	EPBC Act
Acacia bakeri	Marblewood	V	
Acalypha eremorum	Acalypha	E1	
Acronychia littoralis	Scented Acronychia	E1	E
Archidendron hendersonii	White Lace Flower	V	
Bosistoa transversa	Yellow Satinheart	V	V
Cassia brewsteri var. marksiana	Brush Cassia	E1	
Centranthera cochinchinensis	Swamp Foxglove	E1	
Cryptocarya foetida	Stinking Cryptocarya	V	V
Cupaniopsis serrata	Smooth Tuckeroo	E1	
Desmodium acanthocladum	Thorny Pea	V	V
Diospyros mabacea	Red- fruited ebony	E1	E

[1] As listed within schedules of the TSC Act (1995) and EPBC Act (1999).

Diospyros major var. ebenus	Shiny-leaved Ebony	E1	
Diploglottis campbellii	Small-leaved Tamarind	E1	E
Endiandra hayesii	Rusty Rose Walnut	V	V
Endiandra muelleri subsp. bracteata	Green-leaved Rose Walnut	E1	
Geodorum densiflorum	Pink Nodding Orchid	E1	
Grammitis stenophylla	Narrow-leaf Finger Fern	E1	
Grevillea hilliana	White Silky Oak/Yiel Yiel	E1	
Lepiderema pulchella	Fine-leaved Tuckeroo	V	
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V
Niemeyera whitei	Rusty Plum	V	
Ochrosia moorei	Southern Ochrosia	E1	E
Phaius australis	Southern Swamp Orchid	E1	E
Peristeranthus hillii	Brown Fairy-chain Orchid	V	
Randia moorei	Spiny Gardenia	E1	E
Sarcochilus fitzgeraldii	Ravine Orchid	V	V
Sophora tomentosa	Silverbush	E1	
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V
Syzygium moorei	Durobby	V	V

TSC 1995: E1– Endangered; V– Vulnerable
EPBC Act 1999: E– Endangered; V– Vulnerable

2.3.2 Site survey

Six (6) vegetation communities were identified **(FIGURE 7)** and one hundred and twenty (120) plant species recorded. A species list is included as **APPENDIX 1**.

Descriptions of vegetation communities are provided in the following section.

2.3.3 Community descriptions

2.3.3.1 Introduction

Six (6) broad vegetation community types were recorded. The vegetation communities are shown in **TABLE 2**. The conservation status of these communities is discussed with reference to the Comprehensive Regional Assessment completed for NSW Forest and Non-forest ecosystems as part of the Regional Forestry Agreement (RFA) process (CRA Unit 1999). The RFA establishes the framework for the management of the forests of upper north-east and lower north-east regions. The RFA document sets out percentage reservation status of forest and non-forest ecosystems in the CAR Reserve System based on vegetation modelling to establish the pre-1750 extent of forest ecosystems in the region.

The conservation status is also discussed with regard to the Tweed Regional Vegetation Management Plan (Kingston *et al* 1999) and Tweed Vegetation Management Strategy (Ecograph 2004).

KIRKWOOD ROAD

MOTORWAY

36
DP1069519
Drainage Reserve

40
DP1069551
Public Reserve

HARRIER STREET

WREN COURT

FIRETRAIL STREET

3
DP1073293
Public Reserve

3
DP1000385

2
DP59548

2
DP1077990

ROAD 20.115 WIDE

N

LEGEND

- Community 1: Tall closed swamp sclerophyll forest (*Melaleuca quinquenervia*)
- Community 2: Tall open wet sclerophyll forest (*Eucalyptus pilularis*)
- Community 3: Tall closed wet sclerophyll forest/woodland (*Eucalyptus siderophloia* / *Corymbia intermedia* +/- *Lophostemon confertus*)
- Community 4: Mid-high closed forest (*Acacia fimbriata* / *Macaranga tanarius*)
- Community 5: Low open forest (*Melaleuca quinquenervia*)
- Community 6: Low closed grassland with scattered trees
- Higher density of rainforest species
- Stinking Cryptocarya (*Cryptocarya foetida*)
- Subject Site

0 100m

1 : 2500

SOURCE: JWA Site Investigations; Michel Group Services (Ref: 8241-30A.pdf & 8241-28.pdf)

SCALE: 1 : 2500 @ A3

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FIGURE 7

PREPARED: BW
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TITLE

VEGETATION COMMUNITIES

TABLE 2
VEGETATION COMMUNITIES ON THE SUBJECT SITE

1	Tall Closed Swamp Sclerophyll Forest (Broad-leaved paperbark)
2	Tall Open Wet Sclerophyll Forest (Blackbutt ± Brushbox)
3	Tall Closed Wet Sclerophyll Forest/Woodland (Northern grey ironbark)
4	Mid High Closed Forest (*Acacia spp.*)
5	Low Open Forest (Broad-leaved paperbark)
6	Low Closed Grassland with scattered trees

2.3.3.2 COMMUNITY 1- Tall Closed Swamp Sclerophyll Forest (Broad-leaved paperbark)

This community dominates the low-lying areas in the east of the Study area and covers an approximate total area of 4.18 hectares. The canopy of the community is dominated by Broad-leaved paperbark with minor occurrences of Umbrella cheese tree. The midstorey is generally sparse, although midstorey shrubs include Lilly pilly, Creek sandpaper fig and Blue lilly pilly. The understorey is dominated by Harsh ground fern, although there are scattered occurrences of Swamp water fern, Giant sedge and Common reed.

Although Threatened species such as Swamp orchids (*Phaius* spp.) are known to occur in Tall Closed Swamp Sclerophyll Forest (Broad-leaved paperbark) habitats, neither these nor other Threatened or ROTAP species were located in this community.

This community is representative of the Endangered Ecological Community - Swamp Sclerophyll Forest on Coastal Floodplain and by definition is of a high conservation value.

2.3.3.3 COMMUNITY 2 - Tall Open Wet Sclerophyll Forest (Blackbutt ± Brushbox)

This community is situated on steep land in the central southern slopes of the site and covers an approximate total area of 1.6 hectares. The canopy of the community is dominated by Blackbutt, although Brushbox is a very common sub-canopy species on the lower slopes and in the gullies.

Midstorey species include Brush ironbark wattle and Bitter pea. Dense patches of Hopbush in the shrub layer indicate previous disturbance. The lower slopes of the site grade into disturbed rainforest.

A very narrow strip of dense midstorey and understorey rainforest vegetation occurs between the Wet Sclerophyll Forest and Swamp Sclerophyll Forest. This portion of the community includes Hard quandong, Water gum, Umbrella tree and Cheese tree. The

midstorey supports a number of species including Domatia tree, White bolly gum, Blue lilly pilly, Lilly pilly and Three-veined cryptocarya.

One Threatened species was recorded in this portion of the community: Stinking cryptocarya (*Cryptocarya foetida*). The plant is approximately 60cm tall. *This species has been listed on Schedule 2 (Vulnerable) of the TSC Act (1995).*

The most appropriate CRA classification for this community is Forest Ecosystem 34 – (Dry grassy Blackbutt - Tallowwood) with elements of FE 72 (Low Relief Coastal Blackbutt) also occurring. The regional Forestry Agreement provides the following data on FE 34 – (Dry grassy Blackbutt - Tallowwood):

- 6052 hectares of this ecosystem type remains within the upper north east section of the NSW North Coast Bioregion. The original extent (i.e. Pre-1750) was approximately 9880 hectares; and
- The ecosystem is not considered to be Vulnerable or Rare.

The regional Forestry Agreement provides the following data on FE 72 – (Low Relief Coastal Blackbutt):

- 859 hectares of this ecosystem type remains within the upper north-east section of the NSW North Coast Bioregion. The original extent (i.e. Pre-1750) was approximately 1574 hectares;
- The ecosystem is considered to be Rare; and
- The forest ecosystem has been identified as a priority for conservation on private land.

Under the Tweed Vegetation Management Strategy (Ecograph 2004) this ecosystem is classified as Sclerophyll open forest on bedrock substrates – 201 Blackbutt open forest complex. The Tweed Vegetation Management Strategy (Ecograph 2004) provides the following data on this ecosystem:

- This ecosystem covers an area of approximately 6875 hectares (vegetated land), which represents approximately 10.02% of the vegetated land in the shire, and 5.22% of the shire; and
- This ecosystem is inadequately conserved over all of its range.

The conservation status of this community is considered to be low to moderate.

2.3.3.4 COMMUNITY 3 - Tall Closed Wet Sclerophyll Forest/Woodland (Northern grey ironbark)

This community occurs on the higher central western portions of the site and covers an approximate total area of 1.82 hectares. Northern grey ironbark is the most common canopy species. There are secondary occurrences of Pink bloodwood and Forest red

gum (the latter species in one discrete clump). The understorey consists of Swamp turpentine and Acacia species.

The most appropriate CRA classification for this community is Forest Ecosystem 71 - Ironbark. The regional Forestry Agreement provides the following data on FE 71:

- 7,713 hectares of this ecosystem type remains within the upper north east section of the NSW North Coast Bioregion. The original extent (i.e. Pre-1750) was 24,667 hectares;
- The ecosystem is not considered to be Rare, Vulnerable or Endangered; and
- The forest ecosystem has been identified as a priority for conservation on private land.

Under the Tweed Vegetation Management Strategy (Ecograph 2004) this ecosystem is classified as Sclerophyll open forests on bedrock substrates – 202 Grey ironbark/ White mahogany/ Grey gum open forest complex. The Tweed Vegetation Management Strategy (Ecograph 2004) provides the following data on this ecosystem:

- This ecosystem covers an area of approximately 12,820 hectares (vegetated land), which represents approximately 18.68% of the vegetated land in the shire; and
- This ecosystem is adequately conserved.

The conservation status of this community is considered to be low to moderate.

2.3.3.5 COMMUNITY 4 – Mid-High Closed Forest *(Acacia* species)

This community occurs on the higher slopes of the site above the Blackbutt Wet sclerophyll forest and covers an approximate total area of 2.94 hectares. This community is dominated almost exclusively by dense *Acacia fimbriata* to a height of 3 metres, with scattered occurrences of regenerating Blackwood wattle, Pink bloodwood, Brushbox, Swamp she-oak to a height of 9 metres.

Understorey development is very poor. The Ground layer consists of a range of grass species including Carpet grass and Paspalum. Other common grassland weeds are scattered throughout.

The conservation status of this community is considered to be low.

2.3.3.6 COMMUNITY 5 - Low Open Forest (Broad-leaved paperbark)

This community occurs between the more mature areas of Paperbark forest in the eastern portions of the site and covers an approximate total area of 1.53 hectares. The community has been cleared in the past and is now in late stages of regrowth. The

community is dominated by Broad-leaved paperbark with secondary occurrences of Swamp oak.

The conservation status of Broad-leaved paperbark forest has been previously discussed.

This community is representative of the Endangered Ecological Community – Swamp Sclerophyll Forest on Coastal Floodplain and by definition is of a high conservation value.

2.3.3.7 COMMUNITY 6 - Low Closed Grassland with scattered trees

This community occupies the balance of the site and covers a total approximate area of 5.81 hectares. Common species include Carpet grass, Paspalum and Pigeon grass. Common grassland weeds are scattered throughout. Scattered trees include Tuckeroo, White fig and scattered Eucalypts.

The conservation status of this community is considered to be low.

3 FAUNA ASSESSMENT

3.1 Introduction

This section includes a description of the methods used in determining which fauna species use, or are likely to use, the Study area and a discussion of the results of the Fauna assessment. The fauna assessment involved a desktop assessment utilising a data base search for Threatened species recorded within the Locality. An assessment was made of the fauna likely to occur on the Subject site, based on habitat availability. The assessment of available habitat was based on the site vegetation survey. Additionally, a comprehensive fauna survey (i.e. specialised bird, bat and amphibian survey, spotlighting, hair sampling and trapping) was completed.

3.2 Methods

3.2.1 Literature Review

A review of relevant literature and previous fauna surveys in the area was completed.

3.2.2 NPWS Database Search

Searches of the NPWS and EPBC databases were completed (March 2013) to find records of State and Commonwealth Threatened species[2] within 10 kilometres of the Subject Site.

3.2.3 Fauna survey

3.2.3.1 Introduction

A detailed fauna survey was completed on the 25th & 26th of March, between the 13th and 17th of May and on the 27th of May 2013. The weather was generally fine and warm during the survey periods with two days of light rain on the 13th and 14th of May 2013.

3.2.3.2 Survey Techniques

Detailed fauna surveys were designed to target threatened species identified as occurring in the Study area. The subject site was stratified based on three separate vegetation communities:

- Community 1: Tall closed swamp sclerophyll forest;
- Community 2: Tall open wet sclerophyll forest; and
- Community 3: Tall closed wet sclerophyll forest/ woodland

[2] As listed within schedules of the *TSC Act (1995)* and *EPBC Act (1999).*

The following survey techniques were utilised in each of the above stratification units where possible in this assessment.

Opportunistic Sightings
The 'random meander' technique (Cropper 1993) was used to traverse the site. All incidental records of fauna utilising the study area were recorded.

Active Searching
Logs, sheets of tin, cardboard, bark and leaves were overturned in search of reptiles and amphibians while incidentally traversing the site. Diggings and signs of droppings were searched for. The site was actively searched for scats and bones. Active observation of bird activity was undertaken during the site visits.

Active searching for Mitchell's rainforest snail (*Thersites mitchellae*) was completed during the survey on the 27th May. This involved a diurnal search (two (2) hours by two (2) scientists) identifying and investigating potential shelter sites such as fallen palm fronds, leaf litter and loose bark on trees within and adjacent to swamp/wet sclerophyll vegetation communities. This was followed by a similar search at night (see below for spotlighting methodology).

Type 'A' Elliott Box Traps and Cage Traps
This methodology provides an insight into the size and density of populations of ground fauna which may form a component of the diet of raptors. It also indicates the extent of invasion by exotic species such as the Black rat and the House mouse which allows an assessment of the 'naturalness' of the area to be made.

Three (3) lines of Type 'A' Elliott traps with twenty-five (25) traps in each line were set for a period of four (4) nights for a total of three hundred (300) trap nights. Six (6) cage traps were also deployed for four (4) nights for a total of twenty four (24) trap nights. Six (6) arboreal tree-mounted traps (two (2) Type A and four (4) Type B Ellitott traps) were set for a period of four (4) nights for a total of twenty four (24) trap nights. Both the Elliott traps and the Cage traps were baited with a mixture of rolled oats, honey and peanut butter. Arboreal Elliot traps were also baited with mango pieces. Cage traps were also baited with apple and chicken necks.

Pitfall traps
One (1) pitfall line of three (3) buckets (20 litre) spaced approximately two (2) metres apart (incorporating drift fencing) was set for a period of four (4) nights. The relatively short spacing between buckets was necessary due to limited opportunities for the use of pitfall traps. A total of 12 bucket nights were achieved during this component of the Study. Pitfall traps were unable to be set in the Swamp sclerophyll forest due to the high water table.

Hair Tubes
Three (3) lines of eight (8) hair tubes each were placed on the site. Each hair tube was baited with rolled oats, honey, and peanut butter and then set for a period of four (4) nights for a total of ninety-six (96) trap nights. Hair samples collected were analysed by Barbara Triggs.

Call playback techniques
Call playback was carried out over three (3) nights at various locations throughout the site for a period of one (1) hour. Target species included:

- Pale-vented bush hen;
- Powerful owl;
- Barking owl;
- Masked owl;
- Sooty owl;
- Marbled frogmouth;
- Southern boobook;
- Koala;
- Sugar glider;
- Squirrel glider;
- Yellow-bellied glider; and
- a range of amphibians including Wallum froglet, Wallum sedge frog, Tusked frog and Green thighed frog.

Calls were broadcast for approximately one (1) minute and then followed by a five (5) minute listening period.

Diurnal bird surveys
Diurnal birds were surveyed by two (2) scientists by habitat search, using visual and aural cues, as follows, for a total of four (4) hours (times are EST):

- 14th May: 0800–0900 h (1 hr; dry); and
- 15th May: 0800–0900 h (1 hr; dry)

Birds were also surveyed opportunistically during all other fauna surveys and site visits.

Harp Netting
Two (2) Harp traps were set in potential bat flyways. One trap was set for three (3) nights while the other was set for two (2) nights. Flyways were chosen on the basis of adequate cover on both sides of the trap, and screening was incorporated to enhance capture success. A harp trap was located between Vegetation Communities 1 and 2, and in Community 3. An overall total of five (5) trap nights was achieved in this component of the Study.

Anabat Recording
An Anabat II sonar detector (Titley Electronics) was used to record the ultrasonic calls of Microchiropteran bats. Recording was undertaken for 2.5 hours per night over two (2) nights. A total of 5 hours of recording was undertaken. Recording times commenced from slightly after dusk. Recording was undertaken by positioning the Anabat II sonar detector facing across possible bat flyways. Anabat recordings were analysed by Greg Ford of Balance Environmental.

Spotlighting
Spotlighting was undertaken on two consecutive nights by two (2) scientists for one (1) hour on the 25th and 26th March. A separate spotlight survey, targeting Mitchell's rainforest snails was completed on the 27th May for two (2) hours by two (2) scientists. A total of eight (8) hours equivalent spotlighting was completed. The weather for the spotlighting surveys was generally fine and warm with some very slight showers on the night of the 27th May.

Nocturnal fauna were surveyed by spotlight-walking on and adjacent to the track system that traverses through the site. The separate survey for Mitchell's rainforest

snail was completed within and adjacent to swamp/wet sclerophyll vegetation communities. Spotlighting was carried out using 50W spotlights powered by a 12V battery and 200 lumens Led lensor® torches. The observers walked at approximately 1km/h allowing intensive listening as an adjunct to visual detection.

Summary of survey effort
A summary of the survey effort and comparison with the suggested minimum effort detailed in the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004) is provided in **TABLE 3.**

TABLE 3
SUMMARY OF SURVEY EFFORT

Method	Survey Effort	Guideline (DEC 2004)
Elliott trapping	300 trap nights	100 trap nights per stratification unit
Cage traps	24 trap nights	24 trap nights per stratification unit
Pitfall traps	12 trap nights	24 trap nights per stratification unit
Hair tubes	96 trap nights	40 trap nights per stratification unit
Call playback	2 nights (2hrs)	5min call broadcast followed by 10min listening period for each target species
Bird survey	Targeted diurnal surveys, 7 days opportunistic records	Not yet resolved but likely that a species-time curve approach should be utilised for surveying diurnal birds.
Harp traps	5 trap nights	4 trap nights over two consecutive nights
Anabat (ultrasonic call recording)	2 nights (5 hours)	Minimum of four hours for two nights
Spotlighting	8 hours	2 x 1 hour and 1 x 2 hour search on three separate nights (two scientists)

3.2.4 Habitat Assessment

Site habitats were assessed to determine their value for native fauna species. This assessment was completed in conjunction with the flora survey **(SECTION 2)** along with a separate survey identifying habitat trees**.** The assessment focused on identifying habitat features associated with Threatened species as well as other native fauna groups. Particular attention was paid to habitat features such as:

- The presence of mature trees with hollows, fissures and/or other suitable roosting/nesting places;
- The presence of Koala food trees;
- The presence of preferred Glossy black cockatoo feed trees (Forest oak and/or Black she-oak);
- The presence of glider feeding scars;
- Condition, flow and water quality of drainage lines and bodies of water;
- Areas of dense vegetation;
- Presence of hollow logs/debris and areas of dense leaf litter;

- Presence of fruiting flora species;
- Presence of blossoming flora species, particularly winter-flowering species;
- Vegetation connectivity and proximity to neighbouring areas of intact vegetation; and
- Presence of caves and man-made structures suitable as microchiropteran bat roost sites.

Each Threatened species known from the locality was regarded as *Likely, Possible* or *Unlikely* to occur on the Subject site based on the occurrence of suitable habitat characteristics (**SECTION 3.3.5**). A rating of *Likely* was given for those species where breeding or high quality habitat is present on the site; a rating of *Possible* was given for those species where suitable foraging or roosting habitat is present on the site; and a rating of *Unlikely* was given for species where no suitable habitat occurs on the site.

3.3 Results and Discussion

3.3.1 Literature Review

The following is a summary of fauna surveys carried out in the area previously:

- Faulks (1989) undertook an analysis of Koala habitat and distribution in Tweed Shire and noted a small dispersed and fragile population in the Bilambil/Piggabeen Road area;

- Public Works Department (PWD) (1991) – Reviving the Tweed- carried out detailed waterbird survey work involving migratory shore birds over summer and winter time periods. The River Management Plan for the lower Tweed estuary contains much survey data. The survey also identified important roosting and foraging areas for waterbirds and shore birds in the lower Tweed estuary. Trutes Bay has been identified as being a major roost site for shore birds and other waders and is also important foraging area for these bird species;

- Warren (1993) – Vintage Lakes- carried out surveys on the western side of Fraser Drive which is a short distance to the south-west of the Study site. This survey identified six (6) Endangered fauna species – Little bent-wing bat, Osprey, Comb crested jacana, Black necked stork, Eastern grass owl and Koala;

- RTA – Piggabeen Road EIS (1993) – undertook survey work contributing to an Environmental Impact Statement in 1985, 1987 and 1992 immediately south of the Cobaki Broadwater. This survey recorded the Black necked stork, Osprey, Freckled duck, Pale-vented bush hen, Rose-crowned fruit dove, Collared kingfisher, Mangrove honeyeater, Koala and Black flying fox;

- Warren (1994) – surveyed the western side of Fraser Drive between the Vintage Lakes site and Trutes Bay. This survey identified five (5) Endangered species –

Greater broad-nosed bat, Common bent-wing bat, Osprey, Koala and Collared kingfisher;

- James Warren and Associates (1995) – carried out fauna surveys in the area of the south-east corner of Fraser Drive and Kirkwood Road. No Threatened Reptiles or Amphibians were recorded and none were considered likely to occur. The Common grass skink, Green tree snake, Common eastern froglet and Cane toad were recorded. Thirty one (31) species of birds and the Threatened (TSC Act) Osprey were also recorded. Rodents included the common black rat, the bush rat and the House mouse. Old Koala scats were also identified. Three (3) species of Microchiropteran bats were recorded: The Little free-tail bat; Large forest bat; and White-striped mastiff bat;

- James Warren and Associates (1998) – undertook fauna surveys on land to the immediate west of the Subject site and recorded four (4) amphibians, three (3) reptiles, fifty-eight (58) birds and seven (7) mammals. Three of these species, the Osprey, Little bent-wing bat; and the Common bent-wing bat are listed as Threatened on the TSC Act (1995).

3.3.2 Results of Database Searches

Searches of the NPWS and EPBC databases revealed records of forty-three (43) significant fauna species within 10 kilometres of the Subject site (**TABLE 3**). Oceanic and coastal species have been omitted from the results as they will not occur on the Subject site.

TABLE 3
RECORDS OF SIGNIFICANT FAUNA WITHIN 10 KMS OF THE SUBJECT SITE

SPECIES	COMMON NAME	TSC Act	EPBC Act
AMPHIBIA			
Crinia tinnula	Wallum froglet	**V**	
Litoria brevipalmata	Green thighed frog	**V**	
Litoria olongburensis	Olongburra frog	**V**	**V**
INVERTEBRATES			
Thersites mitchellae	Mitchell's rainforest snail	E1	CE
BIRDS			
Amaurornis mollicana	Pale-vented bush-hen	V	
Anseranas semipalmata	Magpie goose	V	
Burhinus grallarius	Bush stone-curlew	E1	
Calidris tenuirostris	Great knot	V	
Calyptorhynchus lathami	Glossy black cockatoo	V	
Carterornis leucotis	White-eared monarch	V	
Charadrius leschenaultia	Greater sand-plover	V	M
Coracina lineata	Barred cuckoo-shrike	V	
Daphoenositta chrysoptera	Varied Sittella	V	

SPECIES	COMMON NAME	TSC Act	EPBC Act
Ephippiorhynchus asiaticus	Black necked stork	E1	
Glossopsitta pusilla	Little lorikeet	V	
Haematopus fuliginosus	Sooty oystercatcher	V	
Haematopus longirostris	Pied Oystercatcher	E1	
Hieraaetus morphnoides	Little eagle	V	
Irediparra gallinacea	Comb-crested jacana	V	
Ixobrychus flavicollis	Black bittern	V	
Lichenostomus fasciogularis	Mangrove honeyeater	V	
Lophoictinia isura	Square-tailed Kite	V	
Ninox connivens	Barking owl	V	
Pandion cristatus	Eastern osprey	V	
Ptilinopus magnificus	Wompoo fruit-dove	V	
Ptilinopus regina	Rose-crowned fruit-dove	V	
Puffinus carneipes	Flesh-footed shearwater	V	M
Sterna albifrons	Little tern	E1	
Todiramphus chloris	Collared kingfisher	V	
Tyto longimembris	Grass owl	V	
Tyto novaehollandiae	Masked owl	V	
Xenus cinereus	Terek sandpiper	V	
MAMMALS			
Dasyurus maculatus maculatus	Spotted-tail quoll	V	E
Miniopteru schreibersii oceanensis	Eastern bent-wing bat	V	
Miniopterus australis	Little bent-wing bat	V	
Mormopterus beccarii	Beccari's free-tail bat	V	
Nyctophilus bifax	Eastern long-eared Bat	V	
Phascolarctos cinereus	Koala	V	V
Planigale maculata	Common planigale	V	
Pteropus poliocephalus	Grey-headed flying fox	V	V
Saccolaimus flaviventris	Yellow-bellied sheathtail bat	V	

TSC Act 1995: EA4- Critically Endangered; E1- Endangered; V- Vulnerable
EPBC Act 1999: CE- Critically Endangered; E- Endangered; V- Vulnerable; M- Migratory

3.3.3 Results of fauna survey

3.3.3.1 Amphibians

Six (6) species of amphibian were recorded during site surveys (**TABLE 5**). No Threatened species were recorded. The survey was completed in autumn and during a period of moderate rainfall. Amphibian activity could be expected to be moderate.

TABLE 5
AMPHIBIAN SPECIES RECORDED ON THE SUBJECT SITE

Common name	Scientific name	Method of identification
Cane toad*	*Bufo marinus*	Visual encounter/ Capture
Striped marsh frog	*Limnodynastes peroni*	Call recognition
Southern laughing tree frog	*Litoria tyleri*	Call recognition
Red-backed toadlet	*Pseudophryne coriacea*	Call recognition
Eastern dwarf tree frog	*Litoria fallax*	Visual encounter/ Call recognition
Rocket frog	*Litoria nasuta*	Visual encounter

* Introduced species

3.3.3.2 Reptiles

Four (4) reptile species were recorded during the fauna survey (**TABLE 6**). No Threatened species were recorded. The survey was completed in autumn and during a period of moderate rainfall. Reptile activity could be expected to be moderate.

TABLE 6
REPTILE SPECIES RECORDED ON THE SUBJECT SITE

Common name	Scientific name	Method of identification
Common garden skink	*Lampropholis delicata*	Visual encounter
Carpet python	*Morelia spilota*	Visual encounter
Rough-scaled snake	*Tropidechis carinatus*	Visual encounter
Common tree snake	*Dendrelaphis punctulata*	Visual encounter

3.3.3.3 Birds

Thirty-two (32) bird species were recorded from the subject site. Two (2) threatened species (NSW TSC Act) were recorded. **TABLE 7** lists the bird species recorded during the survey.

TABLE 7
BIRD SPECIES RECORDED DURING THE SURVEY

Common name	Scientific name
Australian brush-turkey	*Alectura lathami*
Australian magpie	*Cracticus tibicen*
Black-faced cuckoo-shrike	*Coracina novaehollandiae*
Southern boobook	*Ninox novaeseelandiae*
Corella	*Corella sp.*
Crested pigeon	*Ocyphaps lophotes*
Eastern osprey#	***Pandion cristatus***
Eastern whipbird	*Psophodes olivaceus*
Eastern yellow robin	*Eopsaltria australis*
Galah	*Eolophus roseicapillus*
Grey fantail	*Rhipidura albiscapa*
Laughing kookaburra	*Dacelo novaeguineae*
Lewin's honeyeater	*Meliphaga lewinii*
Little eagle	***Hieraaetus morphnoides***
Magpie lark	*Grallina cyanoleuca*

Noisy minor	*Manorina melanocephala*
Olive-backed oriole	*Oriolus sagittatus*
Pacific baza	*Aviceda subcristata*
Pied currawong	*Strepera graculina*
Purple swamphen	*Porphyrio porphyrio*
Rainbow lorikeet	*Trichoglossus haematodus*
Red-backed fairy-wren	*Malurus melanocephalus*
Red-browed finch	*Neochmia temporalis*
Spangled drongo	*Dicrurus bracteatus*
Superb fairy-wren	*Malurus cyaneus*
Swamp harrier	*Circus approximans*
Tawny frog mouth	*Podargus strigoides*
Torresian crow	*Corvus orru*
Welcome swallow	*Hirundo neoxena*
Whistling kite	*Haliastur sphenurus*
Willie wagtail	*Rhipidura leucophrys*
Yellow-tailed black cockatoo	*Calyptorhynchus funereus*

bold threatened (TSC Act).
Recorded flying over the site. No nest sites were observed on the subject site.

3.3.3.4 Mammals

Eighteen (18) mammal species were recorded from the subject site (**TABLE 8**). Four (4) Threatened species (NSW TSC Act) were recorded.

TABLE 8
MAMMALS RECORDED DURING THE FIELD SURVEY

Scientific Name	Common Name	Method of Identification
Antechinus sp.^	Antechinus	Hair tube analysis
*Canis lupus**	Dog	Tracks
Chalinolobus gouldi	Gould's wattled bat	Anabat
Falsistrellus tasmaniensis#	**Eastern false pipistrelle**	Anabat
*Felis catus**	Domestic cat	Visual encounter
Isoodon macrourus	Northern brown bandicoot	Capture (Cage)
Miniopterus australis	**Little bent- wing bat**	Anabat
Miniopterus schreibersii oceanensis	**Eastern bent- wing bat**	Anabat
Nyctophilus gouldii	Gould's long-eared bat	Capture (Harp)
Perameles nasuta	Long-nosed bandicoot	Hair tube analysis
Pteropus alecto	Black flying fox	Visual encounter (Spotlight)
Pteropus poliocephalus	**Grey-headed flying fox**	Visual encounter (Spotlight)
*Sus scrofa**	Pig	Wallow and tracks
Trichosurus caninus	Mountain brushtail possum	Capture (Cage)
Trichosurus vulpecula	Brushtail possum	Spotlight, Capture (Cage), Hair tube analysis
Vespadelus pumilus	Eastern forest bat	Anabat
*Vulpes vulpes**	Fox	Visual encounter
Wallabia bicolor	Swamp wallaby	Scats, Visual encounter

* Introduced species, **bold** threatened (TSC Act and/or EPBC Act).
^Probable species - *Antechinus stuartii* (Triggs, 2013).
The probability of this species being present at the study site is relatively low, as it generally occurs at higher elevation in this region. Due to similarities in their call characteristics and the subsequent difficulties in identification, it is possible that other species are potentially responsible for the call recording that has been identified as *Falsistrellus tasmaniensis.* Other species potentially responsible for the calls include *Scotorepens greyii* (low-moderate likelihood of occurrence); *Scotorepens orion* (high likelihood of occurrence); and *Chalinolobus nigrogriseus* (high likelihood of occurrence) (Balance Environmental, 2013).

3.3.4 Habitat Assessment

3.3.4.1 Old growth trees

Old growth trees (both mature canopy trees and those bearing hollows) were mapped across the subject site. These trees are considered to offer valuable resources for a range of wildlife for foraging, shelter, roosting and nesting. The importance of tree hollows for fauna species is well documented with approximately 179 species occurring in NSW forests considered to be hollow-dependent. These include forty-six (46) mammals, eighty-five (85) birds, thirty-two (32) reptiles and sixteen (16) amphibians (Gibbons & Lindenmayer 2002). Forty-three (43) trees >700mm diameter at breast height (DBH) with visible hollows were recorded. Hollow bearing trees occurring on the subject site are chiefly Blackbutt (*Eucalyptus pilularis*) along with some Grey ironbark (*Eucalyptus siderophloia*) and are located predominantly within vegetation community 2. A further one-hundred and twenty-four (124) mature canopy trees were also recorded in which visible hollows were not apparent. However, these trees are considered to offer further habitat resources regardless of the fact that they may not currently contain hollows (**FIGURE 8**).

3.3.4.2 Amphibians

Amphibians occurring in the region are poikilothermic, predominantly insectivorous and generally require free standing water for reproduction, with the exception of two highland genera (*Assa darlingtoni* and *Philoria* spp.) The habitat requirements of most species are unlikely to be determined by forest cover or floristics, but are more strongly influenced by factors such as climate, distance to water bodies, riparian vegetation, hydrological and morphological characteristics of water bodies and the availability of suitable micro-habitat for aestivation and shelter.

The degraded wetlands that occur on the Subject site are likely to provide habitat for commonly occurring amphibian species such as the Green tree frog (*Litoria caerulea*), Eastern dwarf tree frog (*Litoria fallax*) and Common eastern froglet (*Crinia signifera*).

Grasslands provide suitable habitat for a range of Amphibian species, particularly along drainage depressions and soaks. Species commonly encountered in grassland communities include the Common eastern froglet, Eastern sign-bearing froglet (*Crinia parinsignifera*), Striped marsh frog (*Limnodynastes peronii*), Spotted grass frog (*Limnodynastes tasmaniensis*), Eastern dwarf tree frog, Rocket frog (*Litoria nasuta*), Whistling tree frog (*Litoria verreauxii*) and the introduced Cane toad (*Bufo marinus*).

SOURCE: JWA site Investigations; Michel Group Services (Ref: 8241-30A.pdf, 8241-28.pdf & 201017.pdf)
SCALE: 1 : 2500 @ A3

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Ecological Consultants

CLIENT
Kirkwood Estates Pty Ltd

PROJECT
Ecological Assessment
Lot 33 DP1073293
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Tweed Shire Council LGA

FIGURE 8

PREPARED: BW
DATE: 29 August 2013
FILE: N10017_Hollows.cdr

TITLE
LOCATION OF HOLLOW BEARING TREES

The Paperbark communities on the Subject site and adjacent areas would suggest that habitat may occur for the Threatened Acid frog species – Wallum froglet (*Crinia tinnula*).

Species which typically occur in low elevation Rainforest and permanent streams such as the Giant barred frog (*Mixophyes iteratus*) are unlikely to occur at the Subject site.

3.3.4.3 Reptiles

As reptiles are poikilothermic, and predominantly insectivorous or carnivorous, their habitat requirements are less directly determined by vegetation species composition than other taxa which feed directly on plants. Reptile distributions are strongly influenced by structural characteristics of the vegetation, climate and other factors affecting thermoregulation such as shade and availability of shelter and basking sites (Smith *et al* 1994).

The Subject site is likely to represent suitable habitat for commonly occurring reptile species such as the Common garden skink (*Lampropholis delicata*), Friendly sun skink (*Lampropholis amicula*) and Carpet python (*Morelia spilota*).

Development in adjacent areas may have resulted in a proliferation of introduced small mammals such as the House mouse (*Mus musculus*) and Black rat (*Rattus rattus*) which in turn provide prey for snakes such as the Red-bellied black snake (*Pseudechis porphyriacus*), Carpet python, Swamp snake (*Hemiaspis signata*) and Eastern brown snake (*Pseudonaja textilis*).

3.3.4.4 Birds

A number of Forest oaks (*Allocasuarina torulosa*) occur on the Subject site (**FIGURE 9**). These are feed trees for the vulnerable (TSC Act) Glossy black-cockatoo (*Calyptorhyncus lathami*). However, no Glossy black-cockatoos were observed on the site, nor was any evidence of feeding activity such as chewed cones under feed trees.

The Subject site provides suitable habitat for a range of disturbance adapted open country birds such as the Magpie (*Gymnorhina tibicen*), Lewin's honeyeater (*Meliphaga lewinii*), Torresian crow (*Corvus orru*), Magpie-lark (*Grallina cyanoleuca*) and Noisy miner (*Manorina melanocephala*).

Degraded wetlands on the Subject site are likely to generate a substantial food source for insectivorous birds such as the Willie wagtail (*Rhipidura leucophrys*), Grey fantail (*Rhipidura fuliginosa*), Spangled drongo (*Dicrurus bracteatus*), Welcome swallow (*Hirundo neoxena*), etc.

As previously discussed, development of adjacent land may have resulted in a proliferation of introduced small mammals. These small mammals, as well as reptile species on the Subject site, are likely to provide a food resource for various species of

SOURCE: JWA Site Investigations; Michel Group Services (Ref: 8241-30A.pdf & 8241-28.pdf)

SCALE: 1 : 2500 @ A3

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FIGURE 9

PREPARED: BW
DATE: 29 August 2013
FILE: N10017_GBC Food Trees.cdr

TITLE

GLOSSY BLACK-COCKATOO FOOD TREES

diurnal raptors, such as the Black-shouldered kite (*Elanus axillaris*), Brown falcon (*Falco berigora*) and Whistling kite (*Haliastur sphenurus*), as well as for nocturnal raptors such as the Barn owl (*Tyto alba*).

The degraded wetlands occurring on the Subject site may provide habitat for crepuscular species such as Rails and Crakes however disturbance by the surrounding developed areas (i.e. Pacific Highway) is considered likely to preclude any migratory waders.

Paperbark communities on the Subject site, as well as the SEPP 14 Wetland, are likely to provide a forage resource for nectarivorous birds such as the Rainbow lorikeet (*Trichoglossus haematodus*), Scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*), Scarlet honeyeater (*Myzomela sanguinolenta*), Eastern spinebill (*Acanthorhynchus tenuirostris*) and White-eared Honeyeater (*Lichenostomus leucotis*).

Patches of regrowth rainforest vegetation and scattered mature trees on and adjacent to the Subject site may provide forage resources for frugivorous birds, particularly scattered mature Figs.

3.3.4.5 Mammals

Small terrestrial mammals generally occur in highest densities in association with a complex vegetation structure. A dense understorey layer, which provides shelter from predators and provides nesting opportunities, is particularly important. Again, as previously discussed, residential and commercial use of adjacent land may have been likely to result in a proliferation of introduced small mammals.

In general, medium-large terrestrial mammals such as macropods select habitats which provide a dense cover for shelter and refuge and open areas for feeding. The larger species tend to occupy drier, more open habitats. The smaller species prefer moister and more densely vegetated habitats.

All arboreal mammals that occur in the region (with the exception of the Koala) utilise tree hollows for nesting and shelter (although the Common ringtail possum is not dependent on hollows). Smith & Lindenmeyer (1988) consider that shortage of nest hollows is likely to limit arboreal mammal populations where density of hollow bearing trees is less than two (2) to eight (8) trees per hectare.

Insectivorous bats (like insectivorous birds) overlap considerably in diet and broad vegetation preferences (Hall 1981), but specialise in foraging in specific layers or substrates within the forest (Crome and Richards 1988). The Study area is likely to provide forage habitat for a relatively high diversity and abundance of insectivorous bats, due to the combination of open, forested and denser areas of vegetation. The site provides a number of flowering species and mature fig trees and represents suitable foraging habitat for the Commonwealth Threatened species Grey-headed flying-fox (*Pteropus poliocephalus*). Hollow bearing trees on the subject site are likely to provide roosting habitat for bat species that utilise hollows.

3.3.5 Threatened species considered possible occurrences in the Study area

Based on the assessment of habitats in the Study area, Threatened fauna species known from the Locality were assessed for the likelihood of their occurrence. Species considered possible occurrences on the site are listed in **TABLE 4.**

TABLE 4

SIGNIFICANT FAUNA CONSIDERED POSSIBLE OCCURRENCES ON THE SITE

Species	Likelihood of occurrence in the Study area	Notes
Australasian bittern (*Botaurus poiciloptilus*)	**Possible**	The Australasian bittern inhabits freshwater wetland, occasionally estuarine and prefers heavy vegetation such as flooded shrubbery, reed beds and sedges. Solitary pairs breed in deep, densely vegetated swamps building a large, rough platform of sticks and reeds just above water level, typically in shrubs standing in water within screening reed beds. Suitable habitat may occur adjacent to and across the site, particularly within SEPP 14 Wetland No. 23.
Barking Owl (*Ninox connivens*)	**Possible**	The Barking owl is widely distributed throughout Australia, occurring primarily in woodlands but also in forests and partially cleared areas including urban areas. It typically inhabits areas dominated by eucalypts or paperbarks and roosts in large trees including rainforest, Casuarina, Allocasuarina, Eucalypt, Angophora or Acacia species near watercourses or wetlands. It breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands. Suitable habitat may occur on the site in open wet sclerophyll forests and woodland.
Barred cuckoo-shrike (*Coracina lineata*)	**Possible**	The Barred cuckoo-shrike is generally uncommon and is rare in NSW. This species lives in rainforest, eucalypt forests and woodland, swamp woodlands and timber along watercourses, and wanders nomadically in search of fruit. Possible occurrence but lack of well-developed rainforest habitat would restrict its reliance on the site for foraging purposes.

Species	Likelihood of occurrence in the Study area	Notes
Beccari's freetail bat (*Mormopterus beccarii*)	**Possible**	Beccari's Freetail bat is a very rare species that occurs along the NSW coast, from Tweed Heads to Grafton in the south, and inland west of Moree. It inhabits moist eucalypt forest and rainforest, utilising tree hollows and flaking bark. Open sclerophyll forests and woodland on site could be considered potential habitat for this species.
Black bittern (*Ixobrychus flavicollis*)	**Possible**	The Black bittern has a wide distribution- from southern NSW to northern QLD. It inhabits both terrestrial and estuarine wetlands and where permanent water is present, in forests, woodlands and rainforest. Suitable habitat may occur adjacent to and across the site, particularly within SEPP 14 Wetland No. 23.
Black necked stork (*Ephippiorhynchus asiaticus*)	**Possible**	The Black necked stork inhabits wetlands of coastal and near-coastal areas in northern and eastern Australia. It requires Forest red gum (*Eucalyptus tereticornis)*, Swamp turpentine (*Lophostemon suaveolens)* or paperbarks (*Melaleuca spp.)* for nesting. Suitable habitat may occur adjacent to and across the site, particularly within SEPP 14 Wetland No. 23. All habitats which may be suitable for this species will be retained. Overall, impacts to this species are considered to be relatively low.
Bush stone-curlew (*Burhinus grallarius*)	Unlikely	Bush stone-curlews are found across Australia. They inhabit dry open forests and woodlands, near watercourses or swamps. It is unlikely that this species occurs on the site as open sclerophyll forests and woodlands are predominantly wet.
Collared kingfisher (*Todiramphus chloris*)	Unlikely	The Collared kingfisher is most commonly observed in the Tweed River estuary in NSW. It is virtually restricted to mangroves and other estuarine habitats in Australia, mainly about the mouths of the larger coastal rivers. Suitable habitat does not occur on the Subject site.
Comb-crested jacana (*Irediparra gallinacea*)	Unlikely	This species is found in coastal and sub-coastal northern and eastern Australia. In NSW, populations are localised and scattered. It lives amongst vegetation floating on the surface of slow-moving rivers and permanent lagoons, swamps, lakes and dams. Suitable habitat does not occur on the site. Dams generally have poor vegetation cover.

Species	Likelihood of occurrence in the Study area	Notes
Common blossom bat (*Synconycteris australis*)	Unlikely	Common blossom bats occur in coastal areas of north-east NSW and eastern QLD. They often roost in littoral rainforest and feed on flowers in adjacent heathland and paperbark swamps. Not recorded on this site. The flowering eucalypts and paperbarks on the site could possibly be utilised, however roost habitat (mainly dense rainforest vegetation) does not occur at the site.
Common planigale (*Planigale maculata*)	Unlikely	The Common planigale typically inhabits a wide variety of habitat types including rainforest, sclerophyll forests, grasslands, marshlands and rocky areas (Redhead 1991). The surrounding residential development and associated direct and indirect impacts is likely to preclude the occurrence of this species on the Subject site.
Eastern bent-wing bat (*Mormopterus schreibersii oceanensis*)	**Known**	This species occurs in coastal north-east NSW and eastern QLD. It inhabits moist eucalypt forest, rainforest and dense coastal scrub. It generally occupies caves and tunnels during the day, and may occasionally roost singularly or in small collectives under the bark of mature paperbark trees. Caves are the primary roosting habitat for this species, however it will also use derelict mines, stormwater tunnels, buildings and other man-made structures. It hunts in forested areas, catching moths and other flying insects above the tree tops. This species has been recorded foraging over the Subject site however no significant roosting opportunities are present.
Eastern false pipistrelle (*Falsistrellus tasmaniensis*)	**Possible**	This species occurs from the Great Dividing Range to the coast from south-eastern Queensland to Tasmania. It inhabits sclerophyll forest and generally roosts in eucalypt hollows in colonies of 3 to 36 however, it will also use caves and old wooden buildings. This species prefers habitats where trees are more than 20m high. This species may utilise the Subject site, however it is generally found at higher altitudes in this region.
Eastern freetail bat (*Mormopterus norfolkensis*)	**Possible**	This species occurs along the east coast from south Queensland to southern New South Wales. It inhabits dry sclerophyll forest, woodland, swamp forests and mangrove forests. Generally roosts in tree hollows but will also roost under bark or use man-made structures. Open sclerophyll forests and woodland on the Subject site could be considered potential habitat for this species.

Species	Likelihood of occurrence in the Study area	Notes
Eastern long-eared bat (*Nyctophilus bifax*)	**Possible**	This species occurs from Cape York through eastern QLD to the far north-east corner of NSW. It inhabits lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. This species may occasionally forage over the Subject site however no significant roosting opportunities are present.
Freckled duck (*Stictonetta naevosa*)	Unlikely	The Freckled duck inhabits thickly vegetated freshwater wetlands and open lakes. Less vegetated freshwater and saline lakes and islands are utilised during the non-breeding season. The wetland communities in the low lying portions of the site are not considered to provide suitable habitat for this species.
Glossy black cockatoo (*Calyptorhynchus lathami)*	**Possible**	The Glossy black-cockatoo occurs in coastal woodlands and drier forest areas in association with feed trees, particularly Casuarina species). Feed tree species are present on the Subject site (*Allocasuarina torulosa)* however, no evidence of feeding activity (i.e. chewed cones) have been recorded. There are no records of nesting activity.
Grass owl (*Tyto longimembris*)	Unlikely	The Grass owl occupies coastal heath and grassland across northern Australia (Reader's Digest 1993). In NSW they are more likely to be found in the north-east. Suitable habitat is not considered to occur on the Subject site for this species.
Greater broad-nosed bat (*Scoteanax rueppellii*)	**Possible**	The Greater broad-nosed bat is widespread but has a patchy distribution in coastal and near coastal eastern Australia. It occurs in a variety of habitats including rainforest, dry and wet sclerophyll forest and eucalypt woodland utilising tree hollows, cracks and fissures in the trunk, boughs and exfoliating bark for roosting. This species may occasionally forage over the Subject site and roost in hollow-bearing trees on and adjacent to the Subject site.

Species	Likelihood of occurrence in the Study area	Notes
Green thighed frog (*Litoria brevipalmata*)	Unlikely	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. Breeding occurs following heavy rainfall in late spring and summer, with frogs aggregating around grassy semi-permanent ponds and flood-prone grassy areas. The frogs are thought to forage in leaf-litter. This species may forage in the wetter areas of the Subject site. However this species has not been recorded at the site and is therefore unlikely to occur.
Grey-headed flying fox (*Pteropus poliocephalus*)	**Known**	This species occurs from central eastern QLD south to Vic. In NSW they mainly occur in coastal areas and along river valleys. They typically roost in conspicuous camps in lowland rainforest and swamp forest, often in isolated remnants or on islands in rivers. They forage on fruit, nectar and pollen in rainforests and eucalypt forests. Numerous figs on the site, as well as swamp sclerophyll communities, provide an excellent food resource for this species.
Hoary wattled bat (*Chalinolobus nigrogriseus*)	**Possible**	This species occurs across northern Australia from the Kimberly to Cape York and down the east coast to northern NSW. It inhabits dry open eucalypt forests, open woodland and heathy coastal scrub. They typically roost in eucalypt hollows but have also been found to roost in rock crevices. Open sclerophyll forests and woodland on the Subject site could be considered potential habitat for this species.
Koala (*Phascolarctos cinereus*)	**Possible**	The Koala occurs in eucalypt woodlands and forests throughout eastern Australia. It inhabits areas with appropriate food trees including Forest red gum (*Eucalyptus tereticornis*), Swamp mahogany (E*. robusta*) and Tallowood (*E. microcorys*) species. Food tree species for koala occur on the Subject site for this species.
Large-eared pied bat (*Chalinolobus dwyeri*)	Unlikely	This species occurs from south-eastern Queensland to southern New South Wales from the coast to the western slopes of the Great Dividing Range. It generally inhabits dry sclerophyll forests and woodlands mainly in areas with extensive cliffs and caves. These bats roost in caves and mines. Suitable habitat is not considered to occur on the Subject site for this species.

Species	Likelihood of occurrence in the Study area	Notes
Large-footed myotis (*Myotis macropus*)	**Possible**	The Large-footed myotis is widely but sparsely distributed in coastal regions of eastern Australia. It inhabits areas where native vegetation remains along the coastal plains including forested streams, rivers and estuaries. The Large-footed myotis forages over creeks and other water bodies and roosts in caves, tunnels, under bridges and in tree-hollows. Suitable habitat may occur adjacent to and across the site, particularly within SEPP 14 Wetland No. 23.
Little bent-wing bat (*Miniopterus australis*)	**Known**	This species occurs in coastal north-east NSW and eastern QLD. It inhabits moist eucalypt forest, rainforest and dense coastal scrub. It generally occupies caves and tunnels during the day, and may occasionally roost singularly or in small collectives under the bark of mature paperbark trees. This species may occasionally forage over the Subject site however no significant roosting opportunities are present.
Little eagle (*Hieraaetus morphnoides*)	**Known**	The little eagle is found throughout the Australian mainland. It occurs as a single population throughout NSW occupying open eucalypt forest, woodland and open woodland. One (1) individual Little eagle was observed circling above the Subject site and landing/resting in a tall eucalypt on the site.
Little lorikeet (*Glossopsitta pusilla*)	Unlikely	The Little lorikeet occurs along the east coast of Australia. In NSW they are known to occur in dry, open eucalypt forests and woodlands. Little Lorikeets are considered to be nomadic with influxes of individuals occurring at any time of year, related to tree flowering. No suitable habitat occurs on the Subject site for this species. Open forests onsite are predominately classified as wet.
Long-nosed potoroo (*Potorus tridactylus*)	Unlikely	The Long-nosed potoroo has been recorded from habitat to the north west of the Subject site adjacent to Cobaki Broadwater. Preferred habitat of this species at low elevation (dense coastal heath) does not occur in the Study area and this is likely to preclude the occurrence of this species. The species has a very patchy distribution throughout its entire range and on the basis of current records is considered unlikely to occur at the Subject site.

Species	Likelihood of occurrence in the Study area	Notes
Magpie goose (*Anseranas semipalmata*)	Unlikely	The Magpie goose occurs mainly in coastal and sub-coastal areas of northern Australia. The species is now a rare vagrant in NSW. It generally inhabits open lakes, swamps and permanent wetlands which are dominated by rush and sedge vegetation, with grasslands nearby. Suitable habitat does not occur on the site.
Mangrove honeyeater (*Lichenostomus fasciogularis*)	Unlikely	The Mangrove honeyeater is common in QLD but rare in NSW, where it is known from a few scattered localities, including the Tweed, Richmond and Clarence River estuaries. It primarily inhabits mangroves but also occurs in other near-coastal forests and woodlands, including casuarinas and paperbark swamp forests. Suitable habitat does not occur on the site.
Masked owl (*Tyto novaehollandiae*)	Unlikely	The preferred foraging areas of this species appear to be in open forests with a very sparse or grassy ground cover near creeks or small drainage lines, and near the ecotones between forest and natural or man-made clearings (Kavanagh and Murray 1996). Suitable open forest habitat does not occur at the Subject site and the species is highly unlikely to forage over the playing fields. Nesting occurs at any time of the year with nests constructed in deep vertical tree hollows (tall Eucalypts are favoured) or ledges in caves. Nests are prepared by the male and used for successive years. Although a small number of hollow bearing trees occur at the site, nesting opportunities are limited for this species. Unlikely to occur in the Study area. Habitat and prey source known to occur on the Subject site. There will be some loss of forage resource as a result of the development.
Mitchell's rainforest snail (*Thersites mitchellae*)	Unlikely	This snail is restricted to remnant areas of lowland subtropical rainforest and swamp sclerophyll forest with a rainforest understorey on alluvial soils with a basaltic influence on the coastal plain between the Richmond and Tweed Rivers (NPWS 2000). Although potential habitat occurs on the Subject site, intensive searches failed to locate any individuals or any signs of this species occurring (shells of deceased snails etc.).

Species	Likelihood of occurrence in the Study area	Notes
Olongburra frog (*Litoria olongburensis*)	Unlikely	Olongburra frogs occur in coastal areas from Fraser Island in south-east QLD to Yuraygir National Park in northern NSW. They are usually found amongst sedges and rushes in coastal wetlands such as paperbark swamps and sedge swamps of the coastal "wallum" country. Preferred habitat (i.e. tall sedgeland) does not occur in association with the wetland communities on the Subject site.
Osprey (*Pandion cristatus*)	**Known**	This raptor is thinly distributed in coastal Australia. It nests in singularly overtopping, generally dead trees. The Osprey hunts in coastal rivers, estuaries and streams and may gather nesting material from nearby forests. Whilst this species has been observed flying over the site, suitable habitat or nest sites do not occur on the Subject site.
Pale-vented bush-hen (*Amaurornis moluccana*)	**Possible**	The Bush-hen occurs in coastal northern Australia and through eastern QLD to the NSW north coast. It inhabits a variety of coastal wetlands from mangroves, lagoons and swamps, to river margins and creeks running through rainforest. Suitable habitat is considered to occur within SEPP 14 Wetland No. 23 on and adjacent to the Subject site.
Powerful owl (*Ninox strenua*)	Unlikely	The Powerful owl inhabits open eucalypt forests and may forage along the forest edge. It prefers the gullies of coastal forests where prey densities are often highest and preferred roost trees are common. Powerful owls are nocturnal carnivores, specialising in the predation of moderate to large arboreal mammals such as possums and gliders. Birds and Flying foxes are also taken. In northern NSW, predation appears to focus on Greater Gliders and the owls appearance is often governed by the occurrence of sizeable populations of this mammal. Although a small number of hollow bearing trees occur at the site, nesting opportunities are limited for this species. Greater gliders (the preferred arboreal mammalian prey) do not occur at the site. Suitable habitat in the Locality is greatly restricted and this species is an unlikely occurrence.

Species	Likelihood of occurrence in the Study area	Notes
Rose-crowned fruit-dove (*Ptilinopus regina*)	Unlikely	The Rose-crowned fruit-dove occurs along the coast and the ranges of QLD and eastern NSW. It occurs mainly in subtropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful. The patchy nature of vegetation on the Subject site and relative scarcity of mature rainforest trees is likely to preclude the occurrence of this species.
Spotted-tail quoll (*Dasyurus maculatus*)	Unlikely	The Spotted-tail quoll forages in a broad range of habitats but is more abundant in larger, less disturbed forests. A history of clearing and disturbance by cattle has precluded the occurrence of suitable habitat for this species.
Square tailed kite (*Lophoictinia isura*)	Unlikely	The Square-tailed kite prefers open eucalypt woodland/forest that is rich in passerines but will also forage over partially cleared pastoral land and coastal heath. The Square-tailed kite predates mainly on the fledglings and nestlings of passerines, lizards, rabbits and insects. This species usually forages singly among forests and woodlands at or just above the canopy. Continuous stands of open forest/woodland appear to be favoured by the Square-tailed kite. These may optimise foraging success and minimise expenditure of energy by Kites. The site habitats are generally unsuitable for this species and its occurrence is highly unlikely.
Squirrel glider (*Petaurus norfolcensis)*	Unlikely	The core range of the Squirrel glider is the northern NSW and southern QLD regions. They inhabit hollow-bearing, flowering eucalypt open forests and woodlands with a *Banksia* or *Acacia* shrub layer. Not recorded at the site. This species may utilise the sclerophyll and paperbark communities in the eastern portions of the site, including scattered eucalypts (and other large trees with hollows) in grassland adjacent to these communities.
Varied sittella (*Daphoenositta chrysoptera*)	**Possible**	The Varied sittella are a sendentry species that inhabits eucalypt forests and woodlands, especially rough barked species and mature smooth-barked gums with dead branches, in most of mainland Australia. This species may occur in open sclerophyll forest and woodland on site.

Species	Likelihood of occurrence in the Study area	Notes
Wallum froglet (*Crinia tinnula*)	Unlikely	The Wallum froglet is found in coastal areas from south-east QLD to the central coast of NSW. It is found only in acid Paperbark swamps and sedge swamps of the coastal 'wallum' country. Although suitable habitat potentially occurs within the SEPP 14 wetland on the Subject site no Wallum froglets were detected during amphibian surveys.
White-eared monarch (*Monarcha leucotis*)	**Possible**	This species is restricted to eastern QLD and the NSW north coast. It occurs primarily in coastal rainforest, swamp forest and wet eucalypt forest and appears to prefer forest edges. This species may occasionally forage on the Subject site.
Wompoo fruit dove (*Ptilinopus magnificus*)	Unlikely	This species is found along the coast and coastal ranges from Cape York to the Hunter River in NSW. It occurs in rainforests, low-elevation moist eucalypt forest and brushbox forests. They most often occur in mature forests, but are also found in remnant and regenerating forest. The nature of vegetation on the Subject site and relative scarcity of mature rainforest trees is likely to preclude the occurrence of this species.
Yellow-bellied glider (*Petaurus australis*)	Unlikely	The Yellow-bellied Glider has a patchy distribution but wide range across the eastern and south-eastern coast of Australia. They inhabit hollow-bearing, flowering eucalypt open forests and woodlands. Known to occur in the near Locality. Not recorded at the site. May occur in association with Blackbutt (*Eucalyptus pilularis*) in open sclerophyll forest and woodland onsite. This species may also utilise scattered eucalypts (and other large trees with hollows).
Yellow-bellied sheathtail bat (*Saccolaimus flaviventris*)	**Possible**	The Yellow-bellied sheathtail bat is a wide-ranging species found across northern and eastern Australia. It roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, it flies high and fast over the forest canopy, but lowers in more open country. It forages in most habitats across its very wide range, with and without trees and appears to defend an aerial territory. This species may occasionally forage over the Subject site however no significant roosting opportunities are present.

3.4 Movement Corridors

3.4.1 Local Corridor Value

The site vegetation is isolated from other habitats in the Locality, and is effectively an island of habitat rather than a part of a free-flowing movement corridor. The site is bounded by the Pacific Highway (Tweed Heads Bypass) on the east, and cleared and developed lands to the west, south and north (**FIGURE 1**). Small clumps of vegetation occur on adjacent properties.

There is unlikely to be significant movement of reptiles or amphibians between the site and other habitats. Within the site itself, discrete populations of terrestrial fauna are likely to occur in vegetation clumps. Movements of amphibians are likely to be restricted to drainage depressions, whilst reptiles are likely to only move freely under substantial tree cover.

Terrestrial mammals are also unlikely to move freely between the site and adjacent lands. Like reptiles, small mammals require dense vegetation as cover from predators and are unlikely to regularly cross expanses of cleared land.

Movements of arboreal mammals are likely to be restricted to vegetation which provides for all aspects of the species' lifecycle. For many arboreal mammals, there is a requirement for hollow bearing trees as shelter sites. More common species such as Brush tailed possums will probably move through the site on occasions.

Faulks (1989) notes that "Bilambil Heights and Tweed Heads South contains Koalas. The colony of Koalas at Bilambil Heights occupies the Reserve adjoining the Terranora Broadwater". There appears little likelihood that there would be any movement of Koalas between the Subject site and Bilambil in a northwards direction as the only crossing of the Terranora Creek and Inlet occurs at the Freeway and Highway locations.

The Ukerabagh population occurs approximately 2.5 kilometres to the east of the site. There are pockets of remnant forest remaining in between, however there are high levels of impediments to the movement of Koalas in this direction, i.e. Old Pacific Highway and Brisbane Freeway as well as residential and industrial development. The occasional road kills on the Pacific Highway (R. James pers. comm.) indicates that Koalas are attempting to disperse in a westerly or south-westerly direction from Ukerabagh. The only corridor for Koalas to Bilambil appears to be around the southern and south-western margins of the Terranora Broadwater and in the Bilambil and Piggabeen areas.

It is highly unlikely that a viable breeding Koala population occurs in the immediate Locality, given the amount of survey work carried out on this site and surrounding developments. While surveys currently indicate that Koalas do occur in the area, it is likely that they are dispersing sub-adults (vagrants) looking for a home territory. It is obvious that the area and quality of food trees are not sufficient to sustain a viable population for any length of time in the area. The persistence of Koalas in the Tweed is

wholly dependent upon the maintenance and embellishment of existing breeding populations and the conservation and embellishment of habitat linkages between these areas.

The Subject site may be a stepping stone between larger areas of habitat for mobile species such as birds and bats. The site represents an island of habitat in a local context for terrestrial and arboreal fauna rather than forming a part of a larger movement corridor.

3.4.2 Regional Corridor Value

In a regional context, the Study site cannot be considered a part of a substantial movement corridor. Extensive development in the south Tweed Heads Locality has severed links between the site and other habitats. Remaining vegetation is highly fragmented, isolated and vulnerable to catastrophic events such as fire.

Generally, these habitats are considered likely to support a low diversity and abundance of fauna. Only the more benign species (e.g. Brushtail possums) and edge specialists (e.g. Noisy miner) are likely to subsist in such habitats. Mobile species such as birds and bats are also likely to occur.

Corridors linking coastal lowland habitats with the State Forests and National Parks to the west of Tweed Heads are now disjunct. With the exception of mobile fauna, free movement and genetic exchange between fauna populations is unlikely.

Although the site is unlikely to provide significant habitat in its own right for any nomadic or migratory species of fauna, all remaining forest habitat of reasonable quality may be considered significant in the context of providing a 'stepping stone' between larger and more contiguous areas of habitat for mobile fauna.

4 WETLAND CONSERVATION ASSESSMENT

4.1 Introduction

This section discusses the methods used in the wetland conservation assessment and presents the results of the assessment. The assessment includes consideration of the following characteristics of the wetlands on the Subject site:

- Vegetation extent and condition;
- Presence/absence of Threatened flora & fauna species;
- Hydrological integrity;
- Current management issues; and
- Compliance with SEPP 14 mapping criteria.

4.2 Vegetation extent and condition

Wetland communities occurring on the Subject site (i.e. Community 1 & Community 5) have been discussed in Section 2.3.3 of this assessment. The extent of wetland vegetation on the Subject site occurs in the south-eastern portion of the site and covers a total area of 5.29 hectares (**FIGURE 7**).

The condition of the wetland vegetation on the site is generally quite good. Whilst large areas of the Subject site are comprised of taxa consistent with high levels of disturbance, the wetland community is typical of high quality freshwater wetlands on coastal floodplains on the Tweed Coast. There are occurrences of Lantana (*Lantana camara*) and other woody weeds on the fringes of the wetland communities, however, the wetlands themselves are generally weed free.

Vegetation communities, which form the wetland on the Subject site, are representative of the Endangered Ecological Community – Swamp sclerophyll forest on coastal floodplain (as listed within schedules of the *TSC Act 1995*).

4.3 Threatened flora & fauna species

No Threatened flora species were recorded from the wetland on the Subject site. One (1) Threatened flora species – Stinking cryptocarya - has been recorded from the site and occurs within a rainforest dominated portion of the wet sclerophyll forest to the immediate north of the wetland (**FIGURE 7**).

One (1) Threatened fauna species was recorded from the wetland on the Subject site – Grey-headed flying-fox. Based on the results of the habitat assessment, and historical

records from the vicinity of the site, the following Threatened species are considered a possible occurrence within the wetland on the Subject site:

- Australasian bittern (*Botaurus poiciloptilus*);
- Barking owl (*Ninox connivens*);
- Barred cuckoo- shrike (*Coracina lineata*);
- Beccari's freetail bat (*Mormopterus beccarii*);
- Black bittern (*Ixobrychus flavicollis*);
- Black necked stork (*Ephippiorhynchus asiaticus*);
- Eastern bent-wing bat (*Miniopterus schereibersii oceanensis*);
- Eastern freetail bat (*Mormopterus norfolkensis*);
- Eastern long-eared bat (*Nyctophilus bifax*);
- Greater broad-nosed bat (*Scoteanax rueppellii*);
- Koala (*Phascolarctos cinereus*);
- Large-footed myotis (*Myotis macropus*);
- Little bent-wing bat (*Miniopterus australis*);
- Pale-vented bush-hen (*Amaurornis moluccana*);
- Varied sittella (*Daphoenositta chrysoptera*);
- Wallum froglet (*Crinia tinnula*);
- White-eared monarch (*Carterornis leucotis*); and
- Yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*).

4.4 Hydrological integrity

Surface hydrology and water quality are considered to be the most important factors when determining the hydrological integrity of wetland communities and their associated fauna. This is particularly true for the 'acid frogs' which require acidic conditions to breed. Although the Wallum froglet will successfully breed in water displaying a neutral pH reading (i.e. ~ pH 7), breeding is much more successful in acidic waters (i.e. pH <6) as the competition from other native frog species is removed.

The site has been significantly altered over the last century (i.e. clearing and improved drainage) to accommodate farming activities such as dairying and beef cattle. A review of historical aerial photographs as well as previous assessments completed for the Subject site have revealed a likely contraction of permanently inundated areas on the Subject site.

It should be noted that clearing occurred as far back as the early 1900's and the natural drainage patterns were altered, to increase land utilisation when the land was converted from dairying to beef cattle, approximately 50 years ago (Sullivan 1996). The Subject site shows obvious signs of:

- Functional drains;
- Fence lines;
- Paddock differentiation;
- Reclamation;
- Extensive clearing;
- Lack of a natural boundary on at least one side, with bushland, estuary or large waterway;
- Isolation from the waterways of the Tweed River system by existing urban development; and
- Major disturbances from adjacent freeway construction.

Despite these disturbances, the site contains a functioning wetland (in a hydrological and biological sense) and this portion of the site is included in the SEPP 14 mapping.

4.5 Management Issues

4.5.1 Background

It is considered that past clearing and filling operations on the Subject site have impacted upon site wetlands and, potentially, the fauna reliant on them. Wallum froglets are dependent upon specific habitat requirements for breeding, particularly with respect to water quality.

Potential impacts as a result of past disturbance and current management issues identified and are listed below:

- Decline/alteration in water quality (e.g. sediment load, pH, influx of pollutants);
- Alteration to run-off rates;
- Loss or modification of habitat, including introduction of weed species;
- The creation of an isolated meta-population due to habitat fragmentation; and
- Introduction of biological organisms, such as exotic predators/competitors and amphibian diseases (e.g. Chytridiomycosis).

4.5.2 Water quality and hydrology

All acid frogs require free standing water at some stage of their life cycle. Of primary importance to Acid Frogs is the maintenance of water quality (Hines *et al*, 1999) and possibly acidic conditions i.e. less than pH 7 (Lewis 1996). In general, the acidity of water bodies within wallum communities ranges between pH 3.6 to 6.0 (Myer *et al*, 2006). These acidic conditions result in reduced competition from other native frogs.

Acidification within wallum communities occurs due the natural acidification processes resulting from leaching of acid sulphate soils and/or release of humic acids from the breakdown of organic matter such as tannins and lignins.

Increased and/or altered stormwater flows have the potential to adversely impact on Wallum froglet populations through variations in other physio-chemical indicators of water quality. Of particular note are high salinity levels, high pH levels (i.e. neutral pH that allows the colonisation of ecological competitors), consistently low levels of dissolved oxygen and consistently high levels of electrical conductivity.

4.5.3 Weeds

Whilst the wetland community on the Subject site is generally free of exotic plant species, weeds are generally dominant throughout the remainder of the site. This may pose a threat to the wetland communities particularly during drought periods when the extended dry conditions may allow the colonisation of the wetland communities with terrestrial grasses and woody weeds.

4.5.4 Introduction of Biological Organisms

The proximity of the wetlands to residential areas has the potential to allow the introduction of biological organisms that may directly impact on native species. Domestic pets such as cats and dogs, as well as Cane toads and Mosquito fish (*Gambusia holbrooki*), have the potential to prey on native species. In addition, Chytrid fungus (*Batrachochytrium dendrobatidis*) has been identified to be a potential cause of amphibian population declines in Australia (Berger *et al*, 1998) and may potentially impact on native frogs within the wetland.

Cane toads are a generalist species that are able to breed in almost any permanent or temporary water source (including acidic and saline waters) and have no specialised dietary requirements. They have a tough, leathery epidermis, (in contrast to most Australian frogs), which allows them to tolerate water loss up to 50% and variability in ambient temperature. This feature, combined with a tolerance to broad environmental and climatic conditions, has enabled them to occupy a variety of habitats, generally to the detriment of endemic amphibians. Cane toad tadpoles are also known to predate smaller tadpoles of their own or other species (Crossland 1998). Despite their adaptability to the environment, Cane toads prefer habitats with open space, generally avoiding dense ground cover.

The Mosquito fish is a small freshwater fish originally introduced into Australian waterways in the 1920's to control mosquito larvae. This species is recognised as a voracious predator that will feed on other fish (adults and larvae), arthropods and amphibians (tadpoles and eggs). The introduction of this species into the waterways within the site has the potential to permanently exclude amphibians, including Wallum froglets.